PRIME MINISTER'S DEPARTMENT
ECONOMIC PLANNING UNIT

AKADEMI SAINS MALAYSIA



WST 2040

WATER SECTOR TRANSFORMATION

FINAL REPORT

(VOLUME I)



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WATER SECTOR TRANSFORMATION 2040 (WST2040)
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PREFACE

Water is a critical factor for social and economic development with many settlements developing near water sources such as rivers. Changes in landscape, discharging of untreated wastewater and over extraction can affect the "whole ecosystem" balance; hence, the system sustainability.

With rapid development and urbanisation, the Malaysian scenario has increasingly faced water challenges, such as from extreme heavy rainfalls and droughts, floods, pollution and uninterrupted resource supply. The climate change impacts have further exacerbated the situation. With this scenario ramping up and the need for the Integrated Water Resources Management (IWRM) policy implementation established since the beginning of the Eighth Malaysia Plan (8th MP) in 2001, the ASM Water Committee (AWC) was formed in 2008 and its activities and publications culminated in the ASM Publication of 2016 entitled "Transforming the Water Sector: National IWRM Plan – Strategies and Road Map" (NIWRMP). This publication and the AWC's 10 earlier Advisory Reports were reviewed by the Economic Planning Unit (EPU), Prime Minister's Department (JPM). ASM was subsequently invited to be its strategic partner to undertake a study on Water Sector Transformation 2040 (WST2040) to "transform the water sector from an economic enabler into a dynamic economic sector by 2040", with the twin objectives of 1) water security and sustainability and 2) water as an economic opportunity.

The WST2040 Study aims to transform the national water sector by 2040 through the acceleration of IWRM framework adoption, development of globally recognised indigenous technologies, achievement of economies of scale in the water sector and last, last but not least, becoming a regional water industry hub. To achieve this transformation, EPU's Study Terms of Reference (TOR) had identified eight sub-sectors as game changers and key areas to supplement the existing and current knowledge to transform the water sector. The study final reports are presented in nine volumes; Volume I being the Main Report while Volumes II to IX , explain the output of the eight sub-sectors as standalone reports. These are summarised as below:

Volume I – Final Report: This volume is the main volume of study which introduces the background and structure of the WST2040 study, landscape and challenges faced by Malaysia's water sector and ultimately, the National Agenda for the Transformation of the Water Sector 2040. This volume summarises key salient points from the eight standalone reports and highlights the WST2040 roadmap. The roadmap is a guiding tool of strategies over the four Malaysia Plans towards 2040 for the government and policy makers to make informed and evidence-based decisions and plans.

Volume II – Advocacy, Awareness, Capacity Building and Public Participatory Platforms (AACB): This volume focuses on awareness-raising, advocacy and capacity building related to water resources management, which are centred on four clusters, i.e. government, business, community and academia. The main study outputs comprise four separate modules that address each of the four clusters. Volume

II also includes recommendations of AACB programmes for nationwide implementation of all levels of water-related organisations and communities at federal, state and local levels. The AACB roadmap is also given in this volume.

Volume III – Integrated Water Sector Data Centre (IWSDC): This volume highlights the need for Malaysia to establish a single-point reference centre that will provide reliable and quality water data and information, including primary and secondary water-related data. The IWSDC is envisioned to be a vital element in facilitating water research consortia, which is the key to a successful development of a data-driven water sector. The IWSDC roadmap is also given in this volume.

Volume IV – IR4.0 in Various Water Sub-sectors (IR4.0WS): This volume promotes the integration and adoption of IR4.0-based advanced technologies in water resources management towards an evidence-based, efficient and sustainable water sector. A high-tech equipped water sector is a pre-requisite and will provide support and accelerate its position as a dynamic growth engine to ultimately become the regional water industry hub. The IR4.0WS roadmap is also given in this volume.

Volume V – Water-Food-Energy-Nexus (WFE Nexus): This volume centres on the interconnection and roles of water, food and energy in ensuring security and sustainability for the people's and nation's development. It addresses the intricacies and interlinkages of the nexus to allow better balance trade-offs and synergies. The WFE Nexus roadmap is given in this volume.

Volume VI – Virtual Water and Water Footprint (VW&WF): This volume emphasises the need to raise awareness about virtual water (VW) and water footprint (WF) amongst decision makers and the public to ensure better planning, management and consumption of water. It addresses elements, such as calculation of our national VW, establishment of WF inventory for selected economic sectors as well as the incorporation of WF elements in federal and state water governances. The VW&WF roadmap is given in this volume.

Volume VII – Climate Change Impact and Adaptation (CCIA): This volume addresses climate change impacts if the 1.5oC global warming is not arrested. It provides key strategies for strengthening climate change adaptation and leveraging on IWRM and water technologies. CCIA has developed strategic inputs and national strategies to enhance our adaptive capacity and build resilience for the water sector towards adapting to climate change. The CCIA road map is given in this volume.

Volume VIII – Alternative Water Financing (AWF): This volume examines the existing funding mechanisms across the water sector and explores alternative financing mechanisms that are both sustainable and conducive to support the water industry in the long-term. The proposed mechanisms are a holistic system to ensure sustainability of the whole water sector value chain. The AWF roadmap is given in this volume.

Volume IX – Water as an Economic Sector (WES): This volume aims to enable transformation of the national water sector into a competitive economic sector that significantly contributes to the national GDP without jeopardising the sustainability and availability of resources and opportunities for the future generation. It will examine the economic value and viability of the water sector to become a contributor to the national GDP. The WES roadmap is given in this volume.

To make these possible, a special advisory committee was also established to provide insights and strategic advice in preparing the final reports, which comprise the following members:

1. Academician Tan Sri Dato› Ir. Shahrizaila Abdullah FASc – Founding Chairperson of the ASM Water Committee
2. Academician Datuk Fateh Chand FASc – Second Chairperson of the ASM Water Committee
3. Ir. Dr. Salmah Zakaria FASc – Third Chairperson of the ASM Water Committee
4. Mr. Loganathan Ponnambalam FASc – WST2040 Chief Report Writer

In addition, the WST2040 Project Management Committee was formed, which comprise the advisory committee, eight sub-sectoral leads and complimented by four subject matter experts as follows:

1. Academician Datuk Fateh Chand FASc
2. Datuk Dr. Abdul Rahim Nik FASc
3. Dr. Low Kwai Sim FASc
4. Dr. Kalithasan Kailasam

The successful WST2040 implementation hinges on adoption of recommendations put forward by the study, throughout all sub-sectors, across all levels of society and all stakeholders, essentially adopting the "whole-of-government whole-of-society" approach. As the WST2040 implementing Ministry moves forward, new and updated information will be available, and the implementing team is expected to evolve, taking on board the new ideas and measures to ensure sustainability and security of water for the future generation.

On behalf of the WST2040 Project Management Committee, I would like to express my deepest gratitude to EPU, ASM, WST2040 Advisory Committee, PMC Members, Sub-sectoral Chairpersons and Members as well as to all the stakeholders involved in making this study feasible in a timely manner and a step towards transforming the national water sector a reality. My special thanks to the ASM Analysts Team who supported this study, for working very hard and relentlessly for the past 20 months in managing, coordinating and facilitating the study to completion.

Ir. Dr. Salmah Zakaria FASc
Chairperson, Project Management Committee, ASM-EPU WST2040 Study
Chairperson, ASM Water Committee, 2015–2021

LIST OF ACRONYMS

AACB	Advocacy, Awareness, Capacity Building
ABC	Active, Beautiful, Clean
ADB	Asian Development Bank
AFTA	Asian Free Trade Agreement
AGC	Attorney General Chamber
AI	Artificial Intelligence
AKSB	*Air Kelantan Sdn Bhd*
ASEAN	Association of Southeast Asian Nations
ASM	Academy of Sciences Malaysia
ASMA	*Alam Sekitar Malaysia Sdn Bhd*
ATES	Aquifer Thermal Storage for heating and cooling
AWF	Alternative Water Financing
AWRIS	Australian Water Resources Information System
BAKAJ	Badan Kawalselia Air Negeri Johor
BBA	*Bahagian Bekalan Air* (Water Supply Division)
BCM	Billion Cubic Meters
BDA	Big Data Analytics
BERNAS	*Padiberas Nasional Berhad*
BI	Business Intelligence
BKSA	*Badan Kawal Selia Air* (Water Regulatory Body)
BKSAN	*Badan Kawal Selia Air Negeri*
BMP	Best Management Practices
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BOT	Build-Own-Transfer
BPSA	*Bahagian Pengairan dan Saliran*
BPSP	*Bahagian Pengairan dan Saliran Pertanian, MAFI* (Irrigation and Agriculture Drainage Division, MAFI)
BSAH	*Bahagian Pengurusan Sumber Air dan Hidrologi* (Water Resources Management and Hydrology Division)
CAPEX	Capital Expenditure

CAT	Category
CAT-M1	Category M1
CBO	Community-Based Organisation
CBS	Statistics Netherlands
CBWM	Community-Based Water Monitoring
CC	Climate Change
CCIA	Climate Change Impact and Adaptation
CEPA	Communication, Education and Public Awareness
CGM	Climate Governance Malaysia
CGSO	Chief Government Security Office
CIDB	Construction Industry Board Malaysia
CNII	Critical National Information Infrastructure
COE	Centres of Excellence
COVID-19	Coronavirus Disease 2019
CREST	Collaborative Research in Engineering, Science and Technology Centre
CSO	Civil Society Organisations
CSR	Corporate Social Responsibility
CWL	Critical Water Level
DAN	*Dasar Agromakanan Negara* (National Agrofood Policy of Malaysia – NAPM)
DBKL	*Dewan Bandaraya Kuala Lumpur*
DID	Department of Irrigation and Drainage
DIPAN	*Data Industri Perkhidmatan Air Negara*
DIPAN-SMI	*Data Industri Perkhidmatan Air Negara Berserta Spatial Mapping Yang Interaktif*
DLT	Blockchain and distributed Ledger Technology
DOA	Department of Agriculture
DOB	Department of Biosafety
DOE	Department of Environment
DOF	Department of Fisheries
DOSM	Department of Statistics Malaysia
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support System
DTSA	*Data Terbuka Sektor Awam* (Public Sector Open Data)
EC	Edge Computing
EFT	Ecological Fiscal Transfer
EIA	Environmental Impact Assessments
EC	Energy Commission
EoS	Economies of Scale
EPU	Economic Planning Unit
EQA	Environmental Quality Act

ESA	Environmentally Sensitive Area
ESG	Environmental, Social and Governance
ETP	Economic Transformation Plan
FAO	Food and Agriculture Organisation of the United Nations
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FGD	Focus Group Discussion
FMM	Federation of Malaysian Manufacturers
FOIE	Freedom of Information Enactments
FOMCA	Federation of Malaysian Consumer Association
FRIM	Forest Research Institute Malaysia
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEC	Global Environment Centre
GERD	Gross Expenditure on Research & Development
GG Sukuk	Government-Guaranteed Sukuk
GHG	Greenhouse Gas
GIC	Government Investment Corporation
GIS	Geographic Information System
GroW	Big Data Analytics Groundwater
GSM	Geological Society of Malaysia
GTFS	Green Technology Financing Scheme
GTMP	Green Technology Master Plan
GWP	Global Water Partnership
HAM	Hybrid Annuity Model
HEIs	Higher Education Institutions
IADA	Integrated Agriculture Development Area
ICT	Information Communications Technology
ICZM	Integrated Coastal Zone Management
IDM	Integrated Drought Management
IFM	Integrated Flood Management
ILBM	Integrated Lake Basin Management
IMR	Institute for Medical Research
IoT	Internet of Things
IPASA	Centre for Environmental Sustainability and Water Security
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
IR4.0WS	Industrial Revolution 4.0
iSRA	Interstate River Authority
IUWM	Integrated Urban Water Management

IWA	International Water Association
IWK	Indah Water Konsortium
IWRM	Integrated Water Resources Management
IWSDC	Integrated Water Sector Data Centre
JAKOA	*Jabatan Kemajuan Orang Asli Malaysia* (Department of Orang Asli Development)
JANS	*Jabatan Air Negeri Sabah* (Sabah State Water Department)
JAS	*Jabatan Alam Sekitar* (Department of Environment)
JBA	*Jabatan Bekalan Air*
JBALB	*Jabatan Bekalan Air Luar Bandar*
JBANT	*Jabatan Bekalan Air Negeri Terengganu*
JICA	Japan International Cooperation Agency
JKR	*Jabatan Kerja Raya* (Public Works Department)
JKT	*Jabatan Kerajaan Tempatan* (Local Government Department)
JMG	*Jabatan Mineral dan Geosains* (Department of Mineral and Geoscience)
JPBD	*Jabatan Perancangan Bandar dan Desa* (PLANMalaysia)
JPM	*Jabatan Perdana Menteri* (Prime Minister's Department)
JPP	*Jabatan Perkhidmatan Pembetungan* (Sewerage Services Department)
JPS	*Jabatan Pengairan dan Saliran* (Department of Irrigation and Drainage)
JSM	*Jabatan Standard Malaysia* (Department of Standards Malaysia)
JUPEM	*Jabatan Ukur dan Pemetaan Malaysia* (Department of Survey and Mapping Malaysia)
KADA	Kemubu Agriculture Development Authority
KASA	*Kementerian Alam Sekitar dan Air* (Ministry of Environment and Water)
KATS	*Kementerian Air, Tanah dan Sumber Asli* (Ministry of Water, Land and Natural Resources)
KEDA	*Lembaga Kemajuan Wilayah Kedah*
KeTSA	*Kementerian Tenaga dan Sumber Asli* (Ministry of Energy and Natural Resources, formerly known as Ministry of Natural Resources and Environment, NRE)
KETTHA	*Kementerian Tenaga, Teknologi Hijau dan Air* (Ministry of Energy, Green Technology and Water)
KKMM	*Kementerian Komunikasi dan Multimedia* (Ministry of Communications and Multimedia)
KKR	*Kementerian Kerja Raya* (Ministry of Works)
KPI	Key Performance Indices
KPKT	*Kementerian Perumahan dan Kerajaan Tempatan* (Ministry of Housing and Local Government)
KPLB	*Kementerian Pembangunan Luar Bandar* (Ministry of Rural Development)
KSN	*Ketua Setiausaha Negara* (Chief Secretary to the Government)
KWAP	*Kumpulan Wang Persaraan* (Retirement Fund)
kWh	Kilowatt-hour
LADA	Langkawi Development Authority
LAUT	*Lembaga Sumber Air Terengganu* (Terengganu Water Resources Board)
LCA	Life Cycle Assessment
LCD	Litres Per Capita Per Day
LESTARI	Institute for Environment and Development, UKM

LGM	*Lembaga Getah Malaysia* (Malaysian Rubber Board)
LHDN	*Lembaga Hasil Dalam Negeri* (Inland Revenue Board of Malaysia)
LIGS	*Lembaga Industri Getah Sabah* (Sabah Rubber Industry Board)
LPP	*Lembaga Pertubuhan Peladang* (Board of Farmers' Organizations)
LSANK	*Lembaga Sumber Air Negeri Kedah* (Kedah State Water Resources Board)
LTE-M	Long Term Evolution for Machine
LUAS	*Lembaga Urus Air Selangor* (Selangor Water Management Authority)
MADA	Muda Agricultural Development Authority
MAFI	Ministry of Agriculture and Food Industries (formerly known as Ministry of Agriculture (MOA))
MAH	Malaysian Association of Hotels
MAMPU	Malaysian Administrative Modernisation and Management Planning Unit
MAN	*Majlis Air Negara* (National Water Council)
MARDI	Malaysian Agricultural Research and Development Institute
MBSA	*Majlis Biodiversiti & Sumber Air Sabah* (Sabah Biodiversity Centre)
MCM	Million Cubic Metres
MCMC	Malaysian Communications and Multimedia Commission
MCMM	Ministry of Communications and Multimedia Malaysia
MCO	Movement Control Order
MDEC	Malaysia Digital Economy Corporation
MESTECC	Ministry of Energy, Science, Technology, Environment & Climate Change
MET/ METMalaysia	Malaysian Meteorological Department
MGS	Malaysian Government Securities
MGTC	Malaysia Green Technology Centre and Climate Change Centre
MHLG	Ministry of Housing and Local Government
MIDA	Malaysian Investment Development Authority
MIGHT	Malaysian Industry-Government Group for High Technology
MITI	Ministry of International Trade and Industry
MKN (NSC)	*Majlis Keselamatan Negara* (National Security Council)
MLD	Millions of Litres per Day
MOA	Ministry of Agriculture and Agro-based Industry
MOE	Ministry of Education
MOF	Ministry of Finance
MOH	Ministry of Health
MOHE	Ministry of Higher Education
MOHR	Ministry of Human Resources
MOSP	Malaysia Open Science Platform
MOSTI	Ministry of Science, Technology, and Innovation
MOT	Ministry of Transport
MOTAC	Ministry of Tourism, Arts and Culture
MOU	Ministry of Utility

MP	Malaysia Plan
MPC	Malaysia Productivity Corporation
MPIC	Ministry of Plantation Industries and Commodities
MPOA	Malaysian Palm Oil Association
MPOB	Malaysian Palm Oil Board
MSAN	*Majlis Sumber Air Negara* (National Water Council)
MSANg	*Majlis Sumber Air Negeri* (State Water Resources Councils)
MSDN	*Majlis Statistik dan Data Negara* (National Statistics and Data Council)
MW	Magnetic Water
MWA	Malaysian Water Association
MWIG	Malaysian Water Industry Guide
MWT	Magnetic Water Treatment
MYD	Malaysian Youth Delegation
MyDIGITAL	Malaysia Digital Economy Blueprint
MyDRR	Malaysian DRR Platform
MyGDI	Malaysia Geospatial Data Infrastructure
MyGDX	Malaysian Government Central Data Exchange
MYSA	Malaysian Space Agency
*My*STIE	Malaysian Science, Technology and Innovation and Economy 10-10 Framework
MyWAC	Malaysian Water Engineers Action Committee
MyWI	Malaysian Wellbeing Index
MyWP	Malaysian Water Partnership
NADMA	National Disaster Management Agency
NAFAS	National Farmers Organisation
NaFFWS	National Flood Forecasting and Warning System
NAHRIM	National Water Research Institute of Malaysia
NAP	National Agrofood Policy
NATECH	Natural Hazard Triggered Technological Accidents
NAWABS	National Water Balance Management System
NawDac	National Water Data Centre
NB-IoT	Narrowband Internet of Things
NBS	Nature-Based Solutions
NC3	Third National Communication
NCIA	Northern Corridor Implementation Authority
NGO	Non-Governmental Organisation
NGTP	National Green Technology Policy
NIWRMP	National Integrated Water Research Management Plan
NKEA	National Key Economic Area
NKPA	National Key Priority Area
NLCCMP	National Low Carbon Cities Master Plan

NMC	National Management Committee
NRE	Ministry of Natural Resources and Environment
NREB	Natural Resources and Environment Board
NRW	Non-revenue Water
NSP 2021-2025	National Security Policy 2021-2025
NSTIP	National Science, Technology, and Innovation Policy
NTIS	National Technology and Innovation Sandbox
NWC	National Water Council
NWIR	National Water Innovation Roadmap
NWP	Netherlands Water Partnership
NWRP	National Water Resources Policy
NWRS	National Water Resources Study
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OFWAT	Water Services Regulation Authority
OPEX	Operating Expenditure
ORS	Off-River Storage
OSA	Official Secrets Act
PAAB	Pengurusan Aset Air Berhad
PADRN	*Pusat Analitik Data Raya Negara* (National Big Data Analytic Centre)
PAIP	*Pengurusan Air Pahang Bhd* (Pahang Water Management Bhd)
PBAPP	*Perbadanan Bekalan Air Pulau Pinang* (Penang Water Supply Corporation)
PBC	Performance-Based Contract
PBL	Project-Based Learning
PDPA	People's Data Protection Act
PES	Payment for Ecosystem Services
PFI	Private Finance Initiative
PLANMalaysia	*Jabatan Perancangan Bandar dan Desa* (Department of Town and and Country Planning)
PMD	Prime Minister's Department
POME	Palm Oil Mill Effluent
PPP	Public-Private Partnership
PPP	Public Participatory Platform
PRABN	*Pusat Ramalan dan Amaran Banjir Negara* (National Flood Forecasting and Warning Centre)
PUB	Public Utilities Board
RBIMS	River Basins Information Management System
RBMU	River Basin Management Unit
RBO	River Basin Organisation
RDIC	Research, Development, Innovation, and Commercialisation
RENEW	Renewable Energy and Water
RFP	Request for Proposal

RISDA	Rubber Industry Smallholders Development Authority
RISE UTM	Research Institute for Sustainable Environment (RISE), UTM
RMK	*Rancangan Malaysia Ke* (Malaysia Plan)
ROI	Return on Investment
RoL	River of Life
ROV	Return of Value
RTSP	*Rancangan Tempatan Seberang Perai*
RUU	*Rang Undang-Undang*
RWH	Regional Water Hub
RWHS	Rainwater Harvesting System
R&D	Research and Development
SADA	*Syarikat Air Darul Aman*
SC	Securities Commission Malaysia
SCC	Sewerage Capital Contribution
SCP	National Sustainable Consumption and Production
SDG	Sustainable Development Goals
SEADPRI	Southeast Asia Disaster Prevention Research Initiative
SEPU	State Economic Planning Unit
SESB	Sabah Electricity Sdn Bhd
SIRIM	Standards and Industrial Research Institute of Malaysia
SME	Subject Matter Expert
SME	Small and Medium Enterprises
SMSA	*Sistem Maklumat Sumber Air* (Water Resources Information System)
SOP	Standard Operating Procedure
SPAN	*Suruhanjaya Perkhidmatan Air Negara* (National Water Services Commission)
SPV 2030 (WKB 2030)	Shared Prosperity Vision 2030 (*Wawasan Kemakmuran Bersama* 2030)
SRI	Sustainable and Responsible Investment
SSL	Self-sufficiency Levels
ST	*Suruhanjaya Tenaga* (Energy Comission)
STIE	Science, Technology, Innovation and Economy
STP	Sewage Treatment Plant
SWB	Sarawak Water Board
SWMA	Selangor Waters Management Authority
TMDL	Total Maximum Daily Load
TNB	*Tenaga Nasional Berhad*
TNC	Third National Communication
TOR	Terms of Reference
ToT	Training of Trainers
ToT	Technology Development & Technology Transfer
TSM	Tariff Setting Mechanism

TVET	Technical And Vocational Education and Training
UiTM	*Universiti Teknologi MARA*
UKAS	*Unit Kerjasama Awam Swasta* (Public Private Partnership Unit)
UKM	*Universiti Kebangsaan Malaysia*
UM	*Universiti Malaya*
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIMAS	*Universiti Malaysia Sarawak*
UPEN	*Unit Perancang Ekonomi Negeri*
UPM	*Universiti Putra Malaysia*
USM	*Universiti Sains Malaysia*
UTM	*Universiti Teknologi Malaysia*
UUM	*Universiti Utara Malaysia*
VAICE	Vertical Artificial Intelligence Centre of Excellence
VW	Virtual Water
WDM	Water Demand Management
WEI	Water Exploitation Index
WEPLS	Water-Efficient Products Labelling Scheme
WES	Water as an Economic Sector
WF	Water Footprint
WFA	Water Footprint Assessment
WFEN	Water-Food-Energy Nexus
WHO	World Health Organisation
WIF	Water Industry Fund
WQI	Water Quality Index
WRC	Water Research Consortium
WRDC	Water Research and Development Centre
WSI	Water Stress Index
WSIA	Water Services Industry Act
WSM	Water Supply Management
WST2040	Water Sector Transformation 2040
WSP	Water Safety Plan
WTI	Water Technology Innovation
WTP	Water Treatment Plant
WWF	World Wildlife Fund
8i	8i - Internationalisation; Interaction; Institution; Incentives; Infrastructure; Infostructure; Intellectual capital; Integrity

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EXECUTIVE SUMMARY

The Water Sector Transformation Agenda 2040 (WST2040), announced by the YAB Prime Minister of Malaysia during the official launch of the 12th Malaysia Plan (12th MP) on 27 September 2021, aspires to "transform the water sector from an economic enabler into a dynamic economic sector as the future direction of national growth, tapping from the huge global and regional market size of the industry".

The 20-month WST2040 study was commissioned in May 2020 by the EPU to the Academy of Sciences Malaysia (ASM), as its strategic partner, along with the twin objectives of study: (a) water security and sustainability, and (b) water as an economic opportunity. The study involved preparation of a roadmap to transform the water sector by 2040, ,which is to become a dynamic sector that is able to contribute significantly to the GDP of the country as well as provide good quality affordable water to all. This dynamic sector will not only create new jobs, but also facilitate the development of science, technology, innovation, and commercialisation in the water sector.

The Study recognises the National IWRM Plan prepared earlier by the ASM and published in 2016 in a two-volume report titled "Transforming the Water Sector: National IWRM Plan – Strategies and Road Map" targeted then at meeting the UN-endorsed Sustainable Development Goals (SDG) by 2030.

The WST 2040 Study addresses eight additional sub-sectors deemed vital and strategic to empower people in accelerating the implementation of the IWRM Plan; to leverage on the advancements made in STI to enhance capability in data-driven decision making; to ensure sustainable financing; and to develop sustainable infrastructure with cost-effective technology. The eight sub-sector studies are as follows (i) Advocacy, Awareness, Capacity Building and Public Participatory Platforms (**AACB**) (ii) Integrated Water Sector Data and RDIC Centre (**IWSDC**) (iii) IR 4.0 in the various Water Sub-sectors (**IR4.0**) (iv) Water-Food-Energy-Nexus (**WFE Nexus**) (v) Virtual Water and Water Footprint (**VW&WF**) (vi) Climate Change Impact and Adaptation (**CCIA**) (vii) Alternative Water Financing (**AWF**) and (viii) Water as an Economic Sector (**WES**).

Water Sector "Problem Statement"

Problems that are being faced by the Malaysian water sector can be summarised under five focus areas which need to be resolved early so that the envisaged water sector transformation can be achieved by 2040.

- **People**: Lack of ownership/respect for the country's water resources and inadequate participatory platforms, resulting in deteriorating water quality and wastage.
- **Governance:** Fragmented governance of the water sector, at the federal, state and local government levels, leading to marginal implementation of IWRM framework

- **Infrastructure:** Insufficient and unsustainable ageing water infrastructure, lacking resilience to support growth
- **Information:** Difficulty in accessing data, resulting in lack of data-driven and science-based decision-making, restricted by outdated Acts
- **Finance:** Poor financial sustainability of water industry; hence, highly dependent on public funding

WST2040 Strategic Directions

The WST2040, which is to be implemented over 20 years, has laid down a set the strategic directions to be undertaken over four Malaysian Plans as follows, beginning with the launching of the 12th Malaysia Plan (12th MP) on the 27 September 2021:

i) Phase 1 (2021 – 2025): Accelerating implementation of integrated water resources management (IWRM)
ii) Phase 2 (2026 – 2030): Uplifting indigenous technology at par with international standards
iii) Phase 3 (2031 – 2035): Achieving water sector economies of scale
iv) Phase 4 (2036 – 2040): Becoming the regional water industry hub

Phase 1, which begins under the 12th MP, will focus on developing the foundation to enable the initiation of transformation process by accelerating the implementation of integrated water resources management (IWRM), which will be supported by laying special emphasis on five focus areas, namely people (as the driver), governance, information, finance, and infrastructure (as the four enablers).

Water Sector Transformation Vision

Towards ensuring "water security", the Ministry of Economic Affairs had in 2019 proposed the following 6-point **Water Sector Transformation Vision** to be achieved by 2040:

1. Water security so that every Malaysian has access to reliable, sufficient, clean, and quality water supply and sanitation systems at affordable costs
2. Water security for sustainable food production and the environment
3. Viable and economic alternative water sources are available at all times
4. Precision water supply and demand is practised at all levels for better efficiency and sustainability
5. The water sector becomes a vibrant economic sector with a fully competent workforce, contributing to the national gross domestic product GDP, and
6. Every Malaysian is protected from the risk of water-related disasters and the impacts are well mitigated.

The vision achievements will be monitored by a water sector transformation task force[1] (now included as a KPI in the 12th MP under the governance focus area).

For the realisation of the above WST 2040 Vision, the following twin Grand Challenges as well as a set of National Targets were identified as follows:

Twin Grand Challenges

- To ensure nationwide water security and sustainability, in line with global and national targets, and continues to be fulfilled beyond 2040, whereby there will be clean and affordable water supply for all
- To transform Malaysia's water sector from being one of economic enablers to a dynamic economic sector as a growth engine that can contribute to the country's gross domestic product (GDP), generate revenue, increase efficiency in water management as well as to provide enhanced employment opportunities in the water sector and drive the country's science, technology, and innovation in the water arena.

1 This Task Force, as originally proposed in the Governance Focus Area (**MEA, 2019 presentation**), is proposed by this Study to concurrently serve the Majlis Air Negara and the proposed WST2040 National Management Committee, to be chaired by the Chief Secretary to the Government

National Targets

To fulfil the twin grand challenges, the following targets have been identified:

- To ensure increase in effective participation of all stakeholders in planning, decision-making, implementation, monitoring and evaluation through education, public awareness raising, advocacy and capacity building
- To ensure that the Malaysian population is made aware of the importance of rivers and river basins by 2040
- To ensure that water resources with good quality water are available to fulfil the water demand up to 2040 and beyond
- To establish a comprehensive and secure national water data centre to service all water sector stakeholders, including water managers for science-based decision-making
- To ensure a whole-of-government and whole-of-society approach for an optimal return of value on water
- To ensure that impacts of climate-related hazards are considered in water-related development plans
- To use IR 4.0-enabled technologies to promote smart technologies for water management
- To undertake additional water footprint studies and identify optimum water allocation for domestic, industry and agriculture use, and
- To ensure that the water sector becomes a vibrant economic sector with a fully competent workforce, contributing to the national GDP.

Water Sector Declared a National Security Item

In terms of treating the water sector as a national security matter, the **Majlis Keselamatan Negara's National Security Policy 2021 – 2025** (launched by the Right Honorable Prime Minister in July 2021) had placed "Water Security" as its first element under the **Core Value 7 (Sustainable Development)**. It is hoped that MKN will continue to accord the national security status to the water sector in its NSP going forward to 2040 and beyond (Policy details given in Section 2.6).

COVID-19 and Its Impact on the Water Sector

In the light of the COVID-19 pandemic that has impacted the nation, ASM studied its impact on the water sector (Section 2.7). The study concluded that water security is needed to be strengthened in the face of pandemics. When assessing water security issues, the main challenge is to ensure sufficient and good quality water is provided to communities who are exposed to infection, and have to get their water supplies from collection points if there is no piped-in water in rural and areas where water is scarce. Preparedness to the COVID-19 pandemic includes strengthening the resilience of communities from the disease through proactive mitigations.

Water Sector Initiatives by KASA

The KASA paper, submitted to ASM as part of the WST2040 Study and entitled "Water Sector Initiatives by KASA", highlights that "the government implements three continuous efforts to safeguard national water security: 1) ensure water resources sustainability, 2) continuous and sufficient water supply, and 3) demand management" (Section 2.8).

Twelfth Malaysia Plan

The recently launched 12th Malaysia Plan (12th MP), with the objective of 'a prosperous, inclusive, sustainable Malaysia', is in line with the Shared Prosperity Vision 2030 and SDG 2030 targets. The focus until 2025 will be on three key themes, namely (i) *resetting the economy,* (ii) *strengthening security, well-being, and inclusivity* as well as (iii) *advancing sustainability***.** Theme (iii) focuses on advancing sustainability through green growth advancement as well as enhancing energy sustainability and **transforming the water sector.**

The 12th MP (2021 – 2025), has identified two strategic shifts, namely (a) Accelerating implementation of IWRM, and (b) Transforming the water sector from an economic enabler towards becoming a dynamic growth engine for the Water Sector Transformation 2040.

In order to drive the two strategic shifts, five strategies have been proposed in the 12th MP document as follows:

i) Empowering people to drive water sector transformation
ii) Strengthening governance at all levels
iii) Enhancing data-driven decision-making for sustainability
iv) Ensuring sustainable financing
v) Developing sustainable water infrastructure with cost-effective technology

Worthy of note is that the above five strategies stated in the 12th MP document are for all intents and purposes similar to the five focus areas adopted by EPU for the WST 2040 study. In addition, the 12th MP documents "Embracing the Circular Economy" as the 8th Game Changer under Theme 3 of Advancing Sustainability, the same theme which covers Chapter 8 (Advancing Green Growth for Sustainability and Resilience) and Chapter 9 (Enhancing Energy Sustainability and Transforming the Water Sector). The Circular Economy has been addressed by two sub-sectors (Alternative Water Financing and Water an Economic Sector) in their final reports.

WST2040 Sub-Sectoral Studies

Against the above background in regard to the Malaysian water sector and in compliance with the WST2040 study objectives, the ASM Council instituted a study team to undertake the 20-month EPU-sponsored WST2040 study. It comprised a project management committee (PMC) to manage the eight sub-sectoral studies and overseen by a technical committee chaired by an ASM Council member and a steering committee chaired by the Deputy Director-General (Sectoral Division) of EPU. Internal oversight for the study by ASM was provided by STIPAC. The Chair of the PMC and its members who comprise the task force leaders of the eight sub-sectoral studies are all ASM fellows. In addition, there are four other nominated subject matter specialists and a chief writer who are members of the PMC as well as an advisor to the PMC Chair appointed by the ASM Council.

The eight sub-sectoral studies were undertaken in compliance with their respective scope of work as defined in the study terms of reference. They fall under three categories as listed below:

1. **Ensuring Water Resources Sustainability Studies**
   (i) Virtual water and water footprint (VW&WF)
   (ii) Water-food-energy nexus (WFE Nexus)
   (iii) Climate change impact and adaptation (CCIA)

2. **Water as an Economic Opportunity Studies**
   (i) Alternative water financing (AWF)
   (ii) Water as an economic sector (WES)

3. **Enabling Strategy Studies**
   (i) Advocacy, awareness, capacity building and public participatory platforms (AACB)
   (ii) Establishment of integrated water sector data and RDIC Centre (IWSDC)
   (iii) IR 4.0 in the various water sub-sectors (IR 4.0)

In executing the study which began in May 2020[2], the eight sub-sectors had to work under rather restricted conditions bound by SOPs imposed by the Movement Control Order[3] (MCO), totaling nine to date, following the spread and declaration of COVID-19 disease as a national pandemic that began in March 2020. The SOPs were discontinued from 11th October 2021. As a result, only limited face-to-face consultations and visits to various local water-related organisations were possible. It was generally found that the alternatives of holding online meetings instead were less effective and also contributed to some inevitable delays.

2 The EPU-ASM WST 2040 Study Agreement was signed on 10th April 2020. The Study was to be completed in 20 months, by end of 2021.

3 **MCO 1.0** = 18 March 2020 – 3 May 2020; **CMCO** = 4 May 2020 – 9 June 2020; **RMCO** – 10 June 2020 – 13 Oct. 2020; **CMCO** – 14 Oct. 2020 – 12 Jan. 2021; **MCO 2.0** = 13 Jan. 2021 – 4 March 2021; **CMCO** - 5March 2021 - 6 May 2021; **MCO 3.0** = 7 May 2021 – 31May 2021; **FMCO** – 1 June 2021 – 28 June 2021; **EMCO** – 3 July – 16 July 2021; ; **National Recovery Plan** – June 2021 onwards; **Phase 1 SOP –** 17 July onwards; **Inter-state borders opened** – 11 Oct. 2021

Albeit the study was successfully concluded on time and the study report has since been completed, comprising the Main Report and eight sub-sector study reports, which consist of nine volumes.

Conclusions and Recommendations

Conclusions

In Malaysia, there are five basic issues facing the water sector besides the global megatrend challenges that are shaping the world. These issues can best be explained through the essential pillars of good water governance promoted by implementing the IWRM concept. They are the lack of effective water governance, lack of ownership on water, unintegrated and insufficient quality of water data and RDIC, financial constraints and inadequate infrastructure and technology innovation. Moving forward, a vibrant water sector will be recognised as an integral part of both the Wawasan Kemakmuran Bersama (WKB) 2030 and the SDG 2030 to achieve social well-being, environmental sustainability and economic prosperity, leaving no one behind and ensuring water security for all. The water sector will also be regarded as a source for growth of the national economy which will generate income through value-added products and services in the sector via a national agenda on Water Sector Transformation culminating in 2040. Under the12th MP, and besides continuing some of the existing strategies from the 11th MP, focus will be given on building the foundations for the water sector transformation through acceleration of the IWRM framework implementation and ensure water security for all.

Recommendations

Recommendations proposed by the eight sub-sectors (details are given in the individual standalone reports) to overcome the multiple challenges that impact the water sector are described under "general" and across the five focus areas for transformation of the water sector:

A. General

ASM's 8i's Ecosystem Approach to Water Sector Management

This is a recommendation that ASM is forwarding for application not only for the water sector, but also for other similar studies in the future. ASM's 8i's Ecosystem (infrastructure, infostructure, intellectual capital, integrity, incentives, institutions, interactions, and internationalisation) approach to water sector management and the associated 8R-water (Respect water, Rethink the value of water, Reduce wastage, Re-Use water, Recharge Ground Water, Recycle wastewater, Repurpose water for higher value use; and Regeneration of water) and 5S (Safety, Security, Safeguards, Seamless Integration and Sustainable) philosophies are outlined to move the water sector up the socioeconomic value chain (Section 3.3). The 8i-water ecosystem approach is suited to characterise the water sector as a dynamic sector that contributes not only to meet the basic needs, but also the needs of other sectors of the economy, with each of the water ecosystem enablers carefully curating and integrating the 8R-philosophy and the 5S framework to continuously strengthen the water ecosystem, underpinned by the 10-10 *My*STIE framework. Application of the 10-10 *My*STIE within the water sector is expected to help nurture local tech firms to lead the development of catch-up and leap-frogging technologies. In order to be a vibrant and dynamic economic sector, the local water industry must take an international outlook to not only spur knowledge and technology transfer, but also stimulate international trade.

B. People

1) To strengthen the IWRM framework implementation through knowledge and SMART Approach - Public Participatory Platform (PPP) and Environmental Education - Training Modules (based on Quadruple Helix Model) to ensure decision-makers address water issues.
2) To develop and disseminate VW and WF awareness programme and knowledge for public, school and universities, and industries should be carried out to induce lifestyle changes
3) To staff IWSDC with dedicated and talented personnel and equipped with systematic training and capacity building programs via people's participation through the establishment of open science and crowdsourcing

4) To intensify strategic partnerships through quality collaboration between various levels, co-creation and knowledge sharing amongst stakeholders.
5) To undertake wide-ranging capacity building and CEPA on the water-food-energy nexus
6) To enhance public awareness about IWRM and IRBM and their linkages towards addressing disaster risks and climate change impacts by enhancing accessibility of the data and information in time of/ related to drought or flood
7) To improve public awareness about the value of water to save water usage by reducing the national average water usage from 205 litres per capita per day (LCD) in 2020 to 180 LCD in 2025 and 160 LCD in 2030, and thus create public awareness on water conservation and consumption
8) To institute inculcating the 8R's water philosophy amongst the public on respect water, rethink the value of water, reduce wastage, re-use water, recharge ground water (rain harvesting), recycle wastewater, repurpose water for higher value use, and regeneration of water.

C. Governance

1) To consider incorporating policy recommendations which delve on matters pertaining to virtual water and water footprint, data sharing and data centre establishment, implementing IR 4.0-enabled technologies, water-food-energy nexus, groundwater management, disaster risk reduction, competitive tariff/pricing policies, and water trading rules and regulations.
2) To encourage states which have yet to enact contemporary laws for the management of water resources based on **IWRM principles and practices**, to expedite the review and replacement of outdated enactments, some dating back to 1920.
3) To enact '**Freedom of Information Policy'** and the subsequent '**Freedom of Information Law'** to place Malaysia at par with international standards and practices. Such a law is essential for data collection and data sharing in the country.
4) To develop a national policy on IR4.0 for the water sector to facilitate a technologically enabled system of water delivery.
5) To expedite establishment of IWSDC as the national water data hub and serve as a RDIC hub.
6) IWSD Centre to produce independent, annual water accounting reports which will become an essential water governance quantifying tool.
7) To develop a Water Footprint (WF) certification scheme in collaboration with the Department of Standards for water managers.
8) To establish a one-stop centre for WF to disseminate knowledge on virtual water (VW) and water footprint (WF), to get a stronger buy-in from state agencies and double-up as an institutional level platform for industries.
9) For Malaysia to join an international open data alliance such as the Open Government Partnership or Open Data Charter .
10) To form alliances with major international players and consequently assume a leading role in the global WF initiative for international trade agreements and to study the global economic opportunities, drivers, and impacts of WF and VW.
11) To strengthen AACB programmes through strategic alliances with renowned regional and international water research and training centres to enhance leadership skills and capacity in water management.
12) To establish state-level IWRM information centres.
13) To involve parliamentarians in the IWRM and the water sector transformation agenda through the All-Party Parliamentary Group Malaysia (APPGM).
14) To enhance the use of digital governance, aggressively implement IR 4.0 technologies for real time data not only in the management of water resources and services, but also to trouble shoot water disruptions due to pollution and water transmission breakdowns, all of which help address complexities of multiple stakeholder management.
15) To develop an SOP for Crisis Management in the event of major water supply disruptions.
16) The water sector being highly fragmented, recommendations are in place to reorganise the institutional mandates and structure for the water sector to address **WFEN**.
17) Steps should be taken to make **JPS Malaysia the National Water Resources Department** with expanded roles and mandates over cross-sectoral water resources issues.
18) For better coordination of water and sewerage infrastructure works, KASA is working on an amalgamation of its technical departments, JPS, JPP and BBA, into a single technical department.

This amalgamation will not only allow for better optimisation of resources, but also will help in project management, implementation and monitoring in a more effective manner. However, the process will take time as KASA is required to undertake necessary consultations at the federal and state levels with regard to the role of JPS.

19) To review options for the development of a separate entity under MAFI to manage irrigation and agriculture drainage with emphasis on agriculture water management services.
20) For the PM's Department to undertake foresight studies in ensuring long-term sustainability of strategic resources, in which water is one.
21) For states governments to establish river basin organisations to integrate all available resources from different agencies to deal with localised challenges faced by each river basin and, in the case of shared rivers, to establish interstate river authorities (iSRA) to strengthen the cooperation between the federal and affected state governments as well as to ensure the river water quality is always maintained at the river-basin level. This will facilitate land-use planning and strengthen pollution control.
22) To develop informational policy instruments, including a WFEN Technical Guide & Manual and a 'Water Stress Index' (WSI) to identify nexus hotspots in relation to food and energy sectors.
23) To link disaster risk reduction and climate change adaptation at the river basin level through strengthening disaster risk governance, upgrading disaster-related decision-making systems, building capacity, promoting strategic investment in climate proofing infrastructure and assets, enhancing groundwater supply, and promoting nature-based solutions, including protection of groundwater, amongst others.
24) For the National Water Council to set up a standing committee on groundwater led by the KeTSA to oversee integrated management of groundwater resources in view of climate-related changes in rainfall patterns.
25) To further strengthen and expand the Malaysian DRR Platform (myDRR), currently under the aegis of NADMA, and supplemented with a strong inter-ministerial and multi-stakeholder platform for addressing disaster risk reduction, which comprises all relevant sectors, such as planning and finance, education, health, agriculture, food security, environment, emergency response, relevant private sector, scientific and other civil society representations.
26) To establish a regional platform and strengthen linkages on disaster risks, climate change and IWRM, whereby Malaysia could leverage on the linkages at regional level to promote good practices and technologies and become a regional hub in ASEAN
27) To ensure adequate finance is available for managing water resources, currently from the Federal Government, strengthen the existing laws to create a conducive environment for private investment, through the development of appropriate policies and laws, including by amending the existing Water Services Industry Act (Act 655) and Regulations to strengthen SPAN's function and role in pollution control and implement the new government policy on water reclamation and treated effluents.
28) To amend the Environmental Quality Act (Act 127) for better environmental protection within the 12th Malaysia Plan.
29) To develop a binding Integrated River Basin Management Policy to supplement the National Water Resources Policy to ensure uniformity in the management of river basins across all states in the country.
30) To review polluter-pay principle, beneficiary pay, licensing fees, cess charges, incidental incomes, environmental taxes, levies, and royalties favouring better management of an integrated water sector.
31) To review role of Majlis Air Negara's (MAN) and other institutional arrangements to enhance the federal-state cooperation in water resources.
32) To establish an integrated water management institutional framework to foster strong collaboration between government agencies (at the federal, state and local council levels), industry and community organisations to work in partnership to better manage and harness the economic value of the national water resources, requiring a "whole-of-government & whole-of-society" approach and needing a "champion with clout"
33) To foster strong collaboration and partnership between government, research institutions, industry, and community organisations to create the multiplier effects in the water industry, the "synergistic governance models" should put in place appropriate strategies and policies. These include ensuring that the policies are business-friendly and conducive to attract foreign investment, enable data sharing and best practices by all stakeholders.

34) To establish 'community champions' in various localities to play catalytic roles to foster strong cooperation with key agencies and authorities to ensure effective management of the upstream and downstream water ecosystem of the country.
35) To ensure that the complex relations between all stakeholders are managed effectively across the multiple jurisdictions, there is a need to intensify the governance systems by using the best technologies identified under the 10-10 *My*STIE and STIE foresighting framework to capture multiple spillovers across the different economic sectors.
36) To establish the proposed WST2040 National Committee, chaired by the Chief Secretary of the Government, to coordinate and implement WST2040 projects.
37) To enable the transition from the conventional linear economy to the **circular economy** to create a more sustainable and responsible businesses and investments, an enabling framework needs to be developed as guidance for the economic sectors to shift to the circular economy, whereby the entire value chain of products and services as well as the stakeholders involved will be mapped (12th MP document).
38) A blueprint for the **circular economy** related to solid waste, plastics, scheduled waste and agricommodities will also be introduced to deliver better system-wide economic and environmental outcomes (12th MP document).

D. Information and RDIC

1) To establish the IWSDC as a one-stop centre for all water-related data and to function as an integrated, single point platform for data sharing, to allow interested parties to harness available data rapidly and effectively.
2) IWSDC to also serve as a hub for research, development, innovation and commmercialisation (RDIC) and eventually become a water research collaboration platform for interaction between the public and private sector to collaborate and innovate in R&D niche areas of .
3) To establish state-level IWRM Information Centre or Hub to assist in accelerating the implementation of IWRM throughout Malaysia.
4) To align R&D collaborations undertaken in institutions of higher learnings/research institutes with the water industries to help bridge the chasm between academic research and translational outcomes that benefit the water sector.
5) To develop technologies to monitor water quality and water supply, and potential risks of climate change and other natural disasters based on water basins.
6) To establish a Decision Support System (DSS) to institutionalise the WFE nexus approach, consisting of, amongst others, hydrological databases that allow monitoring of key indicators of resource use, security and sustainability within selected river basins.

E. Infrastructure and Technology

1) To use IR 4.0 technologies in identifying water-food-energy nexus flashpoints within catchments or river basins, particularly by using big data analytics, IoT-connected devices, remote sensing, and artificial intelligence.
2) To use remote sensing/GIS platform as a field verification mechanism for a continuous monitoring of catchment health.
3) To set up *Pusat Informasi Sungai* for capacity building.
4) To establish strategic alliances with renowned regional and international water research and training centres.
5) To develop and manage a comprehensive data sharing framework.
6) To accelerate IWRM implementation by integrating water and land data.
7) To empower public participation.
8) To affirmatively support the National Digitalisation Blueprint.
9) To establish an experimental nexus infrastructure.
10) To use judiciously climate change models in the country for decision-making
11) To invest in groundwater use
12) To improve surveillance on climate and health of communities
13) To improve water standards to reflect the quality of water services to consumers

F. Finance

1) MIDA to introduce a new category in green incentives that is related to water management project and relevant incentives and awards for green watershed restoration and nature-based solutions, aiming to encourage more stakeholders to adopt and implement water management project in their premises and operations.
2) MOF and Inland Revenue Board of Malaysia (LHDN) to give tax incentives to businesses and industries that manage, protect, and upgrade the condition of the nearest water body (company tax exemption given to business and industry entities) for their involvement and contribution in conserving water resources.
3) SPAN to consider awarding green incentives in recognition and certification for SMEs and other general attendees attending the IWRM-related training programmes before water servicing licensing and relicensing.
4) KASA to radically overhaul the incentives structure, whereby water must be valued appropriately to discourage its inefficient use, including creating appropriate economic instruments, promoting sustainable resource use, such as payments for ecosystem services, enforcement of polluter-pays principle and a uniform pricing model for water resources.
5) KeTSA to provide fiscal and non-fiscal benefits to encourage groundwater development and maintenance of aquifer systems.
6) KASA to push for greater private participation in the water sector through policy changes, such as by providing incentives in purchasing water-efficient products and rainwater harvesting systems through easier market accessibility as well as by extending the licensing period of the public water supply system and wastewater treatment system from three years to until 20 years via the setting up of a think tank group to formulate the various incentive schemes and programmes to make the water sector much more participative, including collating and merging incentives from other subsector groups such as to propel the paradigm shift forward.
7) KASA to implement a transparent and fair Tariff Setting Mechanism (TSM) to improve financial sustainability in the water sector since a systematic tariff revision process is expected to create a chain effect in water usage reduction, reserve margin improvement, leading to decrease production, and more cash for the operator to invest back into enhancing the water supply system and be the crux of a conducive environment to attract private investment into the sector. In addition, the proposed TSM takes into account the interest and rights to water of the B40 group, safeguarding each family's lifeline consumption for 80% of users, by using up to 20 cubic metres of water per month. In contrast, wasteful users should be fairly charged with higher tariff rates
8) KASA to consider maximising the value of existing assets for water security investments by improving the operational efficiency and effectiveness of existing infrastructure and for service providers to delay investment needs.
9) A prerequisite to further investment in water security and for better operation and maintenance of infrastructure, demand management, and engagement with stakeholders in enhancing the assets are the following targets:
    (i) Increase the number of water operators that achieved OPEX recovery from four in 2020 to seven in 2025 and 10 in 2030. From 2030 onwards, KASA is expecting the operators to move towards full cost recovery with eight water operators targeted to maintain 100% OPEX recovery, four water operators to achieve 25% full cost recovery in 2035, four operators to attain 35% full cost recovery, three water operators achieve 25% full cost recovery, and five operators to reach 10% full cost recovery.
    (ii) Improve the OPEX recovery of sewerage service providers from 83% in 2020 to 90% in 2025 and 100% in 2030 with IWK targeted to attain 25% full cost recovery in 2035 and 35% in 2040.
    (iii) These targets have to be supported by the sustainable tariff setting regime to help water operators cover OPEX, CAPEX and make decent profits to continue serving customers. Without that, investment in the water sector will be severely jeopardised and will fail to cope with increasing demands from the domestic and non-domestic sectors.
10) KASA to consider implementing sustainable financing mechanisms for water infrastructure developments by increasing alternative financing from 10% in 2025 to 40% in 2040, increasing 10% in every Malaysia Plan, through:

(i) An improved private finance initiative (PFI) with a build-own-transfer (BOT)/concession model under SPAN's regulation for large-scale water supply and wastewater projects to be realised in the 12th MP .
(ii) Public-private partnership models, namely performance-based contract (PBC) for non-revenue water (NRW) reduction projects, land swap model and hybrid annuity model (HAM) for wastewater projects to be realised in the 12th MP .
(iii) Green climate fund for adaptation projects to be utilised in the 12th MP.
(iv) An innovative cash *Waqf Sukuk* model for large water projects, to be realised in 14th MP.
(v) A water bank to be established as an enabling institution for water projects, to be realised in the 15th MP.

11) KASA to strengthen ***Wakaf Air*** to finance rural water supply and sewerage projects to complement the scope of KPLB by improving public participation and implementation cadences to implement at least 20 projects per year, amounting to RM 1 million investment. The ***Wakaf Air***, launched in December 2020, is targeted to increase its fund size by RM1 million a year so that by the end of the 12th MP, ***Wakaf Air*** has about RM8 -10 million.
12) KASA to consider upscaling financing through improved risk-return frameworks to allow the public and private actors (including water users) to earn returns proportional to the risks they take.
13) KASA to consider establishing the Water Industry Fund (WIF) for water resources conservation as provided for in Section 171(1) of the Water Services Industry Act (Act 655) with the WIF to be set up, controlled, and managed by SPAN (details are given in the AWF FR).
14) KASA to consider developing appropriate mechanisms to select investment pathways that maximise water security returns over time, including the consideration of rigorous triple bottom line analysis on project sequences (or portfolios) and carefully considering the effect of pursuing a specific project in foreclosing or enabling future investment options. It also needs an analysis of the system performance over time under different scenarios.
15) KASA to explore the feasibility of establishing a national water company to achieve operational efficiency and economies of scale, emulating the Tenaga Nasional Berhad in the power sector (details are given in the AWF FR). It is anticipated that this move can smoothen the formation of the RBOs by State Governments as each water operator has mutual interest in the shared river basins.
16) KASA to consider establishing a raw water price mechanism for water resources conservation. The price is based on the water quality of resources (details are given in the AWF FR) with the aim to encourage State Governments to preserve and conserve water resources to obtain higher revenue from raw water extraction. The target is to set a pricing mechanism for inter-state river basins in 2025 and international rivers in 2030

Implementable Projects for 12th Malaysia Plan as well as proposed Strategies, Targets and KPIs for the four Malaysia Plans

The eight sub-sectors had given their lists of immediately implementable projects for the 12th MP as well as their proposed transformation items, Targets and KPIs for the four Malaysia Plans in their standalone Final Reports as well as in their Summary Briefs (Appendix 3.1).

A total of **87 Strategies, 601 Targets** and **601 KPIs** each were identified by the eight sub-sectors over the four Malaysia Plans (Table 3.5). The details are given in the respective standalone sub-sectoral Final Reports.

WST2040 Reforms and Simulated Transformation Trajectory

The potential of the water sector (Figure 3.10), whereby implementing the appropriate reforms to the water sector and water ecosystem (Section 3.3) to resemble that of Japan, can lead to a value-add of **RM13.3B** by 2040, contributing 0.46% to the national GDP. Over the course of 20 years from 2021 to 2040, this simulated transformation trajectory for the water sector would contribute a total of **RM172.6B** to the economy. The reforms include transforming the Malaysian water ecosystem to be knowledge-intensive and technology-driven. A developed water ecosystem will ensure sustainable supply (both quantum and quality) of water to meet the needs of society and key economic sectors of the economy. A sound water ecosystem will also ensure appropriate strategies are in place and will ensure effective management of the demand of water by society.

WST2040 Roadmap and Governance Structure

As part of the study, three roadmaps to 2040 were prepared for submission with the Final Report by using the approved ASM NIWRMP roadmap framework template as basis for populating by the Stakeholders nation-wide. The three being the 11thMP roadmap with strategies and projects continuing into the 12thMP while the second being the updated NIWRMP roadmap (Appendix 2.1) and third being the dominant WST2040 roadmap as a result of the WST2040 study. The 11th MP roadmap and WST2040 roadmap are given as Appendix 3.4 and Appendix 3.5 in Chapter 3 of the Final Report.

The journey towards achieving the aspired 2040 target has been described in the three roadmaps. Nonetheless, it is important to take note of the proposed strategies, initiatives, projects, and where available, the proposed budgets given in the updated NIWRMP roadmap as they, together with the WST2040 strategies, describe in totality the IWRM agenda to be implemented and achieved nationwide.

In terms of the governance structure, it is proposed that in line with the five-step review process (Section 3.4, Figure 3.14-5)**,** it is recommended that a **WST2040 National Management Committee (NMC)** (Figure 3.15) be established, to assist Majlis Air Negara in the implementation of IWRM and WST2040 projects over the four Phases to 2040, and that the committee be chaired by the Chief Secretary to the Government[4] (KSN) and co-chaired by the Secretary-General KASA to oversee the coordinated implementation of IWRM agenda nationwide.

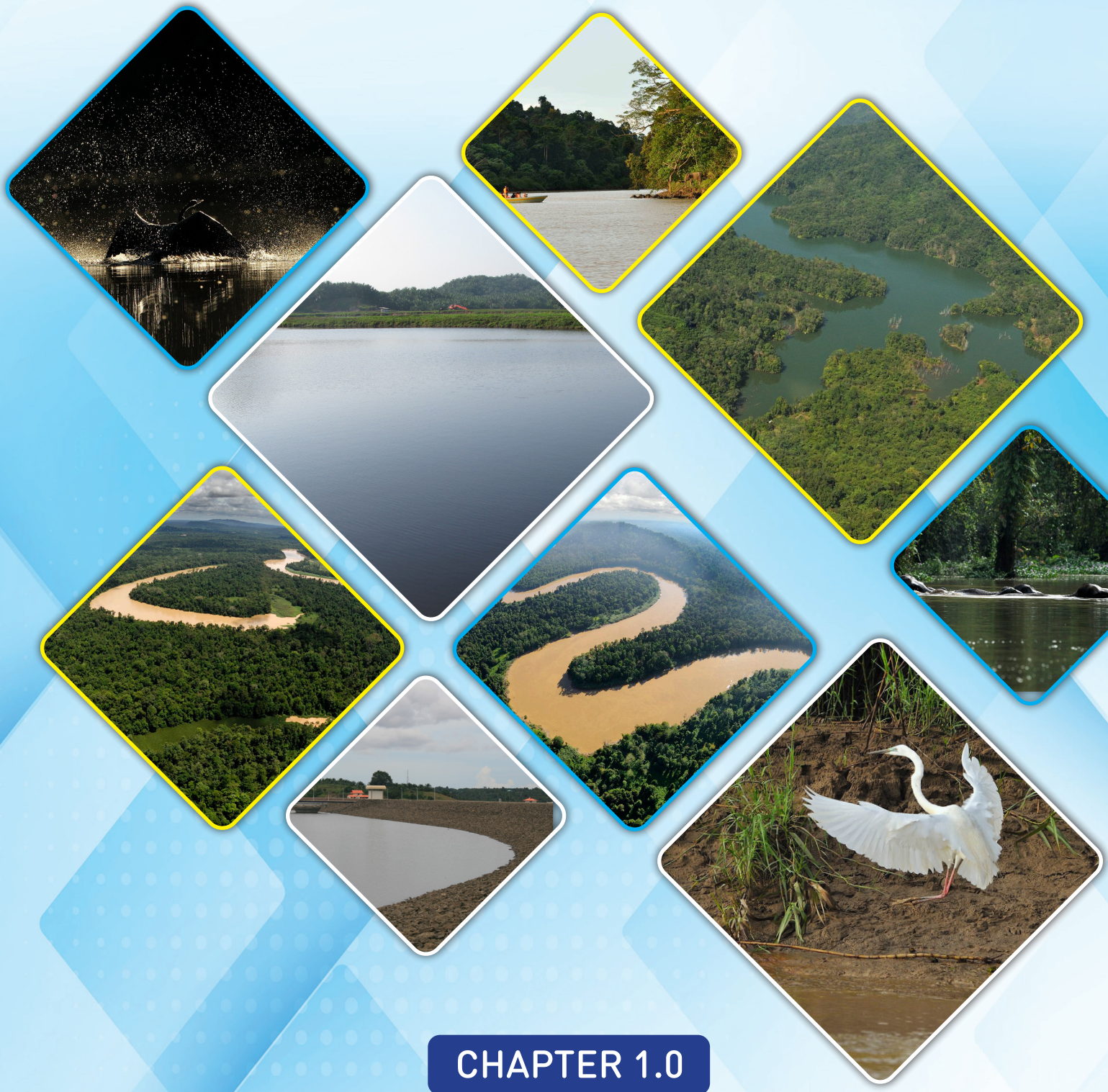
It is also proposed that the secretariat serving this committee be the Water Sector Transformation Task Force[5] is headed by a technocrat who is well-versed in IWRM matters. The task force will assist the NMC to monitor the implementation of all WST2040 projects. It will be ideal if the same secretariat, again for continuity purposes, also serves the **Majlis Air Negara**.

In addition, it is proposed that, further to the five-step review process (Section 3.4, Figure 3.14-5), it is recommended that an **independent monitoring and evaluation body**, modelled after PEMANDU which monitored the ETP Projects, be established during the implementation phase to undertake on a continuing basis, periodic and annual reviews of progress made in implementing the WST2040 roadmap. It is envisaged that the management audit reports and annual score card be submitted to the proposed WST2040 National Management Committee (Section 3.2.5) and be brought to the attention of the Majlis Air Negara, chaired by the PM when needed.

In conclusion, the WST2040 study had included the **WST2040 and composite roadmaps**, as major outputs of the study, and proposed a total of **106** Immediately Implementable Projects **(12th MP)** for the consideration and implementation of the government (details given in the respective sub-sector reports). In addition, the study had proposed a total of **87 Strategies** (each with the proposed targets and KPIs set) over the four phases until 2040 (details given in the respective sub-sector reports).

4 The proposed WST2040 National Management Committee has its membership drawn nation-wide from the State Secretaries, the Secretary-Generals/Permanent Secretaries of the Ministries and the Central Agencies

5 The Task Force, as proposed in the Governance Focus Area (**12MP document),** is proposed by this Study to be modelled after PEMANDU, which monitored implementation of the ETPs.



CHAPTER 1.0

WATER SECTOR TRANSFORMATION STUDY 2040

This year's World Water Day, with the theme "Valuing water", asks: What does water mean to me? The value of water is profound and complex. There is no aspect of sustainable development that does not fundamentally rely upon it. For me, water means protection. A well-managed water cycle – encompassing drinking water, sanitation, hygiene, wastewater, transboundary governance, the environment and more – means a defence against ill-health and indignity and a response to challenges from a changing climate and increasing global demand.

– H.E. António Guterres, UN Secretary-General (Excerpt from his message on World Water Day, March 22, 2021)

1.1 BACKGROUND OF THE STUDY

Water is an important natural resource which serves two broad roles in the development of a nation. Firstly, it is a natural amenity in terms of ecosystem services and life sustenance and secondly, it is an important input in the nation's economic processes to derive the desired economic output On the second point, water is being touted as the new "oil" in terms of its utility to national well-being and its potential in its wealth-contributing aspects to society, more so with the impending impact by on global and national water resources.

In appointing ASM as its strategic partner, EPU had taken into consideration the earlier ASM NIWRMP two-volume study report findings (ASM, 2016) and IWRM-related thematic Advisory Reports (Table 1.1). EPU recognised that tes were important and would serve as complementary references to Ministries/Agencies nationwide when implementing the national WST2040 agenda.

The WST2040 study addressed eight additional sub-sectors as follows (i) Advocacy, Awareness, Capacity Building and Public Participatory Platforms (**AACB**) (ii) Integrated Water Sector Data and RDIC Centre (**IWSDC**) (iii) IR 4.0 in the various Water Sub-sectors (**IR4.0**) (iv) Water-Food-Energy-Nexus (**WFE Nexus**) (v) Virtual Water and Water Footprint (**VW&WF**) (vi) Climate Change Impact and Adaptation (**CCIA**) (vii) Alternative Water Financing (**AWF**) and (viii) Water as an Economic Sector (**WES**).

The WST2040 agenda entails the execution of a comprehensive set of 87 strategies and a roadmap over four five-year plan phases targeted for completion by 2040. The objective for Malaysia's Water Sector Transformation Agenda 2040 is "to transform the water sector from an economic enabler into a dynamic economic sector as the future direction of national growth, tapping from the huge global and regional market size of the industry".

Table 1.1. IWRM thematic studies (NIWRMP)

In-depth Component Plan Studies[1]	Complementary Expert Reviews
1. Integrated Lake Basin Management 2. Integrated Aquifer Systems Management 3. Water Demand Management 4. Water Supply and Wastewater Management 5. National Agenda for Integrated Water Research 6. Climate Change and Water 7. Integrated River Basin Management 8. Water and Agriculture 9. NKPA on Water 10. ASM Mega Science Study: Water Sector	1. Integrated Flood Management 2. Integrated Drought Management 3. Water Quality Management 4. Water and Land (National Physical Plan) 5. Water and Health 6. Water and Green Growth 7. Water and Gender 8. Virtual Water and Water Footprint 9. Water Financing 10. Water-Food-Energy Nexus 11. S&T Awareness, Advocacy and Capacity Building 12. International Networking and Collaboration 13. Integrated Urban Water Management 14. NWRMP Action Plan

Source: ASM (2016)

1 All these ASM Advisory water-related Advisory Reports are downloadable from the ASM website. The 10 titles as well as other Reports are listed in the References. The 14 complementary expert reviews are described in the ASM NIWRMP Report, also downloadable from the ASM website (https://www.akademisains.gov.my/publication/)

1.2 PROBLEM STATEMENT

The issues and challenges being faced the Malaysian Water Sector were identified and exemplified in the following problem statement, categorised under five focus areas (people, governance, infrastructure, information and finance):

- **People:** Lack of ownership/respect for the country's water resources and inadequate participatory platforms resulting in deteriorating water quality and wastage
- **Governance:** Fragmented governance of the water sector and marginal implementation of IWRM
- **Infrastructure:** Insufficient and unsustainable ageing water infrastructure, lacking resilience to support growth
- **Information:** Difficulty in accessing data, resulting in lack of data-driven and science-based decision-making, restricted by outdated Acts
- **Finance**: Poor financial sustainability of water industry, thereby highly dependent on public funding

1.2.1 Summary Causes

The summary causes to the above stated problems could be attributed to the following:

i) Seasonal water scarcity - regional water stress, competing water usage, high NRW and user wastage.
ii) Water resource pollution - point and non-point source from industrial and agricultural development and by the public at large.
iii) Fragmented management - IWRM implemented sporadically, open-source data sharing amongst water agencies not institutionalised.
iv) Flooding - monsoonal and flash floods, tsunamis, land and mud slides.
v) Environmental degradation - extensive and illegal catchment development.
vii) Climate change impacts - vulnerable areas and related infrastructure and services, and
viii) Over-dependence on public sector financing for water infrastructure and services

In order to resolve the issues and challenges identified in the "problem statement" as well as a host of other national challenges (Figure 1.1), the WST2040 initiative was proposed and launched by MEA (MEA, 2019).

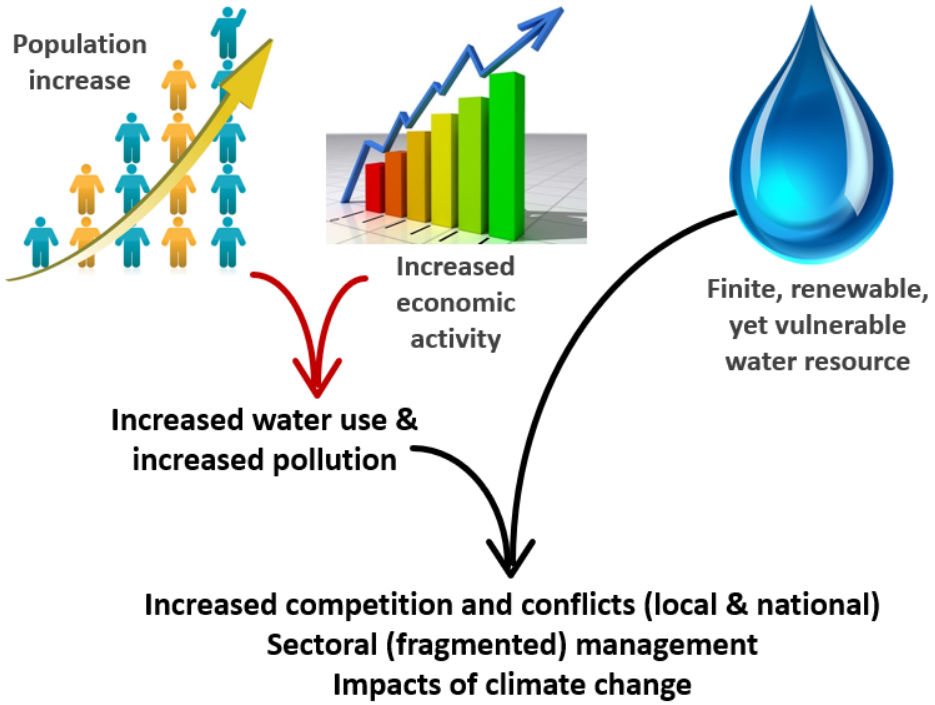


Figure 1.1: Increased competition and conflicts (local & national); Sectoral (fragmented) management; Impacts of climate change

1.3 OBJECTIVES OF THE STUDY

The study has the following key objective and two basic objectives:

Key Objective

Moving away from reactive approach, the water sector will be recognised, reorganised and made more visible as a significant contributor to national growth, economically, socially and environmentally through the National Agenda on water sector transformation.
(Source: MEA, 2019)

Objectives

- To ensure nationwide water security and sustainability, in line with global and national targets, continues to be fulfiled beyond 2040, whereby there is water supply for all.
- To transform Malaysia's water sector from being an economic enabler to a dynamic economic sector that can contribute to the country's gross domestic product (GDP)
  (Source: MEA, 2019).

1.4 WST 2040 STUDY TERMS OF REFERENCE

On 10 April 2020, EPU entered a strategic partnership with ASM for ASM to undertake the study on the Development of the National Agenda Roadmap for the WST 2040. The study period was 20 months, ending in December 2021 with ASM to submit the Final Report, including the roadmap.

The appointment letter had described appointing ASM based on its expertise and experience in conducting many studies on the development of the country's water sector as well as its wide network of experts. The study began on 2 May 2020 and will end 20 months later, on 31 December 2021. The terms of reference (TOR) of study are:

i) **Scope 1**: To review and analyse current policies and propose improvements based on studies that have been implemented by many parties towards improving the nation's water sector.
ii) **Scope 2**: To undertake strategic comparative analyses or business models that have been implemented by other countries, e.g. Korea, Singapore and Denmark to strengthen the water industry.
iii) **Scope 3:** To study the potential of the nation's water sector by taking into account the current global market to establish the water sector as a new dynamic economic sector and capable of driving the nation's GDP growth in future.
iv) **Scope 4:** To prepare a framework for the implementation strategy and water sector transformation initiative for the four phases, including proposing the implementing agencies, budget estimates and main achievement targets based on analyses undertaken as well as expert reviews.
v) **Scope 5:** To implement consultation sessions with stakeholders and experts with the aim of finalising the proposed framework for the implementation strategy and the water sector transformation initiative, and
vi) **Scope 6:** To prepare the complete roadmap for the National Agenda on WST2040 roadmap for reference and guide of various ministries and agencies to implement projects/programmes and activities towards achieving the aim of transforming the water sector.

The appointment letter also specified that the above scopes would cover the following main aspects which form the basis of transformation agenda:

i) Improvement of the overall significant understanding on the IWRM concept at all levels and covering all sectors to ensure effectiveness of the implementation in managing water resources sustainably.
ii) Establishment of a national water Data and RDIC Centre as the basis for strategic planning and decision-making as well as driver for the development of expertise and local innovations in the water sector.
iii) Preparation of the water sector towards adopting IR 4.0 and the use of smart technologies to drive the overall development of the water sector.

iv) Management of sustainable water resources through the water-food-energy nexus to ensure the country's social and economic survival.
v) Preparation of a comprehensive quantitative data concerning current water use and demand as a guide to identify the economic level of water usage by every economic sector.
vi) Preparations towards facing climate change impact on the water sector.
vii) Development of a new economic model to drive the nation's water industry towards an industry which is competitive, attractive and profitable.
viii) Implementation of a strategic programme towards positioning the water sector as a new national economic sector.

The TOR has also prescribed the following committees to oversee the proper and timely completion of the WST2040 study.

1.4.1 WST2040 Study Steering Committee

The steering committee is chaired by Deputy Director-General (Sectoral), EPU, JPM. The Alternate Chairperson is the Director, Infrastructure and Public Facilities Division, EPU, JPM (Appendix 1.1).

The study secretariat staff is drawn from the Infrastructure and Public Facilities Division, EPU, JPM.

1.4.2 WST2040 Study Technical Committee

The technical committee is chaired by Prof. Dato' Ir. Dr. A. Bakar Jaafar FASc (appointed by the ASM Council). Its permanent members are representatives, as shown in Appendix 1.2 (updated as at 6Nov. 2020). Its secretariat is ASM staff.

1.4.3 WST2040 Project Management Committee (PMC)

To manage the eight sub-sectoral studies, a Project Management Committee was established by the ASM Council and chaired by Ir. Dr. Salmah Zakaria FASc (concurrently the Chair of the ASM Water Committee). The ASM Council also appointed academician Tan Sri Ir. Shahrizaila Abdullah FASc as the PMC Advisor. Internal oversight for the study by ASM as the strategic partner was provided by STIPAC. To assist the Chairperson, four subject matter experts were appointed as members of the PMC as follows:

i) Academician Datuk Fateh Chand FASc
ii) Dato' Dr. Abd Rahim Nik FASc
iii) Dr. Low Kwai Sim FASc, and
iv) Dr. K. Kalithasan

ASM had appointed Mr. P. Loganathan FASc PGEOL FIGM as the Chief Writer of study.
The additional members of the PMC are the task force leaders of the eight sub-studies (or sectors) and they are:

i) Prof. Dato' Dr. Mazlin Mokhtar FASc (advocacy, awareness, capacity building and public participatory platforms sector)
ii) Datuk Ir. Mohd Adnan Mohd Nor FASc (integrated water sector data centre sector)
iii) Datuk Ir. Abdul Kadir Mohd Din FASc (IR 4.0 in the various water sub-sectors Sector)
iv) Dr. Ahmad Hezri Adnan FASc (water-food-energy nexus sector)
v) Prof. Dr. Zulkifli Yusop FASc (virtual water and water footprint sector)
vi) Prof. Dr. Joy Jacqueline Pereira FASc (climate change impact and adaptation sector)
vii) Dato' Seri Ir. Dr. Zaini Ujang FASc (alternative water financing sector)
viii) Prof. Dr. Mahendhiran Nair FASc (water as an economic sector)

The various members serving the WST2040 study team in various positions and at different levels are listed in Appendix 1.3.

1.5 COVID-19 PANDEMIC AND THE 12TH MALAYSIA PLAN

During the course of the implementation of the WST2040 study scheduled for completion in December 2021, the above-mentioned global outbreak and the national launch of the 12th MP had a telling effect and impact on the outputs and outcomes of the study and needed to be rationalised:

- **COVID-19 Pandemic:** The effect of the highly infectious COVID-19 virus that initially emerged in late 2019 had since grown into a global pandemic, affecting the lives and livelihoods of the population worldwide. Though not included in the TOR for the WST2040 study, and noting that the pandemic would leave a lasting effect on water security, ASM took the initiative to assemble a small group of experts who report to the PMC to undertake a desk study to add value to the WST2040 study report findings, which included water security as one of its main objectives. The report from the expert group entitled *"Water Security in a pandemic environment with particular reference to COVID-19"* was included under Section 2.8 of Chapter 2 of the Main Report.

- **12th Malaysia Plan:** The Twelfth Malaysia Plan (12th MP) was formally launched by the Right Honorable Prime Minister of Malaysia in Parliament on 27 September 2021. The plan, with the objective of 'a prosperous, inclusive, sustainable Malaysia', is in line with the Shared Prosperity Vision 2030 and SDG 2030 targets. The focus over the next five years will be on three key themes, namely **(i) resetting the economy, (ii) strengthening security, well-being and inclusivity** as well as (iii) **advancing sustainability.**

Theme 3 on "advancing sustainability" is addressed in Chapter 8 and Chapter 9 of the 12th MP document. Chapter 8 focuses on "advancing green growth for sustainability and resilience" while Chapter 9 focuses on "enhancing energy sustainability and transforming the water sector". The two Game Changers to be implemented under Theme 3 are **"embracing the circular economy and accelerating adoption of Integrated Water Resources Management (IWRM)"**.

Chapter 8 has three priority areas relevant to IWRM, to wit, (i) implementing a low-carbon, clean and resilient development (ii) managing natural resources efficiently to safeguard natural capital and (iii) strengthening the enabling environment for effective governance.

Chapter 9 has two priority areas, namely (i) ensuring sustainable energy for all and (ii) transforming the water sector. the transformation of the water sector comprises five strategies, namely **(a) empowering people, (b) strengthening governance at all levels, (c) enhancing capability in data-driven decision-making, (d) ensuring sustainable financing, and (e) developing sustainable infrastructure with cost-effective technology**. These strategies mirror the five focus area framework adopted by the WST2040 study.

Excerpts from the address by the Right Honourable Prime Minister of Malaysia on 27September 2021 at the launch the 12th MP and reproduced as a quote at the beginning of this Chapter 1 is clear testimony that the government not only endorses the WST2040 agenda but is equally committed to its implementation to ensure that "the water sector is recognised, reorganised and made more visible as a significant contributor to national growth, economically, socially and environmentally" in line with key objective of the study.

Chapter 3 of the main report (Volume 1) has duly reviewed the 12th MP document to ensure there is no incongruence between the strategies contained, therein with those recommended under the study and that any gaps that may exist are rationalised.

1.6 COMPLIANCE WITH THE STUDY TOR

The compliance of study with the TOR is as follows:

i) **Scope 1**: The eight sub-sectors had reviewed a total of 45 policies, 75 laws, 73 ordinances and regulations. Measures were proposed to overcome perceived weaknesses in the policies, laws and ordinances.

ii) **Scope 2**: A total of 27 countries were studied for their water sector business models. It was decided to use the 8i's ecosystem approach as used in Japan and South Korea to strengthen the water industry.
iii) **Scope 3**: By using the 8i's ecosystem approach, it was found that the nation's water sector has much potential, not only to contribute to the national economy, but also to the global market in terms of exporting water sector-related training modules and locally developed technologies.
iv) **Scope 4**: The roadmap framework, based on the roadmap category definitions (Appendix 3.2) and framework adopted in the 2016 ASM NIWRMP publication, was approved by both the **Technical Committee at its meeting on 28 October 2020** and **Steering Committee at its meeting on 19 November 2020.**
v) **Scope 5**: As of end of August 2021, a total of **137** engagements were held with **318** (including those Consultations held by the sub-sectors) stakeholders[<?>] (Appendix 3.5); and
vi) **Scope 6**: The WST2040 roadmap was finalised and was included as Appendix 3.4**.**

The scope achievements are shown in Table 1.2.

In addition to meeting the requirements of the TOR, ASM as EPU's Strategic Partner, has also included write-ups on "water security in a pandemic environment with reference to COVID-19" as well as relevant strategies from the 12th MP document.

Table 1.2. WST2040 study terms of reference scope achievement

No.	Scope	Status
1.	To review and analyse current policies and propose improvements based on studies that have been implemented by many parties towards improving the nation's water sector.	**Fulfiled**: A total of 45 policies (including 75 laws, 73 ordinances and regulations) were reviewed. Measures were proposed to overcome perceived weaknesses in the policies, laws and ordinances.
2.	To undertake strategic comparative analyses or business models that have been implemented by other countries e.g. Korea, Singapore and Denmark to strengthen the water industry.	**Fulfiled**: A total of 27 countries were studied for their water sector business models. It was decided to use the 8i's ecosystem approach as used in Japan and South Korea to strengthen the water industry.
3.	To study the potential of the nation's water sector through taking into account the current global market to establish the water sector as a new dynamic economic sector and capable of driving the nation's GDP growth in future.	**Fulfiled**: The section was written by Prof. Mahendhiran Nair FASc, Chair, WES TF. The write-up appears as Section 3.2 in Chapter 3 of the overall Final Report (Volume 1)
4.	To prepare the framework for the implementation strategy and the water sector transformation initiative for the four phases, including proposing the implementing agencies, budget estimates and the main achievement targets based on analyses undertaken as well as expert reviews.	**Fulfiled**: The roadmap framework developed was based on the roadmap appearing in the 2016 ASM NIWRMP publication. It was approved by the Technical Committee at its meeting on 28 October 2020 and the Steering Committee at its meeting on 19 November 2020, respectively.
5.	To implement consultation sessions with stakeholders and experts with the aim of finalising the proposed framework for the implementation strategy and the water sector transformation initiative	**Fulfiled**: As at end of August 2021, a total of 137 engagements were held with 318 (inclusive of consultations held by the sub-sectors) stakeholders

Appendix 1.1
WST 2040 STEERING COMMITTEE

i)	Deputy Director-General (Sectoral), EPU, JPM	**Chairman**
ii)	Director, Infrastructure and Public Facilities Division, EPU, JPM	**Alternate Chair**

Its Permanent Members are representatives from:
iii) Prime Minister's Department
iv) Ministry of Finance
v) Ministry of Environment and Water
vi) Ministry of Agriculture and Agro-Based Industry
vii) Ministry of Energy and Natural Resources
viii) Ministry of Rural Development
ix) Ministry of Health
x) Ministry of Entrepreneurial Development
xi) Ministry of Science, Technology and Innovation
xii) YBhg Tan Sri Ir. Syed Muhammad Shahabudin FASc (ASM Council appointee/ASM Water Committee Member)

Supplementary Members (if necessary) will be from:
i) representatives of related agencies
ii) representatives of non-governmental organisations
iii) academia representatives

Its secretariat is staff from the Infrastructure and Public Facilities Division, EPU, JPM.

Its functions are to:
i) Appoint the Technical Committee members
ii) Check and approve the study TOR
iii) Check and approve the study output

Appendix 1.2

WST 2040 TECHNICAL COMMITTEE

No	Name	Position	Organisation
1	Prof. Dato' Ir. Dr. A. Bakar Jaafar FASc	Chairman	ASM
	Members		
2	Prof. Dato' Ir. Dr. Abdul Wahab bin Mohammad	DVC, R&I	UKM
3	Prof. Datin Paduka Dr. Aiini Ideris FASc	VC	UPM
4	Prof. Dr. Faisal Rafiq Mahamd Adikan FASc	DVC	USM
5	Prof. Dr. Azmi bin Aris	Director	IPASA, UTM
6	Dr. Ahmad Parveez Hj. Ghulam Kadir FASc	DG	MPOB
7	Puan Mazidah Ahmad Ramli	Chief Assistant Director	UPEN Selangor
8	Tuan Mohd Yusof bin Abu Bakar	SUB	UPEN Melaka
9	Tuan Zulkifli Jahaya	Chief Engineer	BPEN Penang
10	Tuan Muhamad Nahar bin Haji Mohd Sidek	Director	UPEN NS
11	Assoc. Prof. Dr. Muhammad Abdullah bin Haji Zaidel	Director	UPEN Sarawak
12	Tuan Wan Kamarul Faisal bin Wan Kamardin	Timb. SUK (Pembangunan)	Perlis
13	Puan Gwendolen Vu	Director	UPEN Sabah
14	Puan Faizah binti Abdul Rahman @ Sulaiman	Director (Water Resources)	Water Regulatory Body, Melaka
15	Mohd Zakwan Mohd Zabidi	Senior VP	MIGHT
16	Dato' Ir. Nor Hisham bin Mohd. Ghazali	DG	JPS
17	Tuan Shamsul Bahar Mohd Nor	CEO	MGTC
18	Dr. Ahmad Fairudz Jamaluddin	Director, Climate & Hidrology Section	MetMalaysia
19	Dato' Ir. Dr. Md. Nasir bin Md. Noh	DG	NAHRIM
20	Tuan Mohd Nasir Bin Warris	DG	Jab. Pertanian
21	Mohd Faris bin Sobri	Penolong Pengarah Kanan (Pengurusan Hutan Darat)	Forestry Department Peninsular Malaysia
22	Dato' Hamzah bin Hussin	CEO	SEDA
23	Tuan Hj. Hisamuddin bin Termidi	DG	JMG
24	Ir. Tauran Zaidi bin Ahmad Zaidi	Director, Engineering Services Division	MOH
25	Dr. Rafiza binti Shaharudin	Head of EHRC	IMR
26	Tuan Haji Mohamed Zaini bin Abdul Rahman	DG	Department of Chemistry
27	Tuan Haji Azlikamil Napiah	DG	MySA
28	TPr Puan Norliza Hashim	Chief Executive	Urbanice Malaysia

Its functions are to:
Monitor the overall implementation involving all the sub-studies
Report on the progress of the overall project to the Steering Committee
Check on the study outputs and present to the Steering Committee for approval.

Appendix 1.3

ACKNOWLEDGEMENT
LIST OF EPU-ASM WST 2040 STUDY TEAM MEMBERS[3]

EPU-ASM WST2040 Project Management Committee (PMC)

No.	Name	Organisation	Position
1.	Academician Tan Sri Dato' Ir. Shahrizaila Abdullah FASc	ASM	Council-appointed Advisor to the PMC
2.	Ir. Dr. Salmah Zakaria FASc	ASM	Chairperson
3.	Academician Datuk Fateh Chand FASc	ASM	Member
4.	Datuk Dr. Abdul Rahim Nik FASc	ASM	Member
5.	Dr. Low Kwai Sim FASc	ASM	Member
6.	Mr. Loganathan Ponnambalam FASc	ASM	Chief Writer
7.	Dr. Kalithasan Kailasam	GEC	Member
8.	Ms. Nitia Samuel	ASM	Chief Analytics Officer
9.	Ms. Joy Grace Rayappan (Withdrawn on 9 August 2021)	ASM	Senior Analyst
10.	Ms. Norazwa Musiran (Joined on 10 August 2021)	ASM	Senior Analyst (Covering Principal Analyst)
11.	Mr. Loh Chia Hur	ASM	Analyst
12.	Ms. Nurul Rahimah Abu Bakar	ASM	Analyst
13.	Mr. Hareehaaran Mathialagan	ASM	Analyst
14.	Ms. Nur Nabihah Nazri	ASM	Admin and Accounts Executive

WST2040 Economic Planning Unit (EPU), Prime Minister's Department (JPM)

No.	Name	Division	Position
1.	Mr. Azhar Noraini (Withdrawn – Retired on 24 September 2021)	Sectoral Division	Deputy Director General
2.	Datuk Yatimah Sarjiman (Joined on 15 October 2021)	Sectoral Division	Deputy Director General
3.	Ms. Hidah Misran	Infrastructure & Utilities Division	Director
4.	Ms. Dayang Shalbia Abdul Ghani	Infrastructure & Utilities Division	Deputy Director II
5.	Ms. Wan Izar Haizan Wan Rosely (Left to pursue her PhD in Imperial College, London on 31 August 2020	Infrastructure & Utilities Division	Principal Assistant Director Water & Sewerage
6.	Ms. Maniza Mahfuz (Joined on 1 September 2020, Left on promotion on 5 July 2021)	Infrastructure & Utilities Division	Principal Assistant Director Public Transport & Training
7.	Ms. Nor Azima Azman	Infrastructure & Utilities Division	Assistant Director (Water & Sewerage II (APII)

3 Membership list valid as at 2nd Nov. 2021

Advocacy, Awareness, Capacity Building and Public Participatory Platforms (AACB)

No.	Name	Organisation	Position
1	Prof. Dato' ChM. Dr. Mazlin Mokthar	UKM	Chairperson
2	Dr. Minhaz Farid Ahmed	UKM	Module Cluster Leader (MCL)
3	Ms. Norizan Mohd Mazlan (Withdrawn on 27 November 2020. Replaced by Assoc. Prof. Dr. Rasyikah Mohd Khalid)	WWF	MCL
4	Mr. Winston Peng (Withdrawn on 27 November 2020. Replaced by Assoc. Prof. Ts. Dr. Lee Khai Ern)	SCRP	MCL
5	Assoc. Prof. Dr. Goh Choo Ta	UKM	MCL
6	Assoc. Prof. Dr. Rasyikah Mohd Khalid (Replacement-Joined on 1 December 2020)	UKM	MCL
7	Assoc. Prof. Ts. Dr. Lee Khai Ern (SME from 2 May 2020 to 30 November 2020. MCL from 1 December 2020)	UKM	MCL
8	Hj. Akashah Hj. Majizat (Withdrawn as Chief Writer and Lead SME on September 2020)	Eco-Development Facilities Sdn. Bhd.	Subject Matter Expert (SME)
9	Prof. Dr Hafizan Juahir	UniSZA	SME
10	Datin Daria Mathew Abdullah	WWF	SME
11	Ms. Saradambal Srinivasan (Withdrawn on 31 August 2021)	WWF	SME
12	Prof. Dato' Ts. Dr Mohd Ismail bin Abdul Aziz	-	SME
13	Prof. Dr. Awang Noor Abd Ghani	UPM	SME
14	Dr. Mohd Yusoff Ishak	UPM	SME
15	Ms. Jagadeswari Mariappan	GEC	SME
16	Assoc. Prof Dr. Poline Bala	UNIMAS	SME
17	Dr. Haslawati Baharudin	DOF	SME
18	Prof. Dr. Ir. Ab. Saman Abd. Kader	UTM	SME
19	Mr. Jamil Tajam	UiTM	SME
20	Dr. Elia Goodong	UMS	SME
21	Prof. Dr. Sharifah Ezat Wan Puteh	UKM	SME
22	Ir. Ellias Saidin	SPAH	SME
23	Prof. Dr. Saleem Mustaffa (Withdrawn on 19 October 2020. Replaced by Assoc. Prof. Ts. Dr. Sitti Rahaennah Muhamad Shaled)	UMS	SME
24	Assoc. Prof. Ts. Dr. Sitti Rahaennah Muhamad Shaleh (Replacement-Joined on 25 November 2020)	UMS	SME
25	Dr. Yew Wong Chin	UKM	SME
26	Dato' Teo Yen Hua	-	SME
27	Ms. Siti Nurbaiyah Nadzmi	-	SME (Communication Expert)
28	Ms. Raden Puteri Khairani Khirotdin	UKM	SME (GIS Mapping)
29	Datuk Prof. Dr. Azizan Baharuddin	IKIM	Member
30	Ir. Hj. Ismail Abdul Rahman	-	Member
31	Dato' Ir. Hj. Hanapi Mohamad Noor FASc	MyWP	Member
32	Dr. Zuritah A. Kadir (Withdrawn on 8 October 2021)	ASM	Senior Analyst
33	Ms. Nurul Ain Sazalli (Withdrawn on 31 October 2021)	ASM	Analyst

34	Mr. Muhammad Irfan Masri	ASM	Analyst
35	Ms. Nurul Iman Abu Hanifah	ASM	Analyst
36	Ms. Siti Nurfazreen Abdul Rahman	ASM	Analyst

Integrated Water Sector Data Centre (IWSDC)

No.	Name	Organisation	Position
1	Datuk Ir. Mohd Adnan Mohd Nor FASc	RPM Engineers Sdn Bhd	Chairperson
2	Ir. Liam We Lin	RPM Engineers Sdn Bhd	Lead SME
3	Gs. Shiamala Velaichamy	RPM Engineers Sdn Bhd	SME on GIS and Data Structure
4	Mr. Arshad Abdul Rahman	Reka1 Tech LLP	SME on IR 4.0 Applications
5	Mr. Zaim Mohd Zuhuri	Millenium Radius Sdn Bhd	SME on Systems Architecture and Human Resources
6	Ir. Mohd Zaki Mat Amin	NAHRIM	SME on RDIC in water sector
7	Mr. Adnan Ismail	MySA	SME on Space Technology
8	Gs. Mohd. Hairi Md Akhir (Joined on 17 May 2021)	RPM Engineers Sdn Bhd	SME on River Basin Data Management
9	Mdm. Khong Lai Quan (Joined on 9 August 2021)	-	SME on Financial
10	Ir. Narimah Mohd Sies (Joined on 1 July 2021)	-	Report Reviewer
11	Mr. Zuraimi Suleiman	MySA	Member
12	Mr. Ardi Bakthiar	ASMA	Member
13	Mr. Voon Kok How (Withdrawn on 14 January 2021)	KKM	Member
14	Ir. Dr. Safari bin Hj. Mat Desa	NAHRIM	Member
15	Ms. Rosni Ismail (Withdrawn on 1 June 2021)	JAS	Member
16	Mr. Mohd Zunaidi Mat	METMalaysia	Member
17	Mr. Alvyn Clancey Mickey	JMG	Member
18	Gs. Yusri Abd Jalil	JPS	Member
19	Mr. Van Kong Tze Yien	JPS Sabah	Member
20	Ms. Normahyusni Mohd Anuar	JPS Sarawak	Member
21	Dr. Muhammad Hakimi Mohd Hussain	PLANMalaysia	Member
22	Ms. Fariza Kambut	DOSM	Member
23	Hj. Alias bin Mohammed	JPP	Member
24	Ms. Yaashinni Peraniandy	DOA	Member
25	Mr. Nik Kun Nik Man	MADA	Member
26	Ts. Ir. Dr. Nordin Ramli	MIMOS Bhd	Member
27	Ir. Ts. Ahmad Fuad Zainudin	Pengurusan Air Selangor Sdn Bhd	Member
28	Mr. Noryusuhasriq Mohd Yusof	TNB	Member
29	Ms. Mastawa Zainuddin (Replacement-Joined on 1 June 2021)	JAS	Member (alternate)
30	Ir. Azmi bin Amat	JPS	Member (alternate)
31	Ms. Nur Suhaida Azemi	PLANMalaysia	Member (alternate)
32	Ms. Noor Zarina Mohd Nazir	JPP	Member (alternate)
33	Mr. Mohd Ibrahim Basri	DOA	Member (alternate)

34	Mr. Roslan Mohamed (Replacement-Joined on 4 March 2021)	KKM	Member
35	Mr. Ahmad Ashrin Abdul Jalil	ASM	Analyst
36	Ms. Aida Syarafina Ismail	ASM	Research Assistant
37	Mr. Najmuddin Abdul Rahim	ASM	Research Assistant
38	Ms. Nurul Syahidatul Balqis Haidzir	ASM	Research Assistant

IR4.0 in the Various Water Sub-sectors (IR4.0WS)

No.	Name	Organisation	Position
1	Datuk Ir. Abdul Kadir Mohd Din FASc	MWA	Chairperson
2	Assoc. Prof. Dr. Norhayati Abdullah	UTM	Lead SME
3	Dato. Ir. Abdullah Isnin	-	SME on Water Data Source and Integration
4	Mr. Farok bin Hj. Azmat	UiTM	SME on IT Systems Architect
5	Mr. Mohd. Emran Ibrahim	-	SME on IT Controller
6	Ms. Nordiana Idris	IWK	SME on Reviewer and Benchmarking for Best Practices
7	Mr. Ahmad Zahrin bin Sahmer	IWK	Working Group
8	Mr. Hizaruddin Razak	MyWAC	Working Group
9	Ms. Ir. Faridah Mohd Razelan	KASA	Working Group
10	Dr. Gary William Theseira	MGTC	Working Group
11	Ir. Dr. Asmadi Ahmad	JPS	Working Group
12	Ts. Ir. Dr. Nordin Ramli	MIMOS	Working Group
13	Mr. Zamri Ramli	JMG	Working Group
14	Ms. Azian Fatilah Mia	NAHRIM	Working Group
15	Ir. Shamsunazarudin Shah Mohd Salleh	PAAB	Working Group
16	Ms. Helwa Anisah Abdul Hamid	SPAN	Working Group
17	Mr. Razim Faris (Joined on 5 August 2021)	i2O Water Malaysia Sdn Bhd	Working Group
18	Mr. Lee Koon Yew	MWA	Report Editor
19	Ms. Panitha Murugaiya	ASM	Senior Analyst
20	Mr. Mohammad Khairi Ali	ASM	Senior Analyst

Water-Food-Energy Nexus (WFE Nexus)

No.	Name	Organisation	Position
1	Dr. Ahmad Hezri Adnan FASc	MIER	Chairperson
2	Hj. Juhaimi Jusoh	-	Lead SME
3	Mr. Alizan Mahadi	ISIS	Coordinating SME
4	Dr. Khor Cheng Seong	UTP	SME
5	Dr. Tey Yeong Sheng (Joined on 14 November 2020)	UPM	SME
6	Ir. Marini Mohamad Ideris	NAHRIM	SME
7	Prof Shaufique Fahmi Ahmad Sidique (Joined on 8 July 2021)	UPM	SME
8	Ms. Nur Ameera A Jaz (Joined on 8 July 2021)	-	SME
9	Prof. Fadzilah Majid Cooke	UMS	Member
10	Ir. Lalchand Gulabrai FASc	-	Member
11	Dr. Larry Wong	-	Member
12	Dr. Asnor Muizan Ishak	JPS	Member
13	Datuk Ir. Mohd Adnan Mohd Nor FASc	RPM Engineers Sdn Bhd	Member
14	Mr. Darshan Joshi (Joined on 1 November 2020)	ISIS	Analyst
15	Ms. Saidatul Hasniza Hasnen	ASM	Research Assistant
16	Ms. Ili Nadiah Dzulfakar (Joined on 1 May 2021 and withdrawn on 1 September 2021)	ISIS	Research Assistant
17	Ms. Syafiqah Syakira Saiftul Yazan (Joined on 1 November 2020 and withdrawn on 28 April 2021)	ISIS	Research Assistant
18	Ms. Ainun Jabi (Joined on 1 April 2020 and withdrawn on 30 September 2020)	ISIS	Analyst

Virtual Water and Water Footprint (VW&WF)

No.	Name	Organisation	Position
1	Prof. Dr. Zulkifli Yusop FASc	UTM	Chairperson
2	Prof. Ts. Dr. Zainura Zainon Noor	UTM	Lead SME
3	Prof. Dr. Fadhilah Yusof	UTM	SME
4	Dr. Muhammad Najib Mohamed Razali	UTM	SME
5	Dr. Wan Farah Wani Fakhuruddin (Joined on 9 February 2021)	UTM	Technical Writer
6	Dato' Dr. Ir. Andy Seo Kian Haw FASc	ASM	Member
7	Dr. Vijaya Subramaniam	MPOB	Member
8	Mr. Nik Kun Nik Man	MADA	Member
9	Dato' Dr. Mohamad Zabawi Abdul Ghani	MARDI	Member
10	Prof. Dr. Sumiani Yusoff	UM	Member
11	Dr. Mohd Nasaruddin Mohd Aris	LGM	Member
12	Mr. Yosri bin Mohd	DOA	Member
13	Mr. Justine Jok Jau Emang	NREB	Member
14	Mr. Vitalis J. Moduying	EPD Sabah	Member
15	Ms. Siti Nurhayati Kamaruddin	ASM	Analyst
16	Ms. Noor Salehan Mohammad Sabli	ASM	Analyst
17	Ms. Nurliyana Mahpof	UTM	Research Assistant
18	Ms. Nurul Hana Mohamed	UTM	Research Assistant

Climate Change Impact and Adaptation (CCIA)

No.	Name	Organisation	Position
1	Prof. Dr. Joy Jacqueline Pereira FASc	UKM	Chairperson
2	Dr. Cheah Wee	UM	SME
3	Dr. Sheeba Nettukandy Chenoli	UM	SME
4	Ms. Aimi Ayuni Mohamad Sapia	MGTC	SME
5	Ms. Kiranjeet Kaur	MGTC	SME
6	Dr. Norsyafina Roslan (Joined on 23 December 2020)	UKM	SME
7	Ms. Nurul Syazwani Yahaya (Joined on 25 September 2020)	UKM	SME
8	Dr. Kwan Soo Chen (Joined on 23 February 2021)	UKM	SME
9	Assoc. Prof. Dr. Arpah Abu Bakar (Joined on 23 February 2021)	UUM	SME
10	Dr. Md. Azizul Bari (Joined on 23 February 2021)	-	SME
11	Prof. Datuk Dr. Azizan Abu Samah FASc	UM	Member
12	Assoc. Prof. Dr. Rawshan Ara Begum	UKM	Member
13	Ms. Siti Nooraznie Rahim	KASA	Member
14	Dr. Nagulendran Kangayatkarasu (Withdrawn- Transferred to MOSTI on 23 August 2021)	KASA	Member
15	Dr. Sugumari a/p Shanmugam (Replacement- Joined on 23 August 2021)	KASA	Member
16	Mr. Ahmad Farid Mohammed	KASA	Member
17	Dr. Gary W. Theseira	MGTC	Member
18	Mr. Wan Faizal Mohd Anwar	MGTC	Member
19	Dr. Ahmad Fairudz Jamaluddin	METMalaysia	Member
20	Mr. Dunstan Anthony	NAHRIM	Member
21	Prof. Dr. Azazi Zakaria	USM	Member
22	Assoc. Prof. Dr. Zelina Zaiton	UPM	Member
23	Dr. Nurfashareena Muhamad	UKM	Member
24	Dr. Lim Choun Sian	UKM	Member
25	Prof. Dr. Mazruza Sahani	UKM	Member
26	Assoc. Prof. Dr. Rozita Hod	UKM	Member
27	Prof. Dato' Dr. Rajah Rasiah FASc	UM	Member
28	Dr. Sharina Abdul Halim	UKM	Member
29	Mr. Zamri Ramli	JMG	Member
30	Mr. Jamil Derus bin Ahmad	NADMA	Member
31	Ir. Dr. Asmadi bin Ahmad @ Hasan	JPS	Member
32	Ms. Raihani binti Che Mamat	KPKT	Member
33	Dr. Muhammad Hakimi Mohd Hussain (Withdrawn on 28 October 2020)	PLANMalaysia	Member
34	Ms. Nor Zaliza Mohd Puzi (Joined on 23 December 2020)	PLANMalaysia	Member
35	Dr. Nurul Sa'dah Bahar	JKR	Member
36	Dr. Asif Raihan (Joined on 25 September 2020)	UKM	Contributor (Postdoctoral Researcher)
37	Dr. Tariqur Rahman Bhuiyan (Joined on 28 October 2020)	UKM	Contributor (Postdoctoral Researcher)

38	Dr. Mohd Fadzil Firdzaus Bin Mohd Nor (Joined on 3 July 2020)	UM	Contributor (Post Doctoral Research Fellow)
39	Ms. Siti Khadijah Satari (Joined on 3 July 2020)	UKM	Contributor (Senior Research Officer)
40	Dr. Go Wen Ze	ASM	Postdoctoral Researcher
41	Mr. Navakanesh M. Batmanathan	ASM	Analyst
42	Mr. Mohd. Shahairudin Hairi (Joined on 9 December 2020)	ASM	Research Assistant
43	Ms. Siti Hasniza Muhammad Arshad (Joined on 4 January 2021)	ASM	Research Assistant

Alternative Water Financing (AWF)

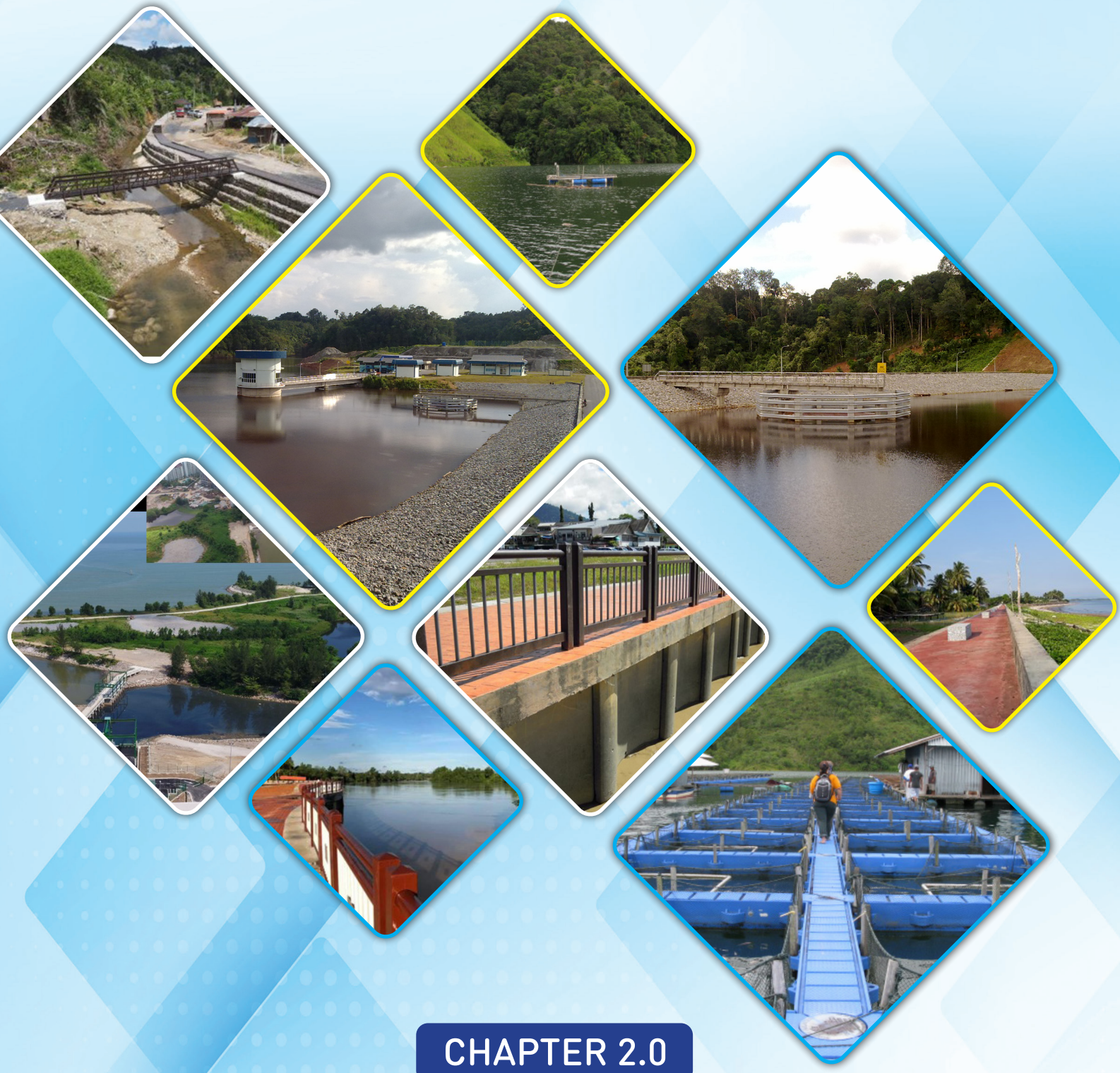
No.	Name	Organisation	Position
1	Dato' Seri Ir. Dr. Zaini Ujang FASc	KASA	Chairperson
2	Dr. Ching Thoo Kim	KASA	SME
3	Prof. Dr. Ashraf Md. Hashim (Joined on 24 November 2020)	ISRA	SME
4	Dr. Razul Ikmal Ramli (Member from 2 May 2020 to 30 April 2021. SME starting from 1 May 2021)	KASA	SME
5	Ms. Chen Shaua Fui (Joined on 1 December 2020)	SPAN	Expert Writer
6	Dr. Kirushantini Balakrishan (Joined on 22 February 2021)	USIM	Expert Writer
7	Mr. Abdul Hadi Ali (Joined on 21 October 2020)	PAAB	Member
8	Mr. Narendran Maniam (Joined on 21 October 2020)	IWK	Member
9	Ir. Ts. Hj. Mohamed Haniffa Hj. Abdul Hamid FASc (Joined on 21 October 2020)	IWK	Member
10	Dato' Ir. Mohd Shukri Abdul Razik (Joined on 21 October 2020)	SPAN	Member
11	En Jamalulail Abu Bakar (Joined on 21 October 2020)	KASA	Member
12	Dato' Ir. Nor Hisham Mohd Ghazali (Joined on 1 December 2020)	JPS	Member
13	Ms. Amalina Abdul Alim (Joined 1 September 2020)	ASM	Analyst
14	Ms. Fatin Atiqah Abd Rahman (Joined on 4 December 2020)	ASM	Research Assistant
15	Ms. Nurul Mehiran Shafikah (Joined on 19 April 2020)	ASM	Research Assistant
16	Ms. Norafrina Shamsul Azwan (Withdrawn on 31 March 2021)	ASM	Research Assistant

Water as an Economic Sector (WES)

No.	Name	Organisation	Position
1	Prof. Dr. Mahendhiran Sanggaran Nair FASc	Sunway University	Chairperson
2	Prof. Dr. Pervaiz K Ahmed	Sunway Institute for Global Strategy and Competitiveness	Member
3	Prof. Dr. Santha Vaithilingam	Sunway Institute for Global Strategy and Competitiveness	Member
4	Prof. Dr. Keshab Shrestra	Monash University Malaysia	Member
5	Mr. Daniel Lee Lih Wei	Sunway University	Member
6	Mr. Yeng Hong Qing	Sunway Institute for Global Strategy and Competitiveness	Senior Analyst
7	Ms. Choong Chai Lim	Sunway Institute for Global Strategy and Competitiveness	Analyst
8	Mr. Ong Chu Sun	Sunway Institute for Global Strategy and Competitiveness	Analyst
9	Ms. Shirlyn Tang (Joined on 15 June 2021)	Sunway Institute for Global Strategy and Competitiveness	Analyst
10	Mr. Leong Zhuan Kee (Joined on 15 June 2021)	Sunway Institute for Global Strategy and Competitiveness	Analyst

Water Security and COVID-19 Pandemic Team (Starting 18 February 2021)

No.	Name	Organisation	Position
1	Datuk. Dr. Abdul Rahim Nik FASc	ASM	Chairperson
2	Academician Datuk Fateh Chand FASc	ASM	Member
3	Dr. Low Kwai Sim FASc	ASM	Member
4	Dr. Kalithasan Kailasam	ASM	Member
5	Prof. Datuk Dr. Lokman Hakim Sulaiman FASc (Joined on 19 March 2021)	IMU	Member (Medical Expert)
6	Dr. Larry Wong	-	Member (Agriculture Expert)
7	Ms. Laviinia Dhanagunan (Withdrawn on 16 July 2021)	ASM	Writer
8	Ms. Joy Grace Rayappan (Withdrawn on 9 August 2021)	ASM	Senior Analyst
9	Mr. Loh Chia Hur	ASM	Analyst
10	Ms. Nurul Rahimah Abu Bakar	ASM	Analyst
11	Mr. Hareehaaran Mathialagan	ASM	Analyst



CHAPTER 2.0

MALAYSIA'S WATER SECTOR

Water is our most precious resource, a 'blue gold' to which more than 2 billion people do not have direct access. It is not only essential for survival, but also plays a sanitary, social and cultural role at the heart of human societies

– Ms. Audrey Azoulay, Director-General of UNESCO (March 2021)

2.1 INTRODUCTION

World Water Day 2021, celebrated on 22 March 2021, carried the theme, **Valuing Water**. The occasion saw the launch of the United Nations World Water Development Report (WWDR) 2021 entitled "Valuing Water", published by UNESCO on behalf of UN-Water. The report highlights that the inability to recognise the value of water is the main cause of water waste and misuse.

It is a timely and appropriate theme, especially for the Malaysian water sector when it is set to begin its journey under the 12th MP (2021–2025) on a four five year-phased implementation plan aimed at the Transformation of the Water Sector by 2040, from its current position as a mere economic enabler to a dynamic growth sector, contributing to the national economy.

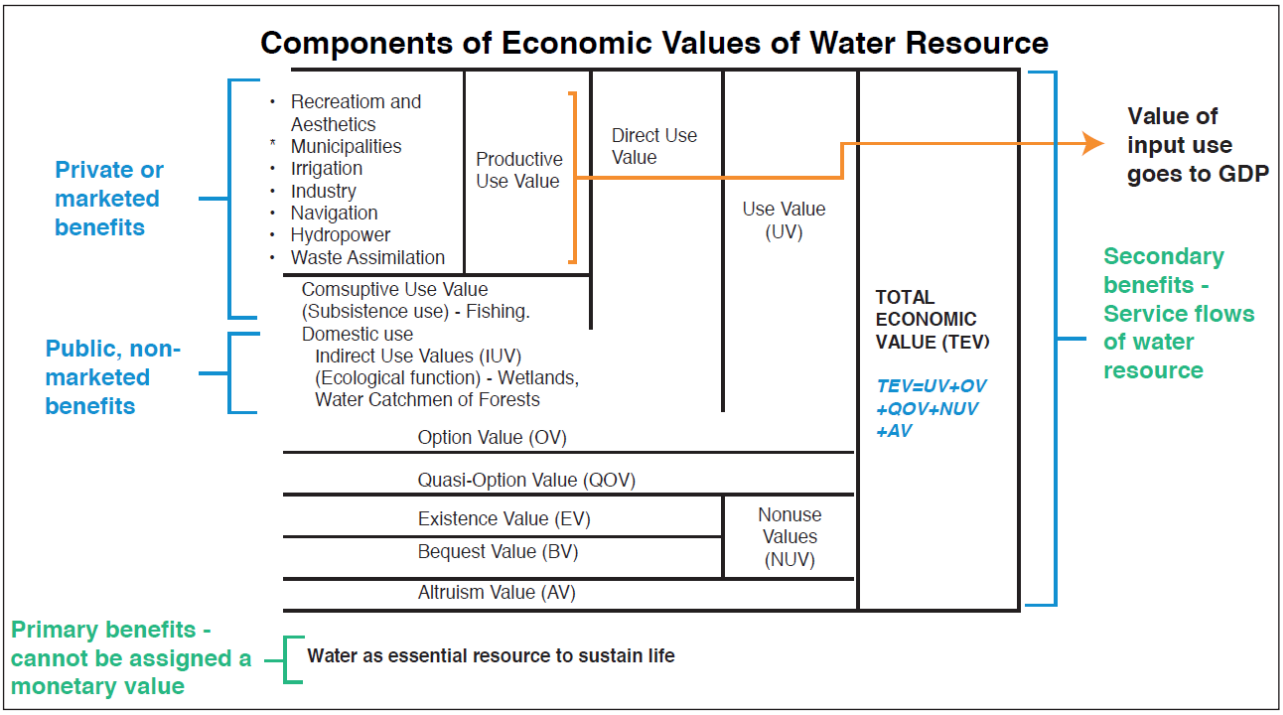
Valuing water for all its economic, environmental, social, and cultural benefits also means valuing its sources, be it surface or groundwater, flowing as lentic and lotic systems in rivers, lakes, and aquifers. It also entails the recognition of water symbiotic relations with other natural resources, namely land, forests, minerals, wildlife, and inland fisheries, as integral components of land-based river basins defined naturally by their hydrological boundaries.

Located in the tropics, Malaysia is blessed with fairly abundant rainfall. As a result, there is a perception that water is readily available, and the rivers would presumably be able to provide all water needed for livelihood and multiple use. Therefore, the tendency not to value water. This is borne by water use data released by SPAN in 2019 for Peninsular Malaysia and the Labuan FT (Suruhanjaya Perkhidmatan Air Negara (span.gov.my)). In 2018, it was reported that there was an increase of 4 litres consumption/capita/day (l/c/d) to 226 l/c/d from 222 l/c/d in 2017. As compared to the UN benchmark of 165 l/c/d, Malaysians are consuming 61 l/c/d (or, 37%) more water per day than is necessary. Therefore, there is an urgent need to look into the factors leading to this high-water consumption with the view of reducing wastage and misuse through the application of appropriate legal, technological and management instruments.

2.2 ROLE OF THE WATER SECTOR IN THE NATIONAL ECONOMY

The NKPA thematic study report by ASM released in 2015 had highlighted that water serves two broad roles in the economy. Firstly, as input in the economic process to derive the economic output (goods and services), which cannot be produced without water. Secondly, water is a natural amenity in terms of ecosystem services and life sustenance (Figure 2.1).

The study report had inferred that the economic value of water and its importance per se are not reflected accurately in the GDP. It is not explicitly categorised in the economic sector of the economy. Its importance is only implicit under the waterworks sector. Even so, not the entire value (cost) of water as an input is captured by GDP or GNI. On the benefits provided by water in terms of ecosystem services and life sustenance, none of these are reflected in the GDP or GNI account.



(*Source*: Jamal Othman[1], UKM)

Figure 2.1. Components of economic values of water resource

The Department of Statistics Malaysia (DOSM–2020) had reported that "total water abstraction from natural resources in 2015 recorded 14,791 million cubic metres, including 14,678 million cubic metres (99.2%) from inland water resources and other sources of 113 million cubic metres (0.8%)."

Domestic production of abstracted water by the water supply and sewerage sectors for distribution dominated the supply in the economy with a value of 3,790 million cubic metres (99.3%) as compared to imports which registered a value of 25 million cubic metres. Total supply and use of abstracted water for distribution and own use in the Malaysia's economy for 2015 registered 3,815 million cubic metres and 8,590 million cubic metres, respectively

In terms of treated water use in the various industries, DOSM data (2015) showed that food crops and flower plants are amongst the highest users of treated water for their production (Figure 2.2) with some 30 industries being supplied with about 70.6% of water supply.

1 Prof. Dr. Jamal Othman was part of the 2015 ASM NKPA Advisory Report Study team and provided the graphic shown to be included in the NKPA Advisory Report

No.	Industry	2015
1	Water*	15.37
2	Soft drinks, mineral waters and other bottled waters	5.62
3	Food crops	3.84
4	Flower plants	2.90
5	Non-profit institutions serving households	2.84
6	Sewerage, waste management and remediation activities	1.96
7	Arts, entertainment and recreation	1.38
8	Vegetables	1.37
9	Scientific research and development	0.87
10	Processing and preserving of fruits and vegetables	0.75
11	Wholesale and retail trade, repair of motor vehicles and motorcycles	0.74
12	Refractory, clay, porcelain and ceramic products	0.69
13	Confectionery	0.64
14	Accommodation	0.64
15	Public order and safety	0.64
16	Basic iron and steel	0.59
17	Food and beverage	0.54
18	Electricity and gas	0.54
19	Fertilizers and nitrogen compounds	0.53
20	Other textiles	0.50
21	Rubber gloves	0.50
22	Postal and courier activities	0.47
23	Real estate	0.45
24	Finishing of textiles	0.42
25	Education	0.42
26	Reproduction of recorded media	0.39
27	Fruits	0.37
28	Other public administration	0.35
29	Printing	0.32
30	Basic chemicals	0.32

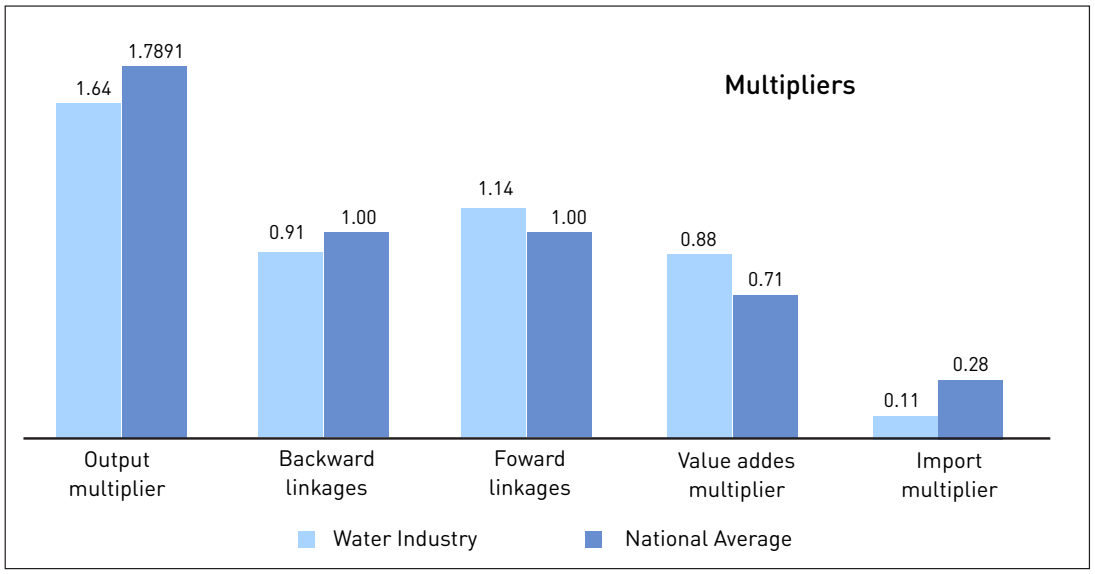
*Treated water supply services
Source: DOSM (2015)

Figure 2.2. Top 30 largest water users in their production

Increasing population and economic activities have raised the demand for water in the last few years. Based on data from DOSM for 2015 and 2019, the WES sub-sector study in its WST2040 Final Report (Volume 9) has reported that "the water collection, treatment and supply sector has experienced a growth of 31% in gross output from RM6.1 billion in 2015 to RM7.9 billion in 2019. The value-add of water sector has increased from RM3.5 billion in 2015 to RM4.5 billion in 2019 (a 29 % growth). The intermediate input in this sector increased from RM2.6 billion in 2015 to RM3.4 billion in 2019. The sector also increased employment from 16,113 in 2015 to 18,662 in 2019, and the salary bill jumped from RM633 million to RM749 million for the same period, respectively".

It is therefore clear that the water industry has much scope for increasing its contribution to the economy. This belief is reflected in the strong forward linkage[2] shown by the water industry as an important supporting industry in the economy (Figure 2.3).

2 Forward linkages are created by adding value to the commodities extracted by the industry by processing and refining in order to locally to produce finished goods instead of exporting them in their raw state. The economic viability of forward linkages varies from commodity to commodity.
Backward linkages refer to inputs to the oil, gas and mining projects from the national economy, which can include local community-focussed procurement, such as security, clothing and food supplies and high value-added items, such as capital machinery and equipment. Backward linkages encompass subcontracting, supplier contracts, input service collaborations and hence can create employment and offer potential for enhancing domestic manufacturing capacity (https://www.extractiveshub.org/topic/view/id/47/chapterId/523 downloaded on 23 July 2020).



Source: DOSM and EPU (2019)

Figure 2.3. Linkage of water industry with other industries

2.2.1 National and State Policies/Acts/Enactments/Ordinances That Can Impact the Water Sector

There are 45 policies (Figure 2.4) that can impact the water sector in one way or another, beginning with the National Water Resources Policy 2012 (currently being reviewed by KASA). In addition, there are 74 Acts (Figure 2.5) and some 70 state enactments and ordinances (Figure 2.6) that can also impact the water sector.

1. National Water Resources Policy (NWRP) 2012
2. National Green-Technology Policy (2009)
3. National Policy on the Environment (2002)
4. National Policy on Climate Change (2009)
5. National Policy on Biodiversity (2016-2025)
6. National Agro-Food Policy (2011-2020)
7. National Timber Industry Policy (2009-2020)
8. National Mineral Policy 2 (2009)
9. New Energy Policy (2010)
10. National Biofuel Policy (2006)
11. National Forestry Policy (1978; Revised 1992)
12. National Urbanisation Policy 2 (2016-2025)
13. National Consumer Policy (2002)
14. National Solid Waste Management (2016)
15. National Tourism Policy (2020-2030)
16. Education Blueprint (2006-2010)
17. National Bio-Technology Policy (2005)
18. Malaysia Space Policy 2030
19. National Standards For Drinking Water Quality (2000; Revised 2004)
20. National Physical Plan 3 (2016)
21. Green Technology Masterplan Malaysia (2017-2030)
22. Malaysia Smart City Framework (2018)
23. Public Sector Open Data Initiative (2014)
24. Water Safety Plan (WHO)
25. National Action Plan for Peatlands (2011)
26. National Policy on Rural Development (2030)
27. National Renewable Energy Policy & Action Plan (2010)
28. National Energy Efficiency Action Plan (2015)
29. National Plan of Action for Nutrition of Malaysia III (2016-2025)
30. Malaysian National Environmental Health Action Plan (2013)
31. National Transport Policy (2019 – 2030)
32. National Ecotourism Plan (2016 – 2025)
33. National Community Policy (2019)
34. Shared Prosperity Vision 2030
35. Malaysia Roadmap Towards Zero Single Use Plastics (2018-2030)
36. National Cleanliness Policy (2019)
37. Communications and Multimedia Blueprint (2018 – 2025)
38. Malaysia Shipping Master Plan (2017 – 2022)
39. Pelan Strategik Jabatan Hutan Sarawak (2015-2020)
40. Sabah Forestry Policy (2018)
41. National Education Policy (2017)
42. The National Physical Plan for Coastal Zone Areas (2012)
43. Central Forest Spine (CFS): The Master Plan for Ecological Linkages (2010)
44. National Policy on Science, Technology and Innovation (2021 – 2030)
45. National Security Policy 2021 -2025

Figure 2.4. Policies that can impact the water sector

1. Abattoirs (Privatization) Act 1993
2. Bintulu Port Authority Act 1981
3. Biosafety Act 2007
4. Control Of Activities On The Lake (Federal Territories Of Putrajaya) By-Laws 2004
5. Drainage Works Act 1954
6. East Coast Economic Region Development Council Act 2008
7. Electricity Supply Act 1990
8. Energy Commission Act 2001
9. Environmental Quality Act 1974
10. Environmental Quality (Schedules Wastes) Regulations 2005
11. Existing Water Project Funding Policy/Budgetary
12. Factories And Machinery Act 1967
13. Federal Agricultural Marketing Authority Act 1965
14. Federal Constitution
15. Federal Lands Commissioner Act 1957
16. Federal Territory (Planning) Act 1982
17. Fisheries Act 1985
18. Geological Survey Act 1974
19. Irrigation Areas Act 1953
20. Iskandar Regional Development Authority Act 2007
21. Islamic Financial Services Act 2013
22. Kemubu Agricultural Development Authority Act 1972
23. Land Acquisition Act 1960
24. Land Conservation Act 1960
25. Land Development Act 1956
26. Langkawi International Yacht Registry Act 2003
27. Lembaga Kemajuan Johor Tenggara (Dissolution) Act 1997
28. Lembaga Kemajuan Kelantan Selatan Act 1978
29. Lembaga Kemajuan Pahang Tenggara (Dissolution) Act 1997
30. Lembaga Kemajuan Terengganu Tengah Act 1973
31. Lembaga Kemajuan Wilayah Kedah Act 1981
32. Lembaga Kemajuan Wilayah Pulau Pinang Act 1983
33. Lembaga Letrik Sabah Act 1983
34. Lembaga Pembangunan Langkawi Act 1990
35. Local Government Act 1976
36. Malaysian Agricultural Research And Development Institute Act 1969
37. Malaysian Forestry Research And Development Board Act 1985 Malaysian Maritime Enforcement Agency Act 2004
38. Malaysian Rubber Board (Incorporation) Act 1996
39. Merchant Shipping (Oil Pollution) Act 1994
40. Mineral Development Act 1994
41. Mining Enactment 1962 (Ft)
42. Town And Country Planning Act 1976
43. Waters Act 1920
44. Water Services Industry Act 2006
45. Water Supply (Federal Territory Of Kuala Lumpur) Act 1998
46. Ministerial Functions Act 1969
47. Statistics Act 1965 (Revised 1989)
48. National Space Authority (Nsa) Bill 2020
49. National Security Council's Directive 20 (2012)
50. Personal Data Protection Act 2010
51. Communications And Multimedia Act 1998Muda Agricultural Development Authority Act 1972
52. National Forestry Act 1984
53. National Heritage Act 2005
54. National Land Code 1960
55. National Land Code (Penang And Malacca Titles) Act 1963
56. National Parks Act 1980
57. Northern Corridor Implementation Authority Act 2008
58. Padi Cultivators (Control Of Rent And Security Of Tenure) Act 1967
59. Penang Port Commission Act 1955
60. Perbadanan Labuan Act 2001
61. Perbadanan Pembekalan Letrik Sarawak Act 1983
62. Perbadanan Putrajaya Act 1995
63. Petroleum Development Act 1974
64. Petroleum (Safety Measures) Act 1984
65. Petroleum Mining Act 1966
66. Port Authorities Act 1963
67. Ports (Privatisation) Act 1990
68. Sewerage Services Act 1993 (Act 508) & Regulations And Orders
69. Solid Waste And Public Cleansing Management Act 2007
70. Solid Waste And Public Cleansing Management Corporation Act 2007
71. Street Drainage And Building Act 1974
72. Suruhanjaya Perkhidmatan Air Negara Act 2006

Figure 2.5. Federal acts that can impact the water sector

Johor
- Mineral Enactment 2003
- Waters Enactment 1921

Kedah
- Mineral Enactment 2004
- Waters Resources Enactment 2007

Melaka
- Mineral Enactment 2002
- River And Coastal Development Corporation Enactment 2005
- Water Resources Enactment (Melaka) 2014

Kelantan
- Mineral Enactment 2001
- Rivers And Drainage Enactment No 18 Of 1935
- Kelantan Enactment No. 4 Of 1971

Negeri Sembilan
- Mineral Enactment 2002
- Quarry Rules 2009
- Negeri Sembilan Enactment No.3 Of 2007

Pahang
- Mineral Enactment 2001
- Water Resources Enactment 2007

Perak
- Mineral Enactment 2003
- Water (Amendment) Enactment 2009

Selangor
- Mineral Enactment 2000
- Waters Management Authority Enactment 1999
- Enakmen Lembaga Urus Air Selangor (Pindaan) 2020

Perlis
- Control Of Rivers And Streams Enactment 1957
- Waters Perlis Enactment No. 9/1357
- Water Supply Perlis Enactment 2/1952
- Mining Enactment Perlis No. 1/1340
- Mineral Ores Enactment Perlis No. 2/1356
- Forest Enactment Perlis No. 3/1370

Pulau Pinang
- Mineral Enactment 2001
- Water Enactment 1967

Terengganu
- Quarry Rules 2007
- Enakmen Sumber Air (Terengganu) 2020

Sabah
- Biodiversity Enactment 2000
- Cultural Heritage (Conservation) Enactment 1997
- Drainage And Irrigation Ordinance 1956
- Environment Protection Enactment 2002
- Forest Enactment 1968
- Ko-Nelayan Enactment 1981
- Local Government Ordinance 1961
- Merchant Shipping Ordinance 1960
- Mineral Enactment 1999
- Mining Ordinance 1960
- Parks Enactment 1984
- Ports And Harbours Enactment 2002
- Ports Authority Enactment 1981
- Public Health Ordinance 1960
- Sabah Inland Fishries And Aquaculture Enactment 2003
- Sabah Land Ordinance
- Sabah Water Resources Enactment 1998
- Sabah Water Supply Enactment 2003
- Town And Country Planning Ordinance
- Water Regulations 1961
- Wildlife Conservation Enactment 1997

Sarawak
- Electricity Ordinance
- The Electricity Rules 1999
- Sarawak Electricity Supply Corporation (Successor Company) Ordinance 2004
- Sarawak Electricity (State Grid Code) Rules 2003
- Forest Ordinance 1954
- Local Authorities Ordinance 1996
- Merchant Shipping Ordinance 1960
- Mineral Ordinance 2004
- National Parks And Nature Reserves Ordinance 1998
- Natural Resources And Environment Ordinance 1958
- Public Park And Green Ordinance 1993
- Regional Corridors Development Authoroties Ordinance 2006
- Sarawak Biodiversity Centre Ordinance 1997
- Sarawak Foresty Corporation Ordinance 1995
- Sarawak Land Code
- Sarawak River Ordinance 1993
- Sarawak Riverine Transport Bill 1993
- Sarawak Water Ordinance 1994
- Water Supply Regulation 1995
- Sewerage Systems And Services Ordinance 2005
- State Fisheries Ordinance 2003
- Wildlife Protection Ordinance 1998

Figure 2.6. State enactments and ordinances that can impact the water sector

2.3 GLOBAL AND NATIONAL CHALLENGES FACING THE WATER SECTOR

Five major global and national challenges have been identified as affecting the water sector before 2050. These are rising population, migration to cities, food production increase, water demand increase and rapid climate change.

2.3.1 Global Challenges

2.3.1.1 Rising Population

In 2017, the UN's Department of Economic and Social Affairs (https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html) had projected that the current world population of 7.6 billion would reach 8.6 billion in 2030 and 9.8 billion in 2050, with roughly 83 million being added to the world's population every year, even assuming that fertility rates continue to decline.

2.3.1.2 Migration to Cities

The UN in 2018 had reported that currently some 55% of the world's population live in urban areas, a proportion is expected to increase to 68% by 2050 (https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html).

2.3.1.3 Food Production Increase

Globally, FAO (2012) had projected a 35% increase in food production by 2030 (trend assumes a 2ºC warmer world by 2030 and an associated 10% reduction in food crop yields) (from http://pubdocs.worldbank.org/en/862271433768092396/Holger-Kray-RO-SustainableAg-hkray-ENG.pdf). In 2050, FAO (2009) had projected that food production (net of food used for biofuels) must increase by 70% so as to be able to feed the enlarged population growth and urbanisation needs. (http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf).

2.3.1.4 Water Demand Increase

Globally, Water Resources Group (WRG) (2012) had projected that the gap between global water supply and demand is projected to reach 40% by 2030 if current practices continue (https://www.weforum.org/our-impact/closing-the-water-gap). By 2050, water demand is projected to increase by 55% globally between 2000 and 2050 (https://globalwaterforum.org/2012/05/21/water-outlook-to-2050-the-oecd-calls-for-early-and-strategic-action/).

2.3.1.5 Rapid Climate Change

Globally, Thomson (2014), for Climate Central Organisation, stated that to mitigate climate change and keep the warming under the 2°C threshold agreed on by the world's governments at a 2009 meeting in Copenhagen, greenhouse gas emissions in 2050 will have to be 40% to 70% lower than what they were in 2010 (https://www.climatecentral.org/news/major-greenhouse-gas-reductions-needed-to-curtail-climate-change-ipcc-17300).

On 9 Aug. 2021, the Intergovernmental Panel on Climate Change (IPCC), in its Sixth Assessment Report, highlighted that "human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Scientists were also observing changes across the whole of Earth's climate system; in atmosphere, oceans, ice floes, and on land. Many changes were unprecedented, and some of the shifts are in motion now, while some, such as continued sea level rise, are already 'irreversible' for centuries to millennia" (IPCC report: 'Code red' for human driven global heating, warns UN chief | | UN News). The UN Secretary-General called for global action now, noting that the internationally-agreed threshold of 1.5 degrees above pre-industrial levels of global heating was "perilously close. He further stated that we are at imminent risk of hitting 1.5 degrees in the near term. "The only way to prevent exceeding this threshold is by urgently stepping up our efforts, and pursuing the most ambitious path".

2.3.2 National Challenges

While Malaysia would not be spared from the five global challenges described above, there are also country specific issues and challenges that the country's water sector needs to address. Some 37 water-related issues and challenges were identified by MEA following the consultations organised jointly by EPU/UNDP throughout 2019. These are listed in Box 2.2[3], classified under five major categories, namely "people", "governance", "finance", "information" and "infrastructure". They were also reported in previous reports regarding the water sector, namely the National Water Resources Study (2011) and the National IWRM Plan report by ASM published in 2016. For a country located in the tropics blessed with fairly abundant rainfall, the problems faced are mainly management related. Malaysia has since the late 1990s committed itself to the adoption of IWRM as its central thrust in sustainably managing the country's water resources. This commitment was reflected in policy statements under OPP3 (2001-2010) and reaffirmed in subsequent 8th MP (2001–2005) and 9th MP (2006–2010) and later embodied in the National Water Resources Policy launched in March 2012 after its passage through Parliament. However, IWRM implementation has yet to take root nationwide and the penetration level can best be regarded as sporadic both at federal and state administration levels.

3 An expanded write-up on the identified Issues and Challenges is given in the following Section 2.4 entitled "Conclusions Drawn from the National Landscape".

BOX 2.2. ISSUES AND CHALLENGES FACING MALAYSIA IN THE WATER SECTOR

PEOPLE

- Low awareness level
- Lack of appreciation to water
- Wastage of water
- Lack public ownership on water
- Increasing population and rapid urbanization
- Unsustainable lifestyle-private vs public goods
- Lack of skilled/competent workers
- Water pollution

GOVERNANCE

- State/Federal involvement in protecting water resource
- Division of functions on water Governance
- Lack of provision on water-energy-food nexus and water for environment
- Legislative gaps
- Lack/ineffective monitoring and enforcement
- Competing of water resources use
- Land use change affecting water resources

INFORMATION

- Lack of data quality
- Unintegrated data
- Lack accessibility to data
- Transparency of data
- Insufficient RDIC activities
- Lack of coordination on RDIC work

FINANCE

- Lack of financial sustainability of water services providers
- Water pricing-too low
- Lack of long-term financial resilience
- Over-dependent on Federal Government funding for CAPEX
- Insufficient allocation for maintenance works

INFRASTRUCTURE

- Depleting water resources
- High NRW level
- Insufficient or outdated infrastructure to support existing or future demand
- Reactive to disaster
- Lack of non-structural measures and nature-based approach
- Lost of opportunity to use flood water dams
- Lack of quality water resources
- Limited resource recovery facilities
- Lack of need-based policies/programmers
- Urban-focused infratructure

Source: MEA (2019)

The above observation is borne out by an UN-Water and the UN Environment Programme (UNEP) Progress Report in 2018 when measuring the degree of IWRM implementation. The report stated that amongst 172 countries, Malaysia scored 43 out of 100, which indicated that IWRM implementation in Malaysia is at a medium-low degree. The publication concluded that, without accelerating progress, 60% of countries, including Malaysia, were unlikely to achieve SDG target 6.5 on implementing IWRM at all levels, including

Country	Final IWRM Score	Section 1 Average Enabling environment	Section 2 Average Institution and participation	Section 3 Average Management Instrument	Section 4 Average Financing
SINGAPORE	100	100	100	100	100
PHILLIPINES	51	64	53	52	37
INDONESIA	48	52	53	52	36
CAMBODIA	46	54	46	50	32
MALAYSIA	43	46	47	47	32
VIETNAM	38	47	35	36	34
MYANMAR	27	17	21	27	45

Implementation categories	Very High	High	Medium-high	Medium-low	Low	Very Low
Score range	91-100	71-90	51-70	31-50	11-30	0-10
General interpretation for overall IWRM score	Plans and programmes are reviewed and revised	Most IWRM objectives are generally met	Most IWRM elements are being implemented under long term programme	IWRM elements are institutionalised, and inplementation is underway	Some implementation of IWRM elements has begun	Development of IWRM elements has generally not begun, or has stalled

Source: UNEP (2018)

Figure 2.7. Malaysia's performance on its implementation of its IWRM programme

through transboundary cooperation, by 2030. Malaysia's Performance as compared to other ASEAN countries is shown in Figure 2.7.

However, in a subsequent national survey conducted in 2020 by UNEP, the achieved results as shown in Box 2.3, indicated a vast improvement in the comparative sectional average and national scores achieved in 2020 over those achieved in 2017. The 2020 average score of 63 places Malaysia in the "medium-high" category (51 – 70) interpreted as "Capacity to implement IWRM elements under long-term programmes generally adequate". There is much room for further improvement. Five main issues highlighted by the UNEP progress report of 2018 were:

- Lack of effective governance at all levels, including updated policies and legislations as well as relevant institutions.
- Lack of ownership and participation of stakeholders ranging from government, private (including water managers) and communities, including school children.
- Insufficient quality, unconsolidated data/information and their limited accessibility, and inadequate effective RDIC activities.
- Lack of necessary financial capabilities for effective implementation.
- Inadequate infrastructure and technology innovation.

Box 2.3: Malaysia's Sustainable Development Goal 6 Achievements in respect of IWRM Implementation

Section	Av. Score (2020)	Av. Score (2017)
1) Enabling environment	76	46
2) Institution and participation	65	47
3) Management instruments	58	47
4) Financing	52	32
Indicator SDG 6.5.1 Score	**63**	**43**

2.4 FOCUS AREA-BASED CONCLUSIONS DERIVED FROM ISSUES AND CHALLENGES IMPACTING THE WATER SECTOR

The following 36 conclusions were based on the issues and challenges derived from the contents depicted in Box 2.2 (page 32), structured along the five focus areas:

2.4.1 People

Under this focus area, the following eight take-away messages and conclusions can be made:

i) Low Awareness of IWRM principles

It was generally found that people, including government officers down to the local level) are unaware of the IWRM framework (in 2018, Malaysia was categorised by UNEP, based on feedback from Malaysia, as being at the medium-low level of implementation) and of the four underlying IWRM categories, relating to:

a. **Enabling Environment** (policies, legislations, regulations and finance).
b. **Institutional Framework** of institutions (at the various levels of national, state, river basin and at the local level) such as Majlis Air Negara and Majlis Sumber Air Negeri, just to name two institutions.
c. **Management Instruments** (covering information management, planning, economic & financial instruments, legal (licenses & penalties), technical instruments, operation & maintenance, participatory management, research & development, awareness, advocacy and capacity building and international collaboration.
d. **Investments in Water Infrastructure** (with 14 EPPs for cross-cutting programmes, 48 EPPs for water as a resource and 33 EPPs for water for livelihood).

ii) Lack of appreciation of water

With the various Malaysian rivers found to be polluted with physical, biological and chemical wastes, these precious sources of water become unsuitable as sources for treatment prior to supply. In addition, the low cost of treated water supply to households leads to wastage of water in many instances. Therefore, factors such as low tariff rates, free water policy, and lack of appreciation over water value drive up consumption.

iii) Wastage of water

The comparatively low cost of treated water supply to households leads to wastage of water in many instances, as mentioned in (ii) above.

iv) Lack public ownership of water

Another conclusion that can be derived from the many images in the media as well as recorded instances in reports, whereby used household items are discarded in rivers flowing by their houses suggest that the public in general tends to regard these natural waterways as dumping grounds for them.

v) Increasing population and urbanisation

Malaysia's population, currently at 32,392,951, is expected to reach 36,930,309 by 2030 and 40,550,371 in 2050. The urbanisation trend, currently at 77.2%, is projected to reach 87.3% by 2050. With these increasing trends, the amount of treated water required to meet the needs of the population would amount to 8,124,667,980 litres in 2030 and 8,921,081,620 litres 2050, assuming the daily requirement per capita remains at 220 litres per day currently. With the urbanisation trend increasing, the amount of treated water to supply to industries is expected to increase, unless the industries re-use treated waste water for non-potable use.

The SDG on water highlights the principle that every human has the right to clean water. Therefore, the government has a responsibility to substantially increase spending on clean water and sanitation for poor people with little or no access in line with water being a public good, more so for Malaysia at this current state of development. To curb an unsustainable lifestyle (wastage of treated water, pollution of water ways) need to be curtailed with the imposition of appropriate penalties.

vi) Unsustainable Lifestyle – private vs. public goods

Currently, in Malaysia water in general and treated water supply is specifically considered a public good; hence, water is not given the respect it deserves as it is considered plenty. Even water that is treated and supplied direct to houses and industries is priced relatively low as compared to the price of treated water in other countries. This situation leads to water being wasted and unsustainably treated. In addition, the wasteful consumption of resources, including water, and littering habits are classic examples of prominent unsustainable lifestyles amongst Malaysians. In 2017, the daily average water consumption stood at 201 litres per person (Malaysia Water Industry Guide (MWIG), 2018) as compared to165 litres per person as suggested by the United Nations. One of the contributing factors is the low water tariff leading to low appreciation of water value and lack of awareness about the importance of protecting water resources. High water consumption also demonstrated the continuing unsustainable lifestyle amongst Malaysians. This practice is counterproductive to the efforts to adopt a sustainable lifestyle. Whether they realise it or not that the rivers are their source of water supplied to their house, most people will continue to see rivers as dumping sites, thereby not appreciating the importance of maintaining a clean river.

vii) Lack of skilled/competent workers

The water operators and wastewater operators need a skilled workforce to maintain in optimally conditions of various mechanical and electrical aswell as computerised equipment. This continuously upskilled workforce is a necessary prerequisite to ensure that the nationwide water supply and sewerage services are continually undisrupted, and thus ensuring the health and economic livelihood are not affected negatively. In addition, the Department of Environment workforce to monitor the pollution levels in rivers needs to be continuously upgraded in terms of skill and technological expertise.

viii) Water pollution

In 2017, the Department of Environment (DOE) reported that 11% of rivers being monitored were badly polluted, 43% polluted and 46% clean. This meant that more than half (54%) of the rivers that were monitored were polluted, a worrisome indicator, as this means that the cost of treatment of water from any of these polluted rivers would invariably rise.

2.4.2 Governance

Under this focus area, the following seven take-away messages and conclusions can be made:

i) State/federal involvement in protecting water resource

Water and rivers within a state are state-owned and it is the Federal Government's responsibility to ensure the protection of the river water quality that it is good and unpolluted. However, the state's responsibility is ensuring that the river basin in their state is not degraded due to unlicensed logging, mining and other activities that cause ecosystem degradation of the basin. Common but important feedback received from the many held stakeholder consultations was that the personnel at federal and state levels, including those at the local authorities' level, are ill-equipped in capability and numbers to deal with the holistic management of water as a resource and for livelihoods. In essence, they have not been trained in or exposed to IWRM principles.

ii) Division of functions on water governance

Currently, the functions on water governance are divided between the Federal Government and the State Governments. Although constitutionally, all water resources are state-owned, the states; however, do not have the necessary technical expertise in governing their rivers. The Majlis Sumber Air Negara (MSAN), established in 1998, and since 2019,was renamed as Majlis Air Negara (MAN), provides an important platform in ensuring uniformity in the provision of integrated programmes and solutions in regard to nationwide water development and resource management issues and challenges. It has also promoted federal-state and inter-state cooperation and assisted in resolving conflicts that may arise from time to time. MSAN 08 that met in October 2013 had since reminded and urged State Governments for early establishment of MSANg (Majlis Sumber Air Negeri). To date, Selangor, Kedah, Sabah, Sarawak and Terengganu have enacted State Water Enactments/Ordinances to establish state water authorities, with Perak expected to pass similar legislation in August 2021. What has been observed was that many of the MAN decisions made that are of national relevance and application do not get expeditiously implemented due to the absence of complementary and effective structures or mechanisms in most of the states that have the ability to timely execute the programmes and directives. It has to be noted that MAN was established as an 'administrative' arm at the federal level with no legal backing in the form of an act of Parliament. As such, its decisions have no legal binding. Furthermore, matters related to rivers are sensitive to the state governments. MAN also has no financial means to implement some of its decisions.

iii) Lack of provision on Water-Food-Energy Nexus and Water for Environment

There are many river basins playing the triple roles in providing water (for human consumption and industries), hydropower and agriculture (paddy, cocoa, rubber, oil palm, aquaculture and horticulture). However, extensive land and industrial development had changed the urban and rural landscape, which has had its toll on both the terrestrial and aquatic ecosystems. Notwithstanding the above role of rivers, an important role that is generally over-looked in planning is the provision of water for the environment. The launch of the revised National Policy on Biodiversity (2016 – 2025) aimed at "sustainable utilisation of biodiversity in the country" and stressing "safeguarding ecosystems" as one of its five goals, is a timely intervention for championing this cause nationally.

iv) Legislative gaps

There is currently no national water resources law to replace the outdated Waters Act 1920 to ensure uniformity in application by all states with the states enacting their respective enactments/ordinances. With the availability of relevant state laws, this will facilitate more holistic water resource management in the states. Another legislative gap is the need for an act to replace the outdated Irrigation Areas Ordinance 1953, the Drainage Works Ordinance 1954, and the combined Drainage and Irrigation Ordinance 1956, which is applicable only in Sabah. There is also a need to review the existing Streets, Drainage and Buildings Act 1974 so as to be contemporary in dealing with urban drainage issues through the application of Integrated Urban Water Management (IUWM) principles and practices for holistic management.

v) Lack/Ineffective Monitoring and Enforcement

The pollution of more than 50% of the nation's waterways, as reported in 2017 by DOE and the many incidents of chemical wastes being dumped into rivers by unscrupulous people is essentially due to weak or ineffective monitoring and enforcement by the authorities. Catching the wrong doers in the act is difficult as it is usually done at night but, when caught, bringing them to court is a long and tedious process as experts in dumped substances are few. Financial resources for data collection and maintenance, especially for monitoring and enforcement activities, are also dependent on public funding. Therefore, lack of funds affects monitoring by the enforcement agencies.

vi) Competing of water resources uses

Another conclusion that can be derived is the long-standing issue ever since dams were constructed to store water for agriculture use (paddy) in Kedah, Perak and Selangor. In the event of climate change that impact the water resources, who gets priority of the stored water? Is it food crops or people or energy? This is because as yet there is no policy to guide this decision-making.

vii) Land use change affecting water resources
As mentioned above under "Lack of provision on Water-Food-Energy Nexus and Water for Environment", extensive land and industrial development had changed the urban and rural landscape which has had its toll on both the terrestrial and aquatic ecosystems. This has invariably affected the role of rivers in providing water for human consumption, industries, and agriculture.

2.4.3 Information and RDIC

Under this focus area, the following six take-away messages and conclusions can be made:

i) Lack of quality data
Before data can be used in data analysis and decision-making, they must be of a standard quality. Currently, all government agencies have standalone databases, whereby data is collected by the agencies and input into their databases with the assumption that they are quality data. There have been complaints that the data cannot be seamlessly used by other agencies or even the private sector as the data quality is questionable as they are inaccurate, incomplete, unreliable and not current or obsolete (lacking timeliness) and worse still, they are irrelevant to the particular context. Lack of public funding have eventually affected data quality, effectiveness of monitoring and controlling pollution to the water bodies and illegal encroachment into water catchment areas.

ii) Unintegrated data
Data management in the water sector has suffered from a lack of utilisation, overlapping of roles amongst various agencies, non-compatible platforms, poor online data storage and reporting, lack of real time data and the existence of non-universal reporting mechanisms. There are more than 10 different ministries and agencies responsible for a broad range of water data and quality, programmes, projects and infrastructure services in the sector. Ministries or agencies manage their duties by using respective systems supported by their own information technology infrastructure and services. However, data sharing and exchange is not happening. Inefficiency, duplication, and information technology systems incompatibility have hindered the ability of the government decision makers to get the necessary high quality and real-time information to support better decision-making.

iii) Lack of accessibility to data
As mentioned above, all government agencies have standalone databases, whereby data is collected by the agencies and input into their databases. However, it is generally believed that all data is secret, under the Official Secrets Act, and sometimes not accessible to other agencies, worse still to the private sector. Those not considered secret can only be accessed if purchased under the Fees Act. The point commonly over-looked is that the data is collected by using public funds.

iv) Transparency of data
Transparency of data refers to the ability to easily access and work with data no matter where they are located or what application created them. The assurance that reported data is accurate and come from an official source. As stated under "Lack of accessibility to data", the first trait is not fulfiled. The second trait is considered fulfiled as, if the data source is the government, it is considered official.

v) Insufficient RDIC activities
The ASM Advisory Report entitled "Setting a National Agenda for Integrated Water Research" (2014), highlighted the inherent shortcomings in research and development of water in Malaysia. The allocation for RDIC in the water sector has also been reduced over the years due to financial constraints, thereby reducing the number of RDIC activities in these agencies.

vi) Lack of coordination on RDIC work
The same ASM Advisory Report stated above entitled highlighted the absence of a national agenda for multi-disciplinary and integrated research, inadequacies in resource allocation and ineffective water research governance. The allocation for RDIC in the water sector has also been reduced over the years due to financial issues. There are also agencies and research institutions which conduct research collaboratively, but the information gathered is kept internally and not widely shared. Without having

a national water agenda for research, the opportunity to harness the best of science, engineering, technology and innovation for national good and competitiveness will be lost.

2.4.4 Infrastructure and Technology

Under this focus area, the following 10 take-away messages and conclusions can be made:

i) Depleting unregulated water resources

Available unregulated water resources continue to be on the decline in all states as the country continues to progress rapidly. Five states in Peninsular Malaysia are already in deficit. Many others are approaching a similar situation while demand continues to increase throughout the country[2]. Of equal concern is that the National Water Resources Vulnerability Index appears to be on the rise as well. Eight states in Peninsular Malaysia are in the moderately vulnerable level, whereas three states, namely Selangor, Penang and Melaka, are already in the vulnerable category. Sabah and Sarawak are in the low vulnerable category.

ii) High Non-Revenue Water (NRW) level

According to KASA (2021), the national NRW level increased year-on-year from 35.5% in 2017, 35.7% in 2018, 36.2% in 2019 and 36.8% in Q2 2020. It is far from achieving the target of 33% set for 2020. Several states recorded NRW levels as high as 60%, and the total financial loss amounted to more than RM2 billion. NRW reduction programme is a capital extensive initiative and requires a considerable investment. It is estimated that between RM800 million to RM1 billion is needed to reduce 1% of NRW. It means the government must invest RM3 billion to achieve its 30% target in 2030. Under the 11th MP, the Federal Government implemented the National NRW Reduction Program 2018–2020 with an initial allocation of RM1.9 billion.

iii) Insufficient or outdated infrastructure to support existing or future demand

Development and maintaining of water infrastructure are very costly and most of the financial resources come from the Federal Government in the form of grants and loans. In addition to public funding, some water companies have resorted to costly private financing to undertake water infrastructure projects. The most capital-intensive projects include construction of new water and sewage treatment plants, upgrading of existing infrastructure, including development of sludge treatment and disposal facilities, building of new dams, irrigation, and flood mitigation infrastructure.

In addition, the rural population is still facing problems to access clean and safe water. Focusing on providing only a vast reticulation system requires a high investment by the Federal Government. The potential of a cheaper alternative water sources, such as groundwater, for the rural population is not fully explored to close the gaps of clean and safe water supply coverage.

Furthermore, many of the Federal Government's water infrastructure projects face issues of maintenance due to insufficient allocation and skilled workers as well as lack of maintenance culture and mentality amongst Malaysians. This can be seen in the cases of flood mitigation infrastructures, water supply dam projects and irrigation infrastructure for agriculture activities which was handed over to the State Governments. Poor maintenance, due to financial constraints had led to the dysfunction of the infrastructure or reduction of their efficiency and lifetime. As an example, under the 11th MP, on average only 10% of the operational expenditure was approved to maintain the newly developed and older infrastructures, such as the irrigation system in the granary areas of Muda Agriculture Development Authority (MADA) and Kemubu Agriculture Development Authority (KADA).

iv) Reactive to disasters

Disaster management in Malaysia still lacks effective legal backing and powers. It is essentially reactive in response. Despite weaknesses and gaps in tackling increasing number of water-related disasters, the National Disaster Management Agency (NADMA) still currently needs to leverage on the National Security Council (NSC) Directive 20 and the National Disaster Management Committee to perform its duties. This includes coordinating the actions of various disaster management-related agencies. Notwithstanding this, another Act, the Malaysia Civil Defence Act, has a number of loopholes

2 The quantification is based on estimates of only 15% flow availability

and weaknesses to be effective in addressing the current challenges. In addition, Malaysia also does not have a national Disaster Risk Reduction (DRR) Policy which is important to be the guiding principle that governs all activities with regard to disaster management and risk reduction. At the state and district levels, there is no guiding policy on DRR and dedicated financial allocation for DRR, which is a major hindrance in mounting effective DRR programmes and initiatives.

v) Lack of non-structural measures and nature-based approach

Non-structural measures are often more cost-effective in the long-term than purely hard engineering and can produce important additional socio-economic benefits for the environment, community, and local economy. However, currently there is heavy focus on the use of hard engineering structural measures, especially for flood mitigation, river restoration and wastewater treatment, which are very costly and expensive to maintain. Although Malaysia has a policy and guidelines on non-structural measures approach, such as the Manual Saliran Mesra Alam (MSMA), which incorporates elements of green infrastructure practices, these solutions are not given enough emphasis. Moreover, non-structural measures through good, informed planning and the need to relocate unplanned premises were not given enough attention.

In fact, river systems in Malaysia are losing or facing degradation of buffer or riparian areas along river stretches, most commonly in urban areas, whereby river channels are modified and the naturally vegetated river banks are replaced with concrete embankments. In parts of the river basins where agriculture activities occur, plantation encroachment into the riparian zones can be seen, adding to loss of biodiversity issues. Therefore, most of investments on water sector are channelled to reactive measures and for remediation works to ensure people continue to be protected from water-related disasters and water as source of livelihood continues to be available and sufficient at an acceptable quality.

vi) Loss of opportunity to use flood water dams

Water abundance, more so during floods and high-flow storm-water events, was envisaged as not having any productive use. Therefore, it was not captured for beneficial use. Generally, flood waters are allowed to flow directly into the sea. Elsewhere in the world, excess storm water is harvested and recharged to the local aquifer system (through managed aquifer recharge, MAR) to recharge groundwater. With this system established, groundwater can be tapped through sustainably managed means for use, either for potable or non-potable use by industries or for horticultural purposes.

vii) Lack of quality water resources

The presence of legislative gaps leads to unresolved issues on water quality deterioration. Currently, control of pollution sources is governed by different agencies; the Department of Environment (DOE) covers point-sources pollution listed under the Environmental Quality Act 1974 (EQA 1974), which is only 20% of total source of pollution. The remaining point sources and non-point sources of pollution are covered by the state and local authorities and are usually overlooked due to enforcement capacity issues, leading to pollution into the river systems, natural lakes, reservoirs and groundwater. Another contributing factor is lack of scheduled wastes disposal facilities. If such situations are left unattended, they can badly affect the people's well-being , environment, businesses and economy as a whole. In addition, the Water Quality Index (WQI) and standards were also not revised since their introduction in the 1980s to capture emerging pollutants arising from human activities, namely pharmaceutical, agricultural, other organic wastewater contaminants, and persistent organic pollutants (POPs). The existing WQI is also not robust enough to indicate the health of rivers, natural lakes, reservoirs and groundwater. Besides, the absence of maximum amounts of pollutants allowed in the river to facilitate development planning is also contributing to the deteriorating water quality. Water bodies, such as lakes, were found to face siltation issues, contain high levels of toxic compounds and nutrients, leading to a state known as eutrophication, harmful algal blooms, deteriorating water quality, declining biodiversity and increasing invasive aquatic species.

viii) Limited resource recovery facilities

One of the challenges facing the waste-to-wealth initiative in the sewerage industry is lack of sewerage infrastructure which has waste recovery facilities for bio-effluents and bio-sludge. There are approximately 90 sewage treatment plants with such facilities. These facilities are situated far from the potential industrial or agricultural users, and thus present some logistical challenges.

Another challenge is related to the use of sewerage by-products and general negative perception accorded to these by-products and their acceptance by the public. Despite the fatwa from many Islamic religious authorities allowing the reuse of bio-effluents, this novel idea remains a taboo amongst Muslims, which are the majority of Malaysia's population. There is also the challenge of bio-sludge penetrating the existing agriculture market which is dominated by chemical fertilisers. Regarding the reuse of sludge from water treatment plants, legislative barriers also exist, whereby the sludge is listed as scheduled wastes under the EQA 1974. This barrier further impedes progress of sludge recovery.

ix) Lack of need-based policies
Directed towards better structuring of and improving the nation's business and industry ecosystems, the transformation agenda will also embrace environmental, social and economic mega trends that is reshaping our world today and in the future. Therefore, the currently lacking inclusive territorial development and strengthening social well-being through needs-based policies and public participation have to be at the centre of the transformative efforts. The megatrends include the climate change, Industrial Revolution (IR 4.0), Internet of Things (IoT), blockchain and 5G technologies. The transformation processes, which have begun in the 12th MP, will turn Malaysia from a consumer nation to one that produces international standard products and services. This will be done amongst others, by reforming human capital to improve labour market and wages in twenty-year time.

x) Lack of rural infrastructure
Currently, there is no holistic overall policy to address water issues in rural areas (including Orang Asal villages) and some islands. Since investments are generally committed to urban areas. Therefore, gaps can be seen with regards to accessibility to water supply and sanitation services, storm-water management and coastal protection measures in those areas. Lack of effective sanitation facilities to manage sewage and sullage is another issues facing rural and island communities. This leads to public health concerns as well as water pollution, affecting both marine biodiversity and income from the tourism-based industry.

2.4.5 Finance

Under this focus area, the following five take-away messages and conclusions can be made:

i) Lack of financial sustainability of water service providers
Water is generally an under-valued resource and not considered a strategic commodity. Therefore, causing exclusion from being properly accounted for by users, policy makers and water managers. However, water management generates a mix of public and private benefits, including valued goods and services and reduces water-related risks. Many of these benefits cannot be easily monetised, and thus undermining potential revenue flows. Apart from this, water infrastructure is also typically capital intensive with long-life span. It calls for high initial investments followed by a very long pay-back period. This type of prevalent business model does not support operations and maintenance efficiency. Low-water rates coupled with under-priced water services inevitably result in poor record of cost recovery for water investments, leading inevitably to the financial unsustainability of water operators. This arose due to the mismatch between water revenues generated from tariff charged to the consumers, as compared to the actual costs to produce and supply treated water to them.

ii) Water pricing too low
As stated above, the low-water rates coupled with under-priced water services inevitably result in a poor record of cost recovery for water investments leading inevitably to the financial unsustainability of water operators. It is evident that the current unsustainable low tariff rate has to be urgently addressed. The tariff setting mechanism (TSM) should also be able to address three important gaps in the current water tariff structure. Firstly, the inconsistent tariff revision period, secondly the non-uniform tariff and finally, cost structure and approach to incentivise water savings at the consumers' end.

iii) Lack of long-term financial resilience
The main reason for lack of financial resilience is that tariff revision was not done for the longest time , e.g. Pahang (36 years) and Perlis (23 years), in effect, reflecting the extremely low and unrealistic value accorded to water. With the low water rates in the past, the water operators' financial performance showed that the full cost recovery target was seemingly beyond reach. For example, in 2016 out of the 12 state water operators, only two operators could to achieve significant profits, with seven posting reduced margins and three water operators experiencing losses. The financial sustainability amongst the water operators was much influenced by the mismatch between water revenues generated from tariffs charged to the consumers, as compared to the actual costs to produce and supply treated water to them.

iv) Over-dependent on Federal Government funding for CAPEX
Development and maintaining of water infrastructure are very costly and most of the financial resources come from the Federal Government in the form of grants and loans. In addition to public funding, some water companies have resorted to costly private financing to undertake water infrastructure projects. In addition, under the migration scheme, the water companies in the migrated states would enjoy financial assistance from Pengurusan Aset Air Berhad (PAAB) for water asset development at competitive rates. However, due to the unchanged tariff rate for the longest time, water companies are unable to pay the lease rental to PAAB. In the absence of long-term financial resilience, the water operators would look to the government for capital expenditure to replace assets that have out-lived their usefulness. It is this downward spiral that needs to be arrested fast by putting in place the tariff setting mechanism which will ensure that the water operators have a sustainable practice established.

v) Insufficient allocation for maintenance works
Many of the Federal Government's water infrastructure projects face issues of maintenance due to insufficient allocation and skilled workers as well as lack of maintenance culture and mentality amongst Malaysians. This can be seen in cases of flood mitigation infrastructures, water supply dam projects and irrigation infrastructure for agriculture activities, which had been handed over to the State Governments. Poor maintenance, due to financial constraints, had led to the dysfunction of infrastructure or reduction of their efficiency and lifetime.

2.4.6 Conclusion

The 36 issues and challenges identified clearly showed that Malaysia still has a long way to go towards resolving them. The Government has taken a positive step forward by implementing, over the next 20 years to 2040, the various recommendations as outlined in the ealier ASM NIWRMP studies as well as in the eight game-changing studies undertaken since 2020. The 12th MP document clearly lays the foundation to resolve the issues and challenges.

2.5 THE NATIONAL IWRM AGENDA

Malaysia is blessed with a wealth of natural resources, inclusive of water which provides necessary sustenance to all living things, thereby globally placing the country as the 12th most biodiverse country. The important role of water in driving the economy is also acknowledged. The duality of this recognition is embodied in the concept of **Integrated Water Resources Management (IWRM).** IWRM based on the Dublin Principles (1992) was globally adopted and endorsed at the Rio World Summit on Sustainable Development (WSSD) Earth Summit, held in 1992. IWRM, which calls for the balanced development of "water as a resource' and "water for livelihoods", involves the integration of natural and human systems, and is founded on the 3E's principle of economic efficiency, equity, and environmental sustainability (Figure 2.8**).**

Malaysia, being a party to international conventions, had since the late 1990s, formally adopted the IWRM paradigm in managing the country's water resources from one of fragmented management, a legacy from the past, to one of holistic management. The establishment of the National Water Resources Council

(NWRC) in 1998, and later in 2019, renamed the National Water Council (NWC, Majlis Air Negara (MAN)), chaired by the Prime Minister, with members drawn from the Chief Ministers of Sabah and Sarawak as well as the Menteri Besar and Chief Ministers of the states in Peninsular Malaysia and the minister responsible for the Federal Territories, including ministers from water-related ministries, was an important milestone that placed water resources at par with other natural resources (land, forestry and minerals), vital for the country's economic development and prosperity. The NWRC, as the apex water body, oversaw the coordinated and sustainable development and management of the country's water resources, following IWRM principles and practices, embodied later as the central thrust of the National Water Resources Policy (NWRP) document launched in March 2012.

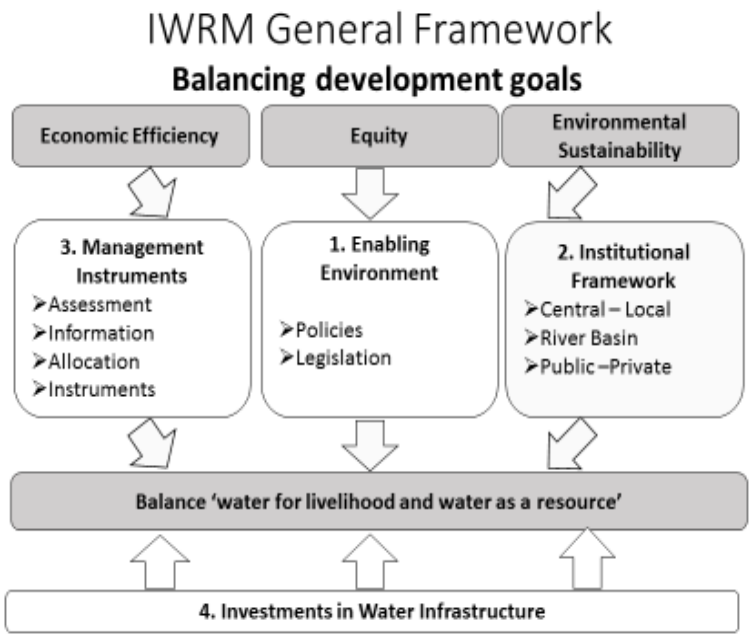
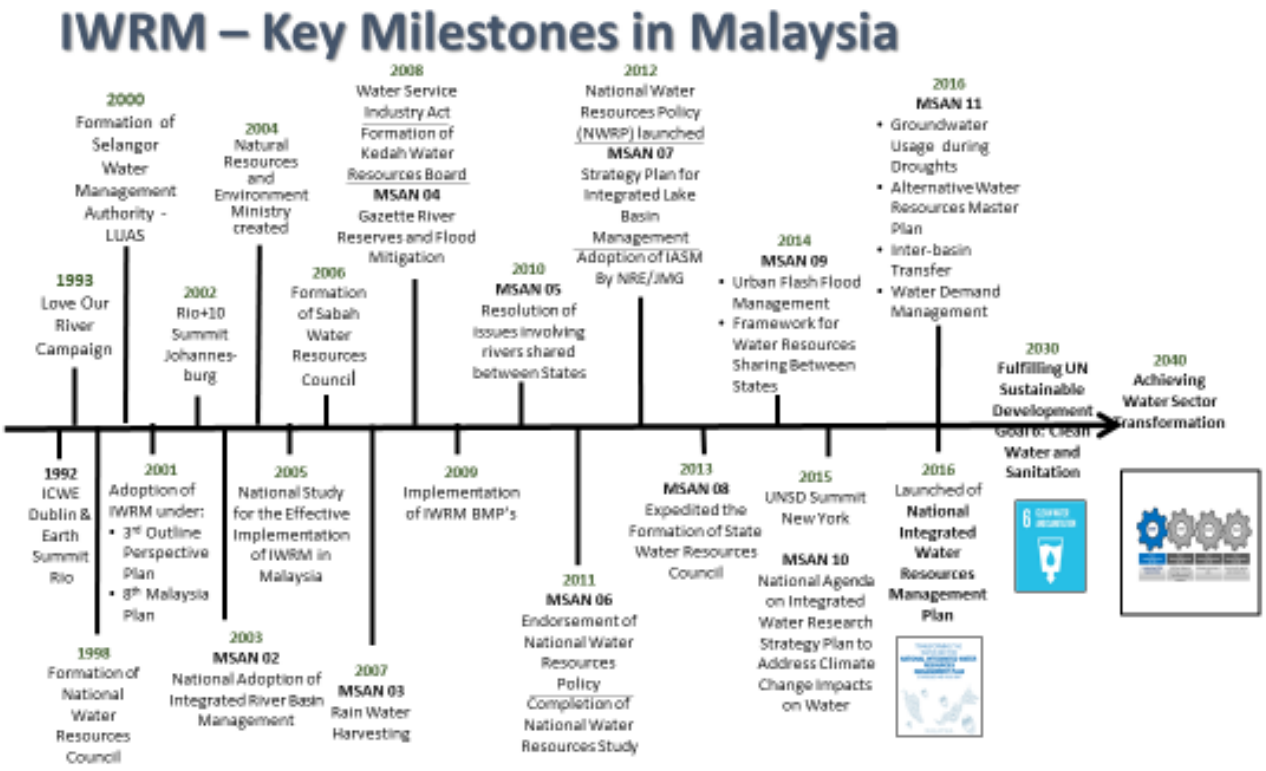


Figure 2.8. IWRM General Framework (GWP)

Amongst the landmark decisions made by MSAN were (i) in 2003 - the nationwide adoption of Integrated River Basin Management (IRBM) and direction that the country's 189 main river basins be mapped and management plans prepared and adopted by each state, (ii) in 2007 - discussed the need to arrest pollution at its source prior to entry into river systems while endorsing the proposal for the use of rainwater harvesting and the potential of groundwater as supplementary water sources for sustainable development, (iii) in 2008 - gazetting of river reserves, and flood mitigation measures in flood areas, (iv) in 2011 - endorsement of the National Water Resources Policy (which was subsequently launched in 2012), (v) in 2012 - adopted the Strategy Plan for ILBM, (v) in 2013 - directed State Governments to expedite the formation of State Water Resources Councils, (vi) in 2015 - adoption of a strategy plan to address climate change impacts on water, considered together with the setting of a national agenda on integrated water research and for a water research consortium to be formed, and (vii) in 2016 - agreed to the following: (a) Federal Government and State Government to use groundwater as an alternate source to augment supplies to WTPs during droughts; (b) JPS and NAHRIM to develop a master plan for conjunctive use of rain water, storm water, low surface flows and groundwater for Wilayah Persekutuan; (c) Consider inter-basin transfers to augment storage capacities in water deficit states; and (d) Water Demand Management and NRW reduction strategies to be pursued actively, especially with regard to potable water supply.

ASM has mapped the IWRM journey and the key milestones achieved in Malaysia (Figure 2.9), beginning from Malaysia's participation in the International Conference on Water and the Environment (ICWE), Dublin, Ireland, in 1992, to the current WST2040 study initiated by EPU and launched in 2019, as the way forward in ensuring that the country's water sector transforms to become a dynamic economic sector by the year 2040.



(*Source*: Adapted from ASM (Unpublished)

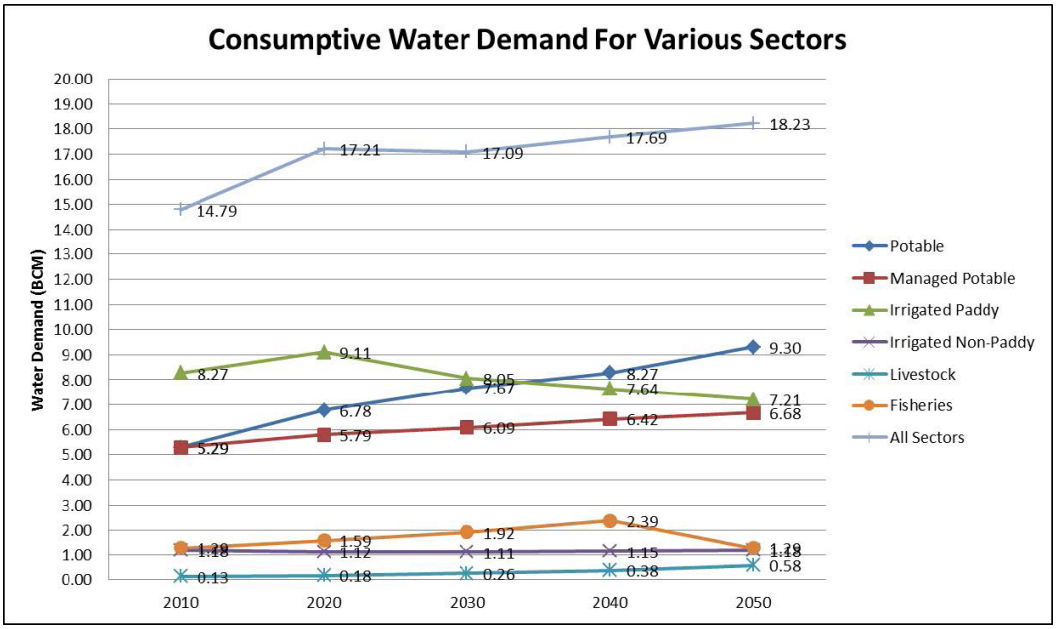
Figure 2.9. IWRM - key milestones in Malaysia

2.5.1 National Water Resources Study, 2011

The National Water Resources Study (NWRS), commissioned by the then Ministry of Natural Resources and Environment (NRE, 2011) and completed in the year 2011, provides a comprehensive assessment of the water situation in Malaysia, both at national level and broken down according to the various states. The study had also undertaken projections of the state of the country's water until 2050, addressing issues related to supply and demand as well as measures required to ensure the sustainable management of water resources and protection of the environment.

In brief, the study reported that Malaysia's annual rainfall was around 973 billion cubic metres (BCM), of which 414 BCM was lost to the atmosphere as evapotranspiration, surface runoff amounted to 496 BCM and some 63 BCM contributed towards groundwater recharge. Consumptive demand was assessed to be 14.8 BCM in 2010 and predicted to increase to 17.2 BCM in 2020 and to 18.2 BCM in 2050 (Figure 2.10).

With total effective rainfall estimated at around 74 BCM, it makes the available resource four times above the projected need and yet Malaysia suffers from seasonal water shortages.



(*Source*: NRE, 2011)

Figure 2.10. Growing water demand – consumptive water demand projections to 2050 (BCM/year)

2.5.2 National Water Resources Policy 2012[3]

Developed as part of the NWRS (NRE, 2011), the NWR Policy 2012 was formally launched in March 2012. The Policy is based on the three essential principles of water resources security, water resources sustainability and collaborative governance, as elaborated briefly below:

i) Water Resource Security:
Water security, similar to food and energy securities in the country, is to ensure that water is readily available to meet all demands of society and environment. It has an intrinsic and a financial cost value that could be much higher than those of other economic sectors.

ii) Water Resource Sustainability:
Water is a catalyst for national development and for societal and environmental well-being. It should be sustained for present and future uses. This opens up vast opportunities to develop the water industry and to explore the use of alternative water sources through science, technology, and investments.

iii) Collaborative Governance:
Inclusiveness and collaboration are essential elements towards ensuring the security and sustainability of water resources as well as achieving the common goals of addressing multiple resource use, governance, and priorities.

2.5.3 ASM's 2016 National IWRM Plan: Strategies and Road Map

As reported earlier in Section 2.4.2 above, implementation of the IWRM agenda has yet to take root nationwide and the penetration level can best be regarded as sporadic both at federal and state administration levels. This can be largely attributed to the absence of a National IWRM Plan to move the agenda forward, involving the concerted involvement and action by all water sector stakeholders (institutional and community stakeholders). It was further noted that Malaysia as a signatory to the Rio+10 Summit (WSSD2002) had committed to the Johannesburg Plan of Implementation which required nations to meet the "IWRM Target" by developing IWRM and water efficiency plans by 2005. In June 2006, the NRE jointly with MyWP, with the assistance of UNEP, had held a one-day workshop that involve institutional stakeholders, to discuss efforts in streamlining the development of a national IWRM strategic plan aimed at achieving the target of the MDGs. But nothing concrete had materialised from this effort.

3 KASA is currently in the midst of undertaking an exercise for the NWRP 2012 to be reviewed and replaced by a more encompassing National Water Policy that would also address water supply services.

At the end of 2008, theASM, in its role as a national think-tank providing strategic advice to the government on STI related matters recognised that the water sector is of strategic importance and vital for the country's economic development. It took the initiative to establish a dedicated ASM Water Committee to address the many issues and challenges faced by this sector with the view of offering strategic advice from time to time to the government and the appropriate water related authorities. Upon its formation the ASM Committee, whose membership comprises fellows of the academy who possess the necessary expertise and experience relevant to the water sector, decided in early 2009 to adopt IWRM as the central philosophy and thrust for its work, and to note that water resources management in Malaysia has hitherto been largely sectoral in nature.

Then, the ASM Water Committee decided to take on the task of developing a National IWRM Strategy Plan and Road Map (NIWRMP) for consideration and adoption by government for implementation nationwide, thereby also fulfiling the country's obligation based on the commitment made at the 2002 Rio+10 Summit held in Johannesburg, as referred above.
The NIWRMP adopted a multi-faceted approach, addressing the status of IWRM implementation from the following three perspectives:
i) Component plan studies by ASM
ii) Complementary component plan studies commissioned to others
iii) state IWRM plans

Details of the three perspectives are as follows:

i) *Component Plan Studies by ASM*: ASM undertook critical reviews of 10 priority thematic sub-sets or sub-sectors with a view of infusing IWRM principles and practices into their planning and management operations. Each of these reviews involved extensive stakeholder consultations. The outcome of these component plan reviews led to the publication of strategy plans or advisory reports for submission to relevant authorities as applicable (Table 2.1; Figure 2.11). A roadmap for the implementation of strategies was also developed for each of these studies.

ii) *Complementary Component Plan Studies Commissioned to Others:* Some 14 other summary briefs and expert reviews, referred to as Complementary Component Plan Reports, were commissioned to other agencies and subject matter specialists on IWRM-related themes and topics also considered relevant. The aim was to expand the synthesised knowledge base to ensure greater comprehensiveness when preparing the proposed NIWRMP (Table 2.2).

iii) *State IWRM Plan Study:* A third important area of focus was an assessment of the extent to which the states have committed and progressed in implementing IWRM. The assessment showed great variance amongst the states. Only three states (Sabah, Selangor and Kedah) were currently equipped with the legal and institutional framework to enable the effective application of IWRM principles and practices, an essential prerequisite for the implementation of IRBM, following MSAN's directive as far back as 2003. Selangor has taken great strides since the establishment of LUAS in the year 2000. It has been able to institutionalise IWRM in all its programmes and activities. ASM did not venture to make a detailed assessment of each state but instead did a case study on LUAS, highlighting the pro-active actions taken to implement IWRM which included the development and implementation of an IWRM Strategy Plan for Selangor projected until 2030.

Table 2.1. Completed component plan study reports by ASM

No.	Component Plan Report	Date of Completion by ASM	Submission to Lead Implementing Ministry[4]	Endorsement by MSAN where relevant
1	Integrated Lake Basin Management	2009	NRE 2010	1 November 2012 (MSAN07)
2	Integrated Aquifer Systems Management	2011	NRE 2012	NA
3	Water Demand Management	2016	EPU/NRE/ KeTTHA/MOA 2016	NA
4	Water Supply and Wastewater Management	2016	KeTTHA 2016	NA
5	National Agenda for Integrated Water Research	2014	NRE/MOSTI 2015	15 October 2015 (MSAN10)
6	Climate Change and Water	2014	NRE/MOSTI 2015	15 October 2015 (MSAN10)
7	Integrated River Basin Management	2016	NRE	NA
8	Water and Agriculture	2016	MOA	NA
9	NKPA on Water	2015	NA	NA
10	ASM Mega Science Study: Water Sector	2011	Cabinet 2012	NA

Note: NA – Not Applicable

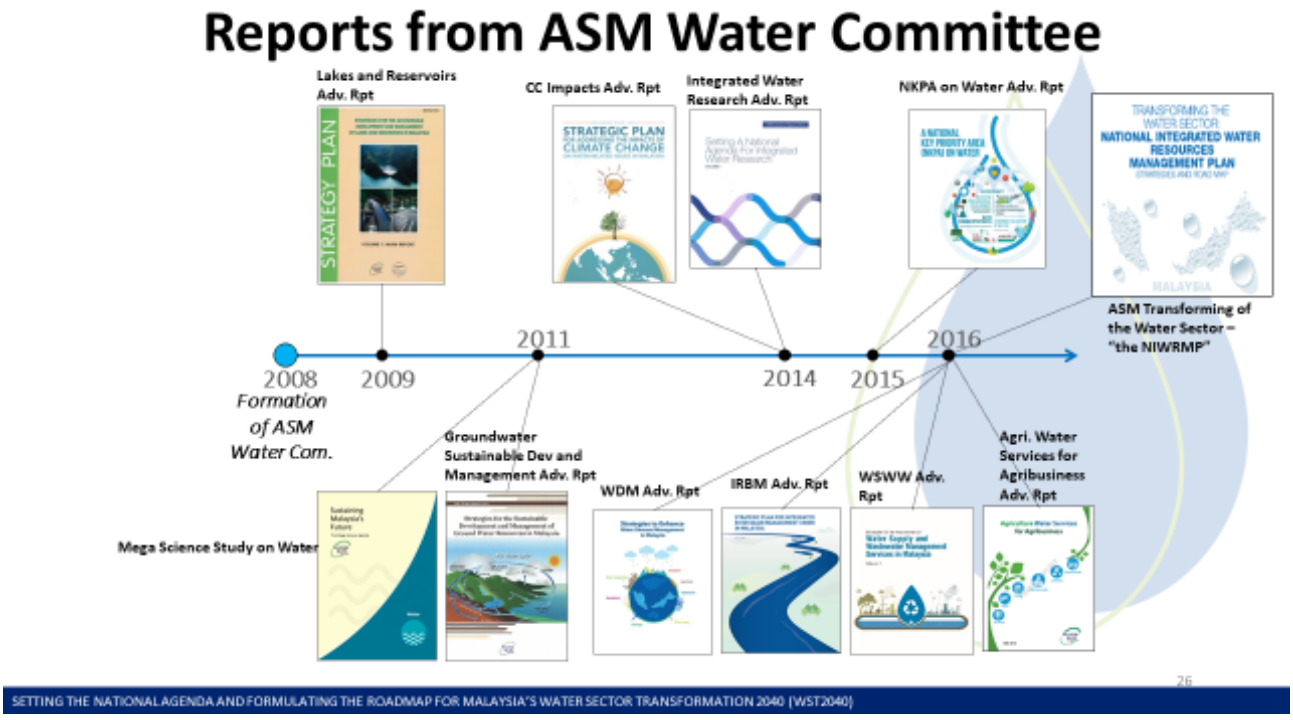


Figure 2.11. The water-related advisory reports (listed in Table 2.1 above as well as in the references)

4 The Ministries are listed according to their names as existing then

Table 2.2. Complementary component plan study reports

No.	Complementary Component Plan Report	Relevance to IWRM	Lead Implementing Ministry/ Authority/Agency [5]
1	Integrated Flood Management	Water as a Resource	NRE/State Government
2	Integrated Drought Management	Water as a Resource	NRE/State Government
3	Water Quality Management	Water as a Resource	NRE/State Government
4	Water and Land (National Physical Plan)	Water as a Resource *(addressing trans boundary issues)*	MUWHLG/State Government
5	Water and Health	Water as a Resource and for Livelihood	MOH/ State Government
6	Water and Green Growth	Water as a Resource and for Livelihood	KeTTHA/NRE/MOA/ State Government
7	Water and Gender	Water as a Resource and for Livelihood	NRE/KeTTHA/MWFCD/ MOA/MPIC/MOSTI/ MUWHLG/MRRD/MOHE/MOH/ State Government
8	Virtual Water and Water Footprint	Water as a Resource and for Livelihood	EPU/NRE/KeTTHA/ MOA/MPIC/FMM/ State Government
9	Water Financing	Water as a Resource and for Livelihood	EPU/MOF/State Government
10	Water-Food-Energy Nexus	Water as a Resource *(addressing trans boundary issues)*	EPU/NRE/MOA/ KeTTHA/State Government
11	S&T Awareness, Advocacy and Capacity Building	Water as a Resource and for Livelihood	NRE/KeTTHA/MOA/ MPIC/MOSTI/ MUWHLG/MRRD/ MOHE/State Government
12	International Networking and Collaboration	Water as a Resource and for Livelihood	NRE/KeTTHA/MOA/MPIC/MOSTI/ MUWHLG/ MRRD/MOHE/State Government
13	Integrated Urban Water Management	Water as a Resource and for Livelihood	MUWHLG/State Government
14	NWRP Action Plan	Water as a Resource and for Livelihood	NRE/State Government

The National IWRM Plan (NIWRMP) is a synthesis of the strategies recommended by each of the component plans, complementary component plans, and state plans mentioned above. The recommended strategies were organized, following the IWRM General Framework (Figure 2.8) and categorised under four discrete elements as follows:

(i) Enabling environment
(ii) Institutional framework
(iii) Management instruments
(iv) Investments in water infrastructure

5 The Ministries mentioned are those occurring at the point of time the respective Reports were completed and submitted to the Ministries

The two-volume NIWRMP Report (ASM 2016) had listed 25 recommendations (Box 2.4) with an accompanying roadmap for implementation by the year 2030, the target year for SDGs set by the UN.

Box 2.4: NIWRMP Summary Recommendations

- **General:**
- A central recommendation calling for the adoption and implementation of the NIWRMP in providing the correct stimulus to spearhead the transformation of the water sector for a better future.
- Component plans contained in the Plan are to be implemented concurrently nationwide by the key ministries and respective state administrations

Enabling Environment: Ten recommendations under this category address policies, legislation, regulations and finance amongst which is the need for an over-arching Integrated Natural Resources Policy; a contemporary National Water Resources Act for adoption by all states to be expedited; and the need for funding arrangements and protocols especially pertaining to environment rehabilitation works.	**Management Instruments**: Five recommendations under this category stress on the establishment of a central IWRM database built around river basin platforms; the use of economic, financial and technical instruments for greater water use efficiency and accountability and to curb abuse; implementing a national agenda for integrated water research; mechanisms for promotion of green growth; and the pooling of resources to establish one-stop capacity building centers to improve skills and raise competency at all levels nationwide.
Institutional Framework: Five recommendations under this category focus on the review and strengthening of governance through the formation of oversight and implementation management structures at national, state, river basin and local hierarchical levels, and a call for greater intra-ministerial integration	**Investments in Water Infrastructure:** Urgent Investments in Water Infrastructure is recommended to cater for the national water sector needs and to spur the transformation of the water sector. 15 major programmes with corresponding 95 Entry Point Projects (EPPs) were identified broken down into three sub-programmes, namely five cross-cutting programmes involving 14 EPPs, five programmes related to "Water as a Resource", involving 48 EPPs, and five programmes related to "Water for Livelihood", involving a further 33 EPPs.

Note:

1. Included in the Report is a Management Structure for the execution of the Plan over a 25–year time frame ending 2030
2. A copy of the ASM NIWRMP roadmap which has since been validated and updated by the WST 2040 study, following consultations and communications in July 2021 with relevant Ministries and agencies are attached as Appendix 2.1.
3. The full two-volume ASM NIWRMP report is included in the list of references as **item** (xiii) while the main conclusions and recommendations are attached as Appendix 2.2

The WST 2040 study commissioned by EPU to ASM is for all intents and purposes a sequel to the above-mentioned NIWRMP study, taking the transformation agenda over a longer 2040 time horizon through enhancement with eight other supplementary studies in strategic areas deemed to be game-changers, namely (i) awareness, advocacy and capacity building (ii) integrated water sector data and RDIC centre (iii) IR 4.0 in the water sub-sectors (iv) climate change and water (v) virtual water and water footprint (vi) water-food-energy nexus, (vii) alternative financing, and (viii) water as an economic sector. The WST2040 initiative, to begin under the 12th MP and set to be attained by 2040, aims beyond the implementation of the National IWRM agenda and meeting SDG targets by 2030. It aspires to transform Malaysia's water sector from an economic enabler into a vibrant economic sector.

2.5.4 ASM NIWRMP Sub-Thematic Report Key Messages

Table 2.1 above lists the 10 component plan study reports by ASM that were taken into consideration when preparing the NIWRMP 2016 report. These sub-thematic standalone reports are listed in the references list while softcopies of each of these reports are available on-line on the ASM (publications) website. Below is a brief narrative of the key messages or takeaways that emerge from each of the 10 sub-thematic standalone reports:

i) Integrated River Basin Management (IRBM)

IRBM, a sub-set of IWRM, has a spatial and ecosystem-focused, and emphasises river basins (and sub-basins) as the natural hydrological units within which sustainable water resource management can best be organised.

MSAN[8], at its second meeting in July 2003 had directed all States to adopt IRBM to ensure that the use of land and water resources are managed in a sustainable manner while also directing the NRE[9] then (and JPS in particular) to prepare river basin management master plans for each of the 189 major river basins in the country for adoption and implementation by each state. The MSAN decision also recognises that IRBM comes under the jurisdiction of respective State Administrations who need to take urgent steps to ensure good governance is set in place by strengthening their respective policy, legislative and institutional frameworks. States like Sabah, Selangor (LUAS), Kedah (LSANK) and Terengganu in December 2020 (LAUT) that have successfully done so are on course towards better management of their respective state water resources. Preparation of river basin management plans to assist states by JPS, a Federal department, currently under KASA, is also progressing satisfactorily.

Rivers, in the course of their passage from their source in the highlands to the sea, flow in surface water and groundwater systems that traverse varying terrain. Each of the river basin segments has its own inherent characteristics and set of management principles to adhere to, which are all sub-sets of IRBM, namely Integrated Catchment Management (ICM), Integrated Lake Basin Management (ILBM), Integrated Urban Water Management (IUWM), Integrated Aquifer System Management (IASM), Integrated Coastal Zone Management (ICZM) and Integrated Shoreline Management (ISM). Therefore, to cater for the variance and for sound resource management, the IRBM Study recommended the promulgation of a binding National IRBM Policy to complement the NWRP 2012.

ii) Integrated Lake Basin Management (ILBM)

A preliminary assessment undertaken as part of a Lake Eutrophication study by ASM observed that there are over 90 lakes in the country, covering an area of at least 100,000ha and holding about 31 billion cubic metres of water.

Lakes are lentic systems, characterised by their integrating nature, long retention time, and subject to a process called hysteresis resulting in complex response dynamics. Past management of reservoirs have largely been focused on regulating inflows and outflows with scant attention to water quality management. Therefore, the need for ILBM to address both quantity and quality controls at the lake basin scale.

Lakes support a wide range of national and locally important economic functions. Amongst the most pertinent of these are: hydroelectricity, water supply for domestic, industrial and agriculture requirements; flood mitigation, fishing and aquaculture, biodiversity, recreation and tourism, and heritage and patrimony. All these activities contribute to an annual multi-billion Ringgit Malaysia to the economy.

iii) Integrated Aquifer Systems Management (IASM)

Groundwater is an integral part of a river basin and must be managed as such. An understanding of this linkage is crucial in ensuring sustainable groundwater development and management. The development of groundwater resources carries with it numerous advantages, many of which are not fully recognised. Amongst these include the following: reliability (groundwater is usually reliable even in times of drought), quality (groundwater can be very clean since water percolating down to the aquifers is filtered by intervening soil and rocks), and lower storage and transfer costs. groundwater resource management cannot, and should not, be seen in isolation of the natural systems that sustain it. It is clearly bound by IWRM regimes, and related Integrated River Basin Management and Integrated Lake Basin Management sub-sets, whereby the overall catchment health is also embedded in Integrated Aquifer Systems Management (IASM). The groundwater resources in Malaysia, that is the volume of water stored in the aquifers, has been estimated at 5,000 billion cubic meters or 5 trillion cubic meters of water, replenished annually by rainfall. This is 200 times the volume of water held by our 90 lakes and reservoirs and 566 billion cubic metres in our rivers. The study main recommendation is to utilise this resource in conjunctive use with surface water up to 20% of the total water supply.

8 MSAN, or Majlis Sumber Air Negara, had its name changed to MAN, or Majlis Air Negara, in 2019.
9 NRE, responsible for water resources and environment, since 2019, is now known as KASA

iv) Water Supply and Wastewater Management

The study highlighted a number of issues and challenges facing the water supply and sewerage services sector. The Study made recommendations focusing on the following areas: (a) formulation of a Water Supply Services Policy encompassing all consumptive and non-consumptive water uses (b) Establishment of a fair and efficient tariff mechanism (c) Participatory management and the role of forum air (d) Measures for reduction of non-revenue water (NRW) (e) Asset management strategies (f) Public engagement strategies (g) Role of SPAN (h) Water safety plans (WSPs) (i) Aluminum sludge as a scheduled waste (j) Integration of water supply and wastewater services (k) Sewerage services coverage, and (l) Capacity building to enhance management and delivery of services.

v) Agriculture Water Services for Agribusiness

Agriculture is one of the water sensitive industries both in terms of water needs (irrigation) and drainage. As a business, water management needs is one of the highest risk management factors to ensure returns on investments and sustainability in agriculture. Therefore, a higher level of Agriculture Water Services (AWS) would be a prerequisite. The study noted that agriculture is the biggest water user accounting for 64.3% of the total water demands for human activity. Of this, 55.9% is for paddy irrigation that is still returning low water productivity. With water demand management, the potential for water savings is estimated to be 1,067 MCM or 2,927 MLD, a substantial relief for the Water Supply Sector. Comparatively, water demand for non-paddy agriculture (non-paddy crops, livestock, and fishery) is relatively small but is projected to increase by 84% between 2010 and 2050. When consolidated in a large contiguous area, the impact on water resources sustainability can be significant as in the case of the horticulture and floriculture industry in Cameron Highlands. Traditionally rain-fed crops may also turn to irrigation for yield increases. Oil palm, for instance has the potential to increase yields from 32 tonnes per ha up to 60 tonnes per ha with irrigation.

Amongst the recommendations by the study are (i) formulation of an affirmative AWS policy for agribusiness in all agriculture sub-sectors, (ii) promulgate legislation, rules and regulations for AWS, (iii) form a dedicated government institution for AWS with adequate capacity to support agribusiness and cater for private sector involvement as AWS providers (iv) formalise the formation of agriculture water user groups (for individuals and agribusinesses) (v) replicate the Granary model for all other key production areas and commodities of each of the agriculture sub-sectors (vi) develop agriculture water accounting and auditing tools that are harmonised with other water sectors.

vi) Water Demand Management

Water demand management (WDM) is generally defined as efforts to reduce the loss in quantity and quality of water as it flows from source through to disposal. The WDM study noted that (i) Overall water losses and wastages are excessive particularly in consumptive water use sectors in water supply and sewerage services and in agriculture water services. Environmental water needs have hitherto been neglected. Implementing WDM provides tremendous opportunities for economic growth and employment. The study recommended the following measures to incorporate and implement WDM in all water supply service sectors: (1) Harmonised policies and laws for water management in the country (2) Develop water accounting, auditing and feedback systems for within sector and inter-sector WDM (3) Realistic tariffs and rates for treated water supply services and for raw water extraction and supply services. In return to provide transparent and high levels of service. (4) The need to focus also on environmental water needs (5) Reduce, reuse and recycle (6) Enhanced level of public participation in water management (7) Ownership and use of leading-edge water saving technologies (8) Continuing R&D to enhance WDM and (8) The formulation of a WDM master plan encompassing all water supply service sectors.

vii) National Agenda for Integrated Water Research

The study team had identified 97 R&D topics, and classified them under five categories as follows: (1) water resources and watershed management, (2) water supply and demand management, (3) irrigation and drainage, (4) sanitation, wastewater treatment & environmental issues, and (5) water and climate change

The study had also developed a framework for Integrated Water Research, comprising Guiding Principles, Research Philosophy and corresponding Research Themes, and a Sustainable Water Resources Development and Management Agenda.

In addition, the study proposed a Water Research Governance system, including the setting up of a Water R&D Centre (WRDC). As an interim solution, it proposed setting up a Water Research Consortium (WRC) built around NAHRIM with the appropriation of necessary human and financial resources. The study also recommended the adoption, dissemination and implementation of the proposed National Integrated Water Research Agenda.

viii) Climate Change and Water

The study had adopted the five principles of Asia Pacific Water Forum (APWF) strategic framework to address the impacts of climate change in the water sector. It provides the basis and guidelines for the formulation of recommended strategies in this advisory report to address the climate change (CC) impacts in the following eight focus areas: (1) Water bodies management capacity (2) Water services management capacity (3) Water-related hazards management capacity (4) Governance and institutional capacity (5) Climate Change Projections and R&D capacity (6) Information management capacity (7) Land use management capacity, and (8) Stakeholder awareness and participation.

ix) NKPA on Water

The NKPA on Water, undertaken by ASM in 2014 with the twin objectives of water security and water economic opportunities, recommended 15 major infrastructure investment programmes (10 under "water as a resource" and five under "water for livelihood") that include a total of 72 EPPs that have been identified for implementation.

x) ASM Mega Science Study 2050: Water Sector

This report, completed in 2011, highlighted that "Malaysia's water sector faces a number of challenges and great opportunities in the future". Most of the challenges centre on maintaining or improving the quantity, quality and health of the nation's water resources and increasing efficiency of use. Opportunities accrue from more effective economic exploitation of Malaysia's water resources on a sustainable basis. "Sustaining the resource" and "creating new wealth opportunities" are both required to harness future economic development. Recognising this duality, the study has identified important investments to maximise future economic development potential. Investment roadmaps were designed for each opportunity, which indicate the nature of the investment, required enablers (such as incentives, research funding) and the outcomes targeted in five-year to ten-year periods from 2011 to 2050.

2.6 NATIONAL SECURITY POLICY 2021- 2025 AND ITS IMPACT ON THE WATER SECTOR

2.6.1 Preamble

In many countries and regions, the challenges of water security stem from several factors. Firstly, there is inadequate supply of water due to climate change or other environmental conditions. In some countries, water shortage is tied to seasonal weather patterns, low precipitation and other climate-related conditions. Secondly, there is increasing demand for water due to increasing population, rapid urbanisation, increasing economic activities and industrial development. In other countries and localities, the demand for water far outstrips the supply of water. Thirdly, there is water contamination problem as a result of pollution, industrial activities and poor sanitation. All these issues have impact on Malaysia as well. In developed countries, the reliable supply of quality water and demand for water are managed as a totality rather than discretely. This ensures water resources are used optimally to derive the best return on value (ROV) and return on investment (ROI) for all stakeholders in the country, while the simultaneous ensurance of water resources are managed in a sustainable way for the future generation. These elements imply that water security has to be treated as a national security measure, along with other national security measures.

ASM's WST2040 task forces, in the course of their sub-sectoral studies, had called for water security to be listed as part of the National Security Policy.

2.6.2 Introduction

In the preamble to the National Security Policy, launched in July 2021 by the Prime Minister, it is stated that the government is responsible in ensuring that sovereignty and national security are continuously safeguarded and maintained. In this context,Malaysia's National Security refers to a state of being free from any threat, whether internally or externally, to its core values. Since 1957, threats to national security, such as the Communist Party of Malaya insurgency, incursion by the terrorist army of the Sulu Sultanate into Sabah in 2013, indicated efforts to overthrow the government through non-democratic process, militancy, and terrorism. Additionally, global threats in various forms have necessitated the formulation of a comprehensive National Security Policy (NSP).

The policy document further stated that "the NSP is introduced as the principal policy in confronting various security threats which have become increasingly dynamic and complex. Through the NSP, the implementation of primary strategies will ensure that national core values are safeguarded thereby keeping Malaysia safe from all forms of threat, not only physical, but also non-physical that may influence and corrupt people's minds. This includes interference by foreign powers in the administration and internal affairs of the nation. In this sense, the formulation of the NSP as the primary guide and reference for federal and state ministries and agencies is evident that the government is persistently committed in ensuring that national security is assured and maintained. Consequently, the support and cooperation of the people is detrimental in guaranteeing the survival of Malaysia as an independent, safe and sovereign nation based on the principles of parliamentary democracy and constitutional monarchy. Not only is the NSP intended for the society in-being but more importantly, for the well-being and peace of generations to come".

2.6.3 Policy Statement

The Policy Statement states that "the NSP is the overarching policy or basis for comprehensive national security aimed at maintaining, safeguarding and defending the national core values which will ensure the survival of Malaysia as an independent, peaceful, safe and sovereign nation".

2.6.4 Core Values

The NSP describes that Malaysia's core values are required to be maintained, preserved and strengthened in order to guarantee its survival as an independent, peaceful and sovereign nation. The nine core values are:

i) Core Value 1: Territorial sovereignty and integrity
ii) Core Value 2: Socio-political stability
iii) Core Value 3: National integration
iv) Core Value 4: Good governance
v) Core Value 5: Economic integrity
vi) Core Value 6: Social justice
vii) Core Value 7: Sustainable Development
viii) Core Value 8: People's security
ix) Core Value 9: International recognition

2.6.5 Core Value 7 – Sustainable Development

The NSP describes sustainable development as "a development that meets current and future needs to achieve a balance of economic, social, demographic and environmental development". Security aspects should be given priority in every development plan to ensure the continuity of the nation's resources, people's well-being and the needs of future generation. Disproportionate development has the potential to cause an ecological and demographic imbalance in the country. Sustainable development is not only seen in terms of materials and infrastructure, but enculturation of a mentality that places environmental sustainability in strategic policymaking in various sectors is also considered important. Commitment to a sustainable development approach should also be seen as a branch of national security whose dependence is interconnected with other sectors.

Sustainable development also includes how technological adaptation can be handled efficiently and effectively for the purpose of ensuring the sovereignty, peace and well-being of each group within the Federation of Malaysia.

Under Core Value 7 (sustainable development), there are 17 elements listed as follows:

i) Water security
ii) Food security
iii) Climate change management
iv) IR 4.0 development strategy
v) Strategic security infrastructure
vi) Special development projects
vii) National capacity and competence development
viii) Urban and rural development impact
ix) People's housing and ownership capability
x) Environmental conservation
xi) National natural resources management
xii) Preserving and defending critical national infrastructure
xiii) CBRNE (chemical/biological/radioactive/ nuclear/explosive) management
xiv) Destructive technology
xv) Digital access
xvi) Awareness development, ability and education
xvii) National security awareness

It is heartening to note that this new National Security Policy 2021 – 2025 is an improvement over the 2017 version as Sustainable Development has been identified as a core value in which the first element is "water security".

2.6.6 Comprehensive Security Concept (COMSEC)

In managing national security, Malaysia has undergone various evolutionary processes in adopting approaches that are compatible with threats. Amongst the concepts and doctrine that have been and still applied are KESBAN (safety and development), HANRUH (total defence) and winning hearts and minds. All these concepts are proven in their applications and are still relevant. In facing new challenges, Malaysia must be prepared to adapt its doctrine and approach to the changing times and conduct of human civilisation.

Therefore, the concept of comprehensive security is in line with the needs of the current security management. Security management is becoming more complex with interconnection and cross-sector dependency that requires integrated action in terms of policy, strategy, operational actions, and resource management.

2.6.7 National Security is Joint Responsibility

The responsibilities of national security management are no longer fully dominated by the machinery of government. Each party must play the same role in fulfiling their respective responsibilities in accordance with their duties, expertise, roles and obligations as permanent members of "Team Malaysia". This obligation is translated into the commitment of the whole machinery of government with the cooperation of all levels of society in facing any challenges in the management of national security. This is closely related to:

"Whole of government, whole of society approach"

2.6.8 Conclusion

Going forward, even beyond 2040, the nation needs to be prepared for any eventuality since the nation's water sector may be affected in negative ways, and thus affecting the country's well-being in terms of potable water supply, health sector, agriculture, the manufacturing and construction industries and other critical sectors.

A vibrant national water sector will be recognised as an integral part of both the Wawasan Kemakmuran Bersama (WKB) 2030 and the Sustainable Development Goals (SDG) 2030 to achieve social well-being, environmental sustainability and economic prosperity, leaving no one behind and ensuring water security for all. The water sector will also be regarded as a source for the growth of national economy, which

will generate income through value-added products and services in the sector through a national agenda on Water Sector Transformation culminating in 2040. Under the 12th MP, besides continuing some of the existing strategies from the 11th MP, the focus will be given on building the foundations for the water sector transformation through the acceleration of the IWRM framework implementation ensuring water security for all.

In addition, as one of the elements in the Core Value 7 (sustainable development), "water security" has been listed as the first element. In addition, the remaining 16 elements listed under Core Value 7, all play a part, in one way or another, in safeguarding the nation's water wealth.

It is hoped that with "water security" being listed as the first element under the Core Value 7 (sustainable development), the water sector, being now recognised as a national security item, will have the necessary added positive measure of water security going forward to 2040 and beyond. For this to happen, "water security" will need to be listed in future national security policies of the nation.

2.7 THE COVID-19 PANDEMIC AND ITS IMPACT ON THE WATER SECTOR

"The devastating effects of the COVID-19 pandemic remind us of the importance of having access to water, sanitation and hygiene facilities, and highlight that far too many people are still without them. Many of our problems arise because we do not value water highly enough; all too often water is not valued at all" - Gilbert F. Houngbo, Chair of UN-Water and President of the International Fund for Agricultural Development (IFAD) (World Water Day, 2021).

Preamble: Following the agreement signed between EPU and ASM in May 2020, whereby ASM was formally commissioned by EPU as its strategic partner to undertake the WST 2040 study, the effect of the highly infectious COVID-19 virus that initially emerged in late 2019 had since grown into a global pandemic affecting the lives and livelihoods of the population worldwide. Though not included in the TOR for the WST2040 study, and noting that the pandemic would leave a lasting effect on water security, ASM took the initiative to assemble a small expert group to undertake the above mentioned desk study to add value to the main WST2040 study report findings, which includes water security as one of its main objectives. The report from the Expert Group is appended hereunder:

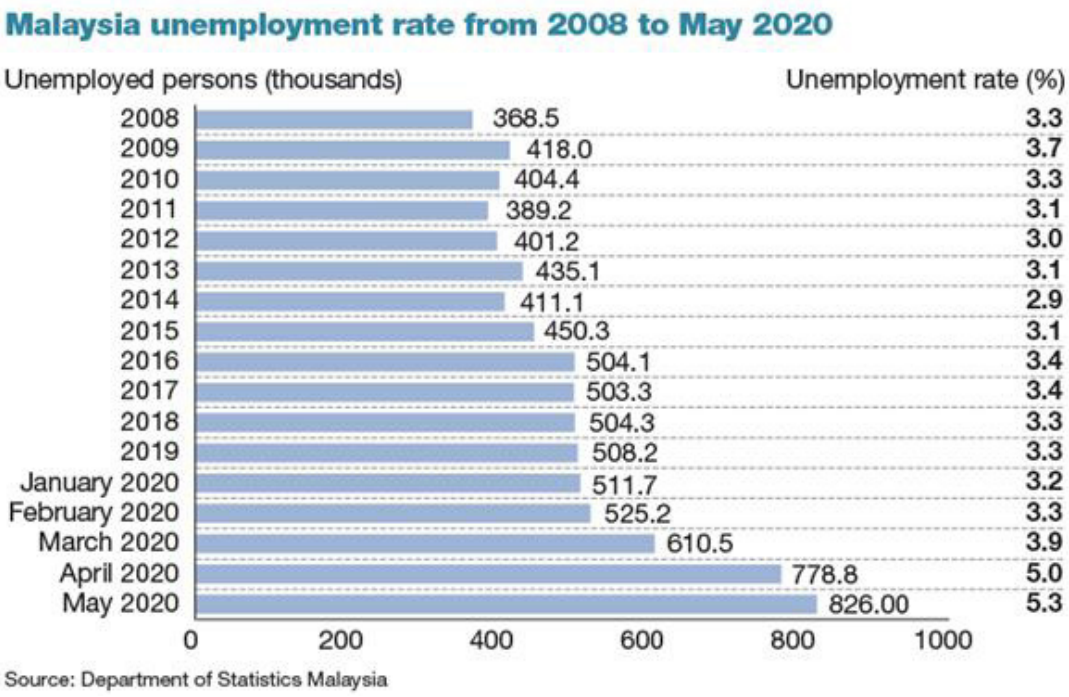
2.7.1 Introduction

Over the past three decades, Malaysia has experienced three major epidemics (enterovirus, severe acute respiratory syndrome or SARS, the Nipah virus), and two pandemics; the H1N1 swine flu pandemic in 2009 and the SAR-CoV-2 virus or COVID-19, which is still raging worldwide. COVID-19 is a highly infectious air-borne disease and within just six months after it was first reported, it has spread to the entire world from its epicentre in Wuhan, China, to cause an unprecedented pandemic never before seen since the Spanish Flu, 100 years ago in 1918.

Malaysia reported the first imported COVID-19 case on 25 January 2020, involving a tourist from China to Malaysia and Singapore; and local infection was detected from 6 February 2020[2] onwards. By 15 June 2021, 667,876 people were infected nationally, with 4,609 succumbing to the disease[3]. Globally, as of June 15 2021, COVID-19 had wrought devastation to a tune of 175,847,347 confirmed cases and 3,807,276 deaths, and still counting.

The rapid pace at which the virus spreads has caught the country by surprise, no less testing severely the country's public health and socio-economic systems. The first line of defence was a series of lockdowns (full-MCO), followed by partial or conditional MCO. The ramifications are far-reaching within the socio-economy and infrastructure. The Department of Statistics Malaysia (DOSM) reported that the GDP has contracted by 5.6% as compared to a growth of 4.3% in 2019, mainly due to several waves of COVID-19 lockdowns throughout the year. Of great concern too was unemployment, which increased from 3.3% in 2019 to 5.3% as of May 2020 in the 1st (MCO), involving some 826,000 people (DOSM, 2020; Table 2.3).

Table 2.3. Unemployment rate in Malaysia from 2008 to May 2020



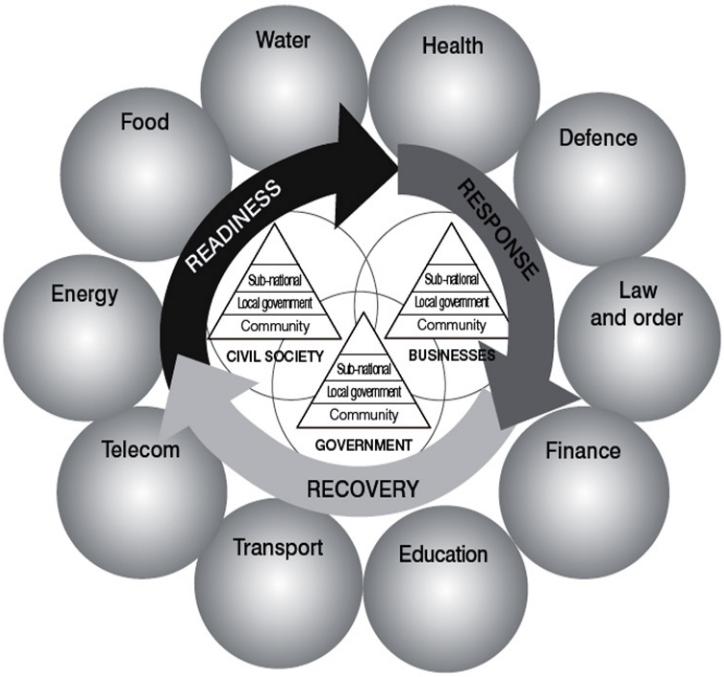
Fortunately, the infrastructure and utilities are not compromised. Water, electricity and sewerage systems still function `normally', as these are classified as essential services. If these were to malfunction or are disrupted, the situation could deprive the communities with water, food and health security, so it is vital to build up resilience during the COVID-19 pandemic. Therefore, the integrity of these same will be the subject of this discourse to ensure that a strategic plan is contributed to the overall national mitigative plans for the COVID-19 pandemic, and in anticipation of future emergence of pandemics before they inflict greater damage on the welfare and health of the communities across the country.

2.7.2 Objectives

The WST2040 study, commissioned to ASM by the EPU, will set the strategic direction towards repositioning of the water sector as a dynamic growth engine while ensuring water security for all by 2040, as underscored by the international Millennium Goals and Sustainable Development Goals. Towards this end, it is prudent and logical that water security and its linkages to food and health securities will form an integral component for all socio-economic and infrastructural sectors in general, and the epidemic and pandemic agenda for future well-being in the country, in particular.

Conceptually, every sector is involved (Figure 2.12: A multi-sectoral whole-of-society approach to pandemic preparedness), and COVID-19 has shown the linkages of systems in our modern, globalised world today and how destructive disruption (worse if synchronised) to the systems can be. Given this interconnectivity, there needs to be a whole-of-society approach to pandemic preparedness, forming the first objective.

Figure 2.12. A multi-sectoral whole-of-society approach to pandemic preparedness



Source: Adapted from Caballero-Anthony (2009)

The second objective, *inter alia* to the above, water security will address a variety of operations, particularly on how it will affect and be affected by the COVID-19 pandemic to the communities and the country. While the real ground situations could not be assessed due to the lockdown, the spectrum of the main components of water security can be examined in the context of, but not limited to:

- Water, sanitation and hygiene (WASH)
- Supporting productive economies such as agriculture, energy, industry
- Healthy ecosystem and environmental sustainability
- Building resilience within water sector and the community
- Ability to cope water related public health disasters and pandemics

The objective is geared towards preparedness to respond and manage threats posed to security and prosperity of the country in a holistic manner, as evident after the Avian Flu (Caballero-Anthony, 2009) on the need to prepare for the inevitable consequences of future pandemics, which could be at the expense of our limited natural and biological sustainability.

Thirdly, Malaysia has not prioritised water security in all its Malaysia Plans, creating a plausible false sense that the country will always have vast natural water reserves that exceed water demand to satisfy basic socio-economic needs of the population. This perception tends to override any future efforts to remedy any water variance regarding water resources, especially in the face of wide fluctuations in water variability in river basins, climate change, floods, droughts, pollution, and inadequate access to treated water for all, and the dichotomy of water governance, now and in future (ASM, 2015). This third objective is to create an understanding that water is a basic driver across health, food, nature, energy, and finance. In the present COVID-19 context, it ensures both the effectiveness of COVID-19 response efforts, and promotes economic growth and building resilience in a post-pandemic world (Sadoff &Smith, 2020).

2.7.3 Water Security

Water security (two separate definitions are given in Boxe 2.5 and Box 2.6) has a connotation of uncertainty and neglect, both inextricably linked as risk indicators. In the context of COVID-19 pandemic situations, preparedness and responses are paramount. If the institutional and governance structures are unable to react fast enough to the crisis, the devastation will be magnified, which is unacceptable. It must be emphasised that public and environmental health is by its nature, an area in which the public has a considerable and

legitimate interest. The worst situation is when health risks occur in tandem with periods of water shortages, underlining the need for water security, not to make the situation worse.

Box 2.5. Water security definition (UN-Water Analytical Brief, 2013)

Box 1
Water Security; as given in Water Security & the Global Water Agenda, A UN-Water Analytical Brief (2013); is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livehoods, human well-being, and socio-economic developmwnt, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

Box 2.6. Water security definition (ADB)

Box 2
The Asia Development Bank (ADB) defines water security as the availability of adequate water to ensure safe and affordable water supply, inclusive sanitation fo all, improved livelihoods, and healthy ecosystems, with reduced water-related risks toward supporting sustainable and resilient rural-urban economies.

Therefore, as part of the efforts to manage the COVID-19 pandemic, the following have to be considered:

a. Water, Sanitation, Hygiene (WASH)
The UN Habitat for a *Better Urban Future* considers WASH as entry point to reduce COVID-19 vulnerabilities and other water-related hazards, emphasising that improved access to WASH can lead to:

- Reduced vulnerabilities and reduced spread of diseases
- Better inclusive urban development with improved access to basic WASH services
- Improved community engagements through communication, education and public awareness (CEPA) on the importance of WASH and other relevant activities;
- Urgent need to fill data gaps through digitalisation to improve water management and to cope with scarcity and climate extremes through climate change mitigation and adaptation; and
- Increased food and water security, especially for the most vulnerable, as food and water supply chains may be affected.

There are many scattered communities in Malaysia who lack basic WASH services. Annually, there are requests for surface water or groundwater by State Governments, village heads, Jabatan Kemajuan Orang Asli (JAKOA), mosques authorities in rural areas and schools in Sarawak and Sabah, through Department of Mineral and Geoscience Malaysia (JMG), Ministry of Health (MOH), Ministry of Rural Development (KPLB) and Department of Irrigation and Drainage (DID).

While economic values tend to focus on development to improve the standard of living, water security has a social dimension (both urban and rural communities) that transcends into quality of life, whereby water sustainability will help dampen any ill health effects for a better quality of life to them.

b. Support Productive Economies
Besides the COVID-19 pandemic, there is the risk of natural disasters—including drought, extreme weather, and flooding—occurring during the pandemic, which will threaten water security leading to long-term recovery.

Recovery from the pandemic will require effective water management that reinforces the stability of disrupted food systems. In some areas, lockdowns have impacted agricultural cycles, interrupting supplies of inputs, depressing demand and keeping workers away from fields and factories.

The prospect of overlapping shocks is yet another serious concern. The World Economic Forum 2020 Global Risks Report ranked risks from water crises higher than either infectious diseases or food crises. In 2020 and beyond, there will likely be places, whereby we see all three occurring concurrently.

Consequently, there is a need to mainstream the new dimensions and dynamics and their implications to underscore the importance of water security in relation to future pandemic preparedness and response.

c. Protect Ecosystem Health

Ecosystem health constitutes another core element of water security. Ensuring that ecosystems are protected and conserved is crucial in achieving water security – both for benefits of humans, natural habitats and the environment.

Healthy freshwater resources, suh as rivers, lakes, wetlands and peat swamp forests, provide a range of ecosystem services, including good quality water, basic flood protection, and food security from agricultural products and healthy freshwater fisheries. Locally, rivers have always played an important role in the country's economic development to provide water for domestic, industrial and irrigation agriculture, power generation, recreation and environmental maintenance.

Over the last few decades, the country's river systems have significantly degraded due to rapid pace of physical developments, land conversion for large agricultural projects and improper forest logging practices. In this respect, the Department of Environment (DOE) reported in 2019 that only 60% of our rivers are classified as clean, while the remaining 30% and 9% are slightly polluted and polluted, respectively (Figure 2.13).

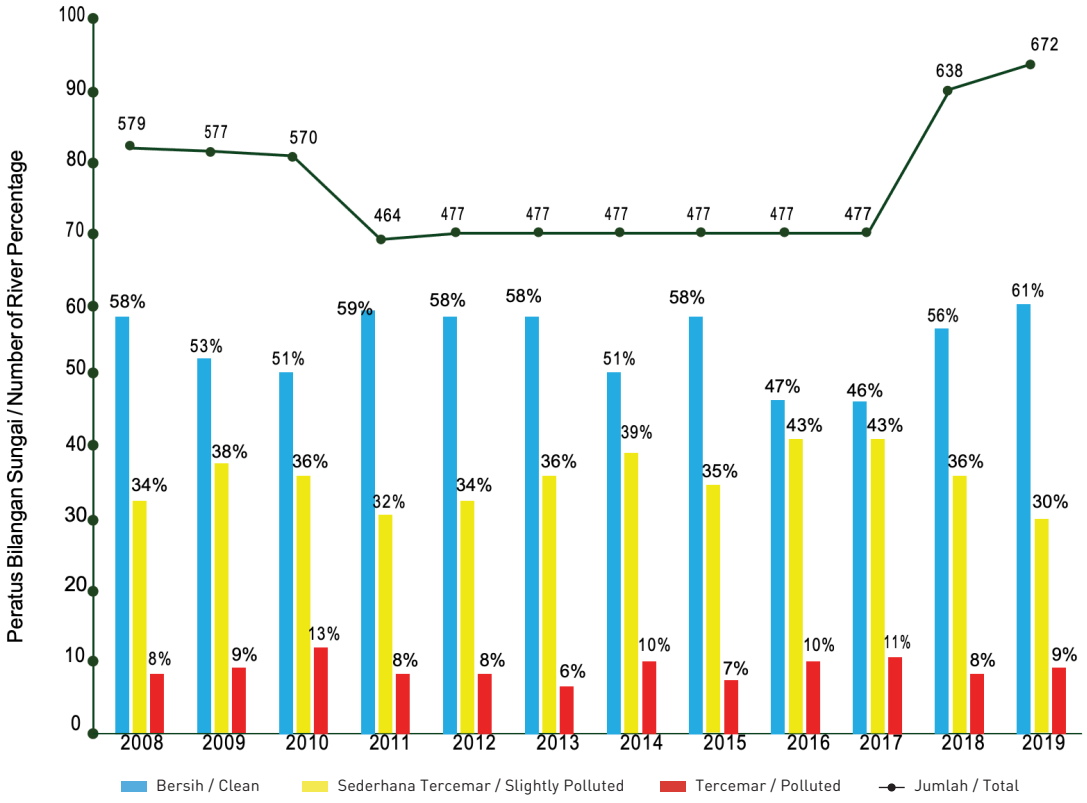


Figure 2.13. River water quality status from 2008 – 2019 (DOE, 2019)[8]

Undisturbed natural habitats and intact ecosystems support a diversity of species in quasi-equilibrium as well as provide numerous provisioning services. However, they face increasing pressures from human encroachment into their wildlife habitats, leading to emergence of new animal-to-human transmitted diseases. Amongst the human-induced factors most likely to drive the emergence of zoonotic diseases are:

i) Deforestation and unsustainable exploitation of natural resources, land use change and extractive industries,
ii) Increasing human demand for animal protein,
iii) Unsustainable agricultural intensification,
iv) Increased use and exploitation of wildlife,
v) Increased travel and transportation, and
vi) Changes in food supply (UNEP, 2020).

At the local front, deforestation is still being practised in Malaysia, albeit at a declining rate. The current rate of natural forest conversion has reduced from 1.2% (237,000 ha) in 1990 to 0.26% (70,000 ha) in 2019. This can lead to forest fragmentation and wildlife habitats destruction, and thus encourages more human-wildlife contacts.

Controlling and preventing zoonotic outbreaks require coordinated interdisciplinary responses across humans, animal and public health. As zoonotic diseases generally will require a host to jump from animals to animals or from animals to humans, deforestation will hasten the process. In controlling pandemics such as the COVID-19, there is a need to reduce the risk of future zoonotic disease outbreaks affecting public health, from destruction of forests and ecosystems, bad agricultural practices, and wildlife trade.

d. Build resilience within the water sector

Water investments should be used as an instrument to increase resilience to climate, health, and food system shocks, as well as to effectively manage water-related risks as well air borne pandemics like COVID-19. It entails rethinking our "waste streams" as "resource streams" and making food production and trading systems more resilient to water scarcity.

Instead of dumping 80% of the world's wastewater untreated into the environment (United Nations, 2017), the world should invest in wastewater treatment, which could protect cities and habitats from biological threats, including epidemics, while still safely recycling water, electricity, and nutrient resources.

Water availability and how it is allocated to multiple uses must be taken into account in food system transformations in various locations and geographical areas. Appropriate water accounting in the agricultural trade and production policies and investments is critical to long-term viability. Water-stressed areas can import crops (and their "virtual" water) from water-rich areas, whereby their production is sustainable and does not compete for drinking water or ecosystem requirements.

The dynamism of interconnected systems needs to be "built better" for now, especially in the post-pandemic world. Building better means constructing more resilient water, sanitation, and hygiene networks that can continue to provide the essential services amidst the hydrological uncertainty caused by climate change, increasing water scarcity and pollution. It involves building more "circular" water supply systems and better collection, cleaning and re-use of water resources to protect the health of humans and ecosystems.

e. Advocacy and Capacity Building

Malaysia needs to focus on raising awareness, advocacy, and capacity building for effective community participation in water resources management (Ahmed et al., 2020). However, advocacy and capacity building of the stakeholders in water management are not highlighted significantly in the policies and acts.

Realising this in early stage, there are some impactful advocacy and awareness programmes implemented by NGOs, such as Malaysian Water Partnership (MyWP), MyCDNet, Global Environment Centre (GEC), WWF Malaysia, and Water Watch Penang (Academy Sciences Malaysia, 2017). While efforts are taken to empower and involve communities in business-as-usual water sector, there a paradigm shift to prepare these communities for the future will be needed specially to consider, disaster risk management such as the COVID-19 pandemic.

Community disaster resilience is rooted in the concepts of "resilience" and "community resilience". Since building resilience is a key factor, measures need to be outlined to enable intended outcome to be realised. Measures can be divided into short-term and long-term.

2.7.4 Connection between Water Security and COVID-19 pandemic

COVID-19 is an airborne disease and so far, the presence of the virus has yet to be definitively detected in water, especially in drinking water. This has led to many, including the World Health Organisation (WHO), to surmise that the risk to water is low.

Water is important for all usage and hygiene, whereby sufficient water can lower diseases by 10 %, and deaths by 6% (Claudia Sadoff and Mark Smith). That being the case, sufficient water befits the crucial recovery from the COVID-19 pandemic in the country. Secured water through effective water management could play an important role, not only to lower the rate of disease infections, but also to stabilise disrupted water supplies and food systems during the pandemic.

One of the Standard Operating Procedure (SOP) for COVID-19 is always to wash hands and observe good hygiene to reduce the spread of the diseases. Adequate and continuous supply of water will; therefore, be required for sanitation and hygiene in all areas.

While there is no special legislation pertaining to water security and health per se, there is a specific legislation on infectious diseases, which is the *Prevention and Control of Infectious Diseases Act 1988 (Act 342), (with latest amendment - P.U (A) 374/2006).* This piece of legislation is by far the most comprehensive in terms of defining infectious diseases by pathogens of which COVID-19 could be one, as it pertains to *`a product of virus capable of causing the infectious disease'.*

The said legislation is also interesting in that it has detailed provisions for containment of infectious diseases with penalties to those flouting the Act. Unfortunately, the legislation did not mention the medium of infection such as through air or water, but rather the focus was on the prevention of the disease, or when the disease has already spread (the list of diseases did not mention COVID-19, as presumably it is a very new disease), for which precautionary measures should be taken. Clearly, as seen in the legislation, Ministry of Health would be the main platform to administer the COVID-19, but may not be for water security, which will need a broader platform with other relevant agencies. The main features of this legislation are shown in Box 2.7.

Other legislations that pertain to water quality are the Environmental Quality Act (EQA) 1974 and amendments thereof, and the Water Services Industry Act (WSIA) 2006, with water safety elements.

Box 2.7 - The relevant legislative sections

PART III – Prevention of Infectious Diseases
Section 6: Declaration of infected area
Section 7: Entry into and examination of vehicles and the measures thereafter (vehicles include ships, aircrafts, trains, cars and other means of transport)

PART IV – Control of the spread of Infectious Disease
Section 10: Requirement to notify infectious diseases
Section 11: Declaration of an infected local area
Section 12: Infected persons not to act in a manner likely to spread infectious diseases
Section 13: Control of contaminated articles and infected animals
Section 14: Isolation of infected person and suspects
Section 15: Observation or surveillance of contacts
Section 18: Disinfection and closure of premises

The preliminary data from Suruhanjaya Perkhidmatan Air Negara (SPAN) onwater consumption (domestic and non-domestic). However, water demand for Peninsular from 2019 and 2020 showed some interesting observations relating to water and COVID-19 (as depicted in Table 2.4 and Table 2.5 and Figure 2.14 and Figure 2.15, respectively) before and during the COVID-19 time periods.

Water usage in 2020 increased by 0.93% as compared to in 2019. Furthermore, water demand also increased by 1.77% in 2020. The main reason for the hike could be the continuous call to practise the Standard Operating Procedure (SOP), as an act to reduce COVID-19 infections, whereby more water is utilised for sanitation and hygiene as an immediate water security impact. It will be interesting to see more long-term effects in future.

Table 2.4. Total volume of water consumption

Year	Water Consumption (m^3)		
	Domestic	Non-Domestic	Total
2019	2,179,992,898	1,317,894,105	3,497,887,003
2020	2,309,975,422	1,220,604,591	3,530,580,013
Difference	+1,299,826	-972,896	+326,930
% Difference	+5.96%	-7.38%	+0.93%

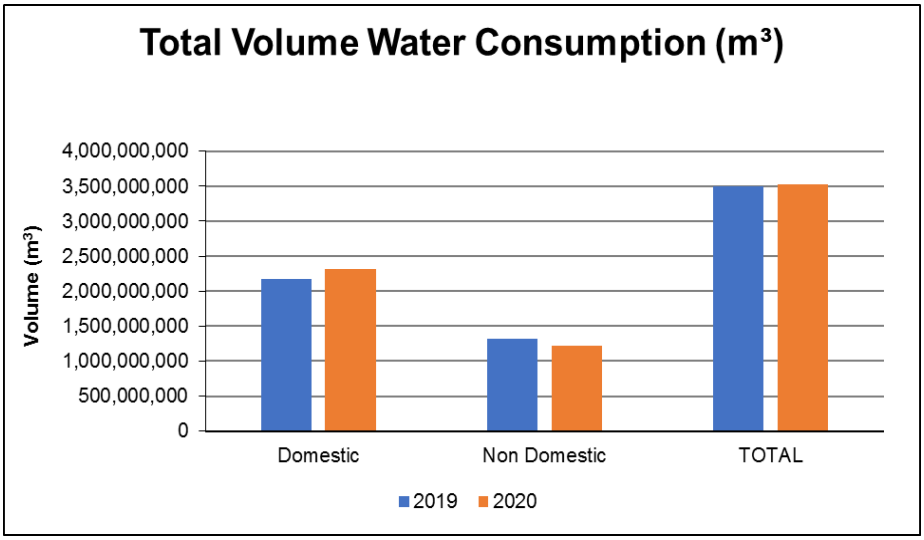


Figure 2.14. Total volume water consumption 2019 and 2020

Table 2.5. Total volume water demand 2019 and 2020

Year	Water Demand (m^3)
2019	5,388,974,348
2020	5,484,453,837
Difference	+954,795
% Difference	+1.77%

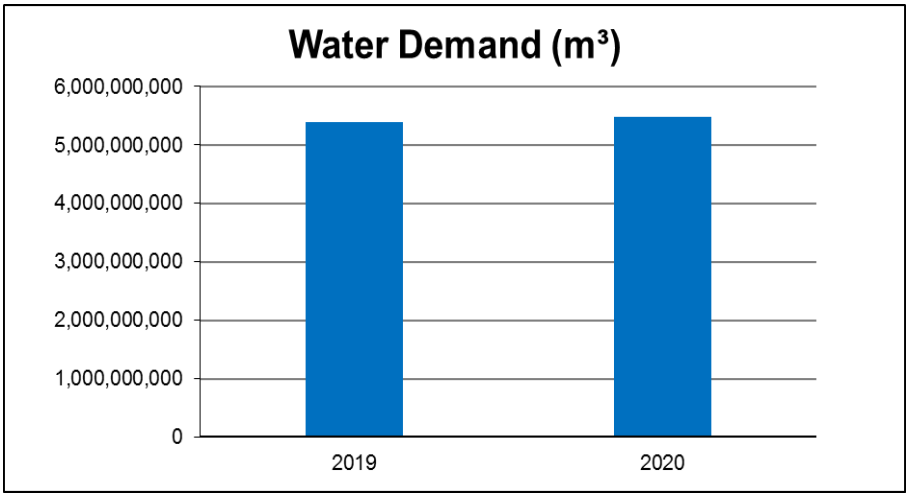


Figure 2.15. Total volume water demand 2019 and 2020

2.7.5 Risks and challenges of future pandemics

During infectious disease outbreaks such as the current COVID-19 pandemic outbreak, safely managed WASH services are an essential part of preventing the spread of disease and protecting human health.

One of the most cost-effective strategies for increasing pandemic preparedness is the investment in strengthening core public health infrastructure, including water supply and sanitation systems. Good and consistently applied WASH and waste management practices serve as essential barriers to animal-to-human and human-to-human transmissions of the COVID-19 virus in communities, homes, healthcare facilities, schools, and other public spaces. Safe WASH services and medical waste management in healthcare facilities are also essential to deliver quality health services; protect patients, health workers, and staff; and prevent further transmission.

Policies and plan for WASH and wastewater should always be improved and supported with science-informed actions as water and potentially soil may be major modes for spread of water-borne diseases. Plausible causal pathways and growing evidence suggests that effective WASH and wastewater management will reduce risks posed to humans, animal and plant health due to contamination of water sources.

Chemical contaminants, faecal pollutants, household wastes, animal husbandry wastes, and industrial effluents are hazards that are dispersed via water, sludge and manure potentially resulting in the transmission of disease-causing pathogens to humans, animals and plants[15]. As a result, humans are subjected to waterborne diseases such as diarrhoea.

Of late, antimicrobial resistance (AMR) is an emerging issue which is worth looking into. AMR refers to microorganisms, including bacteria, fungi, viruses, and parasites which have become resistant to antimicrobials as a result of a variety of mechanisms, such as mutation or genetic exchange (acquired resistance).

Human consumption of antimicrobials can result in antimicrobial resistant pathogens being discharged into waterways via open defecation, raw, partially and treated sewage, and liquid effluent from septic tanks and pit toilets. Similarly, the use of antimicrobials in terrestrial and aquatic animals and plants can also contribute to the spread of antimicrobial compounds and their metabolites to waterways via point source pollution (e.g. discharge from feedlots or aquaculture ponds) or diffuse pollution (e.g. manure-treated fields).

Exposures to waterborne diseases may occur when humans come into contact with contaminated water downstream of point or diffuse sources. Poor animal husbandry practices such as the release of urine and faecal matters produced by animals into the rivers, wastewater or water sources can be a cause for water pollution and waterborne diseases as well.

Improper management of water supply and wastewater will also lead to the emerging of infectious diseases that are of zoonotic origin. Zoonotic diseases are infectious diseases that are naturally transmitted between vertebrate animals and humans. Prevention of waterborne zoonotic diseases is mainly by observing and practising good hygiene and sanitation.

Water-borne infection through person-to-person contact and consumption of contaminated food and water, is very unlikely to be the source of a pandemic. Nevertheless, the provision of safe water, sanitation, and hygienic conditions is essential to protecting human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces, and healthcare facilities will help prevent human-to-human transmission of the COVID-19 virus[18]. Measures to ensure water safety starting with protecting the water source, treating water at the point of distribution, collection, or consumption, as well as storing water safely at home should be in place.

In this regard, the importance of establishing water quality index and monitoring those indices cannot be ignored. Over the last 50 years, WHO has provided guidance on drinking water quality standards, which is

widely regarded as an authoritative basis for the setting of national regulations and standards for drinking water safety for public health.

Malaysia published the first *National Guidelines for Drinking Water Quality in 1983,* under the guidance of the experts from the WHO Western Pacific Regional Centre for the Promotion of Environmental Planning and Applied Studies (WHO/PEPAS). The *National Drinking Water Quality Surveillance Program* (*Program Kawalan Mutu Air Minuman*, KMAM) was launched and implemented nationwide in the following year. The guideline was revised in 1990 and again with the publication of the *National Drinking Water Quality Standard (NDWQS) 2000.* There are a total 40 parameters recommended for raw water quality criteria and 131 parameters for drinking water standards. The guideline provides guidance on the method and number of samples as well as frequency of sampling.

Although raw water quality standard parameters were included in the NDWQS, a more comprehensive raw water quality monitoring programme is required to ensure safe water for human consumption as well as for economic and recreational purposes.

2.7.6 Recommendations

In the context of COVID-19 pandemic, preparedness, utility services, including the provision of safe and quality drinking water, are considered as essential services that need to be protected. Therefore, a plan of action must be established, along the lines of a Business Continuity Plan (BCP) in the *Majlis Air Negara* (MAN), so that the country is prepared for an infectious disease disaster when it occurs.

A comprehensive programme to monitor the water quality of all water bodies throughout the country will form part of the action plan. Water Quality Index and Standards need to be established for all forms of water bodies. The MAN, which was established in 2019, will be able to undertake all these activities. It however has to be strengthened to formulate overall policies, implement decisions and monitor the progress.

The environmental and physical status of 189 river basins of more than 80km^2 in the country should be frequently assessed and analysed in order to monitor their ecosystem health and functions. Effective assessment of ecosystem health is thus vital to understanding the environmental water security of the country.

The following are recommended policy interventions/guidance that are needed to address the short and long-term measures for the relevant core areas.

i) Short-term Recommendations

1. Amend the *Prevention and Control of Infectious Diseases Act 1988 (Act 342), (with latest amendment - P.U (A) 374/2006), to include the term "water security" in it, with guideline provisions for measuring and abatement me*asures.
2. Rapidly accelerate WASH investments in Malaysia to facilitate access to safely-managed water and sanitation services especially in the most vulnerable areas such as in urban slums, city peripheral areas and in some rural settings.
3. Implement the core recommendations of *WHO Guidelines on Sanitation and Health*. Ensure that MOH fulfils the core functions for sanitation, especially ensuring WASH promotion and monitoring of status of WASH is included into health services and surveillance systems.
4. Aggressively implement CEPA programmes immediately, with emphasis on the SOP for WASH.
5. Empower communities with the
    i. Ability to identify the issues in the areas of pandemic preparedness, water stress and the interlinkages between waste and water pollution and the potential risk that the three areas have on their community
    ii. Guidance to protect and prepare themselves to be resilient and conduct self-assessments
    iii. Skills to mobilise local emergency response actions to reduce water dependency and wastage and be water smart.
    iv. Conduct regular audits on water supply and rivers around them so they can sustain them through pandemics.

v. Training on proactive disaster management.
vi. Information about the importance of boosting the self-immune system as a part of the body's defence system and water efficiency practices, alternative water resources and priority nutrition interventions.
vii. Digital skills to ensure that effective and timely information is shared as it is a key factor in disaster management and allow for relevant authorities to be alerted about water related issues.

6. Protect forests, which is a crucial actionable tool, to safeguard water resources and wildlife and to prevent a jump of zoonotic viruses from wildlife to humans. While protecting forests and conserving water are under state purview, nevertheless, the State Governments through binding decisions; via the National Land Council; can explore ways to minimise forest conversion or clearance in order to protect natural habitats and to protect the human population in the world. This will ensure the forest cover in the country remains within 50% of the land area, a commitment pledge at the Rio Earth Summit 1992.

ii) Long-term Recommendations

1. Introduce stepwise improvements, based on national level risk assessment, by allocating investments in areas of highest risk to achieve a safely managed water and sanitation system for all.
2. Place water at the centre of sustainable rural development by promoting water-effective irrigation agriculture and community-based water and sanitation services (WASH).
3. Target urban and rural water security by investing in water, sanitation, and disaster risk reduction infrastructure services not only in cities but also in rural, slum and city peripheral areas.
4. Investments in water, with good governance, should be used to build greater resilience to climate, health, and food system shocks, and more effective management of water-related risks and pandemics.
5. Rebuild better water infrastructure facilities to ensure better practices for tomorrow. This will drastically reduce pollution, stimulate a circular economy, increase land protection, and facilitate nature-based approaches.
6. Diversify our sources of water instead of being heavily dependent on rivers.
7. Government should work together with academia, scientific bodies and NGOs to strengthen water security.
8. Invest in a good public health intervention system.
9. Deploy advanced wastewater treatment technologies in the highest risk areas to ensure water security.
10. Install a better digital monitoring system, in line with IR 4.0, to effectively manage the water and sanitation services which will help towards achieving water security.
11. Formulate a pandemic preparedness chapter for inclusion in the community preparedness module (Local Agenda, LA21)
12. Establish a proper SOP for the disposal of medical face masks and personal protection equipment.
13. Spearhead one common partnership or scheme, in keeping with Wakaf Air, to support community resilience. This can be achieved through Public Participatory Platforms (PPP) in order to not leave anyone behind.
14. Implement Nature-based Solution (NbS) approaches to support strengthening water security for future pandemics. This could include source water protection; conserving or rehabilitating natural ecosystems, afforestation, protecting mangroves, sustainable drainage systems, amongst others.
15. Better protect environmentally sensitive areas within river basins by identifying pristine areas and hot spots for biodiversity conservation and aquatics life protection.

2.7.7 Conclusions

Water security needs to be strengthened in the face of pandemics. When assessing water security issues, the main challenge is to ensure sufficient and good quality water is provided to communities exposed to infection, who have to get their water supplies from collection points if there is no piped in water in rural and areas, where water is scarce.

Preparedness to the COVID-19 pandemic includes strengthening the resilience of communities from the diseases through proactive mitigations. These include provisions of advocacy; dissemination of accurate information; capacity building regarding the disease; and what they have to do to protect themselves and their communities; and a good monitoring system to trace and tract down any epicentres or clusters of

the disease, and lines of communications with the relevant authorities concerned. At the public health centres, management by crisis, should be routine since there should already be experience in managing risks associated with floods, drought and so on. Therefore, training of the centres' staff needs to be an ongoing exercise for the short-term and long-term.

Investments can be promoted through the banking system, on the value of investing in water and wastewater. The right policies and government directions as well as injection through grants and schemes, can form part of the creation of a futureproof resilient economy for communities who have suffered during the COVID-19 pandemic.

2.8 WATER SECTOR INITIATIVES BY KASA[6]

Preamble: While executing the WST2040 study commissioned by EPU to ASM as its strategic partner, the study team received this memorandum from KASA pertaining to its initiatives regarding the water sector. It is considered relevant for inclusion in the WST2040 study report. The KASA memorandum is reproduced in its entirety below:

2.8.1 Introduction

Water security refers to the availability and accessibility to water resources and the ability to ensure adequate water with good quality for the people and environment. Most countries, especially developed countries, prioritise and protect water resources as a strategic asset.

United Nation-Water defines water security as "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

Malaysia has implemented various efforts over the decades to ensure the nation's water security from source to source. The water governance in Malaysia remains challenging due to its constitutional setup, sectoral-based water management, insufficient financial resources, and institutional capacity. Over time, the country incorporates the concept of integrated water resource management (IWRM) into its policy, but its implementation takes time.

The Federal Government approached this through institutional setup by putting water under the Ministry of Energy, Water and Communications portfolio for the first time in 2004. Later, the ministry embarked on transforming the water services industry by amending the Federal Constitution.

Since 2005, Malaysia has undergone a water services sector transformation to place water supply and services under the shared responsibility of the Federal and state governments. The management of the sewerage sector has been under the Federal Governmenut control since 1993. The restructuring of the water services industry is a public policy innovation from the Federal Government to solve existing problems in the Malaysian water supply industry. It anchors towards the long-term financial sustainability of water services sector, underpinned by broadening participation.

Before the restructuring, water resources and water supply were under the state Government's purview. The restructuring permits the Federal Government to regulate water services. However, the arrangement only applied to Peninsular Malaysia and Labuan.

The initiative's notable outputs include introducing new laws and institutional arrangement to regulate the water services industry under a licensing regime regulated by the National Water Services Commission (SPAN).

6 This is a paper submitted by KASA to be included in the WST2040 Report (EPU had agreed to its inclusion). It lays out the issues and challenges facing the water sector and proposes a number of solutions.

The Federal Government has set a policy direction for the restructuring based on an "asset-light" model for all states. With this model, the state government handed over all water-related assets and liabilities to Pengurusan Aset Air Berhad (PAAB), a water asset management company owned by the Minister of Finance Incorporated. Via the "asset-light" mechanism, water operators are relieved from the obligation to raise funding for water projects. Instead, they can focus on operations and enhance efficiency and cost-effectiveness. Meanwhile, PAAB finances their capital expenditure (CAPEX) at a competitive financial cost in a long-term low-interest rate loans to the water operators. It positively impacted water supply coverage and water loss management, amongst others, to the state water operators who participated in the initiatives for more than six years.

However, challenges remain. One of the main difficulties is the depoliticising of water tariff rate setting. Once a systematic, fair and transparent tariff setting mechanism (TSM) is fully implemented, it could unlock the operators' revenue stream to achieve full-cost recovery.

In 2012, Malaysia launched the National Water Resources Policy to set the country's aspiration in safeguarding the security and sustainability of water resources for all. It is a unifying policy that would guide the formulation of legal and management frameworks to manage water and address the existing issues related to policy and jurisdictive disparities between federal and state agencies and update existing water laws. In the same vein of this policy, the Federal Government drafted the Water Resources Bill with the IWRM concept to lobby the State Governments to adopt a uniform water law. However, the states did not show great interest. The Federal Government later proposed the law to be a model law, but it did not receive the necessary support to table the bill in Parliament.

The challenges of water governance between the federal-state and between states remain. However, KASA has proposed the setting up an interstate river authority (iSRA) to manage interstate rivers more efficiently. Formed by and reported to the Ministry responsible for water management, iSRAs will be entrusted to manage the development and management of water resources shared between two or more states. In addition, iSRAs will be the secretariat for federal-states engagement on water resources governane and other matters of mutual interests. Main functions of iSRAs will include (i) to identify and formulate action plans for efficient interstate river management based on IRBM; (ii) to review the effectiveneness of existing measures; (iii) to coordinate with other interested stakeholders as well as state governments and (iv) to manage water allocation amongst various economic sectors in a fair and efficient manner. However, active engagement with state governments is paramount to realise the formation of iSRAs.

2.8.2 Water as a strategic asset

Malaysia has high rainfall of 2900 mm/year and rich in various water sources that are readily available and could be harnessed at a low cost. Despite this, water resources governance is still challenging due to pollution from illegal discharge of prohibited effluents to the river, silts from land clearing activities, and releases from various economic activities. The changing climatic patterns, causing prolonged hot weather or monsoon flood, are affecting the readily available water for treatment in water-stressed states such as Kedah, Pulau Pinang, Melaka and Johor.

It is no longer sufficient to manage water resources based on socio-economy and environmental considerations. It is time to view water resources management as the nation's strategic sector. For example, Singapore placed water security as its utmost priority to ensure the availability, accessibility, and capability to secure water resources and supply. All developments must provide enough water with high quality to meet the demand of rising population and economic activities to safeguard the nation state's security, sufficiency, and resilience.

In Malaysia, the Federal Government plays a prominent role in planning, developing, regulating, and financing water resources governance. It is realised by developing long-term plans that emphasise the conservation and preservation of water resources, water supply and services, demand management, and environmental sustainability.

The government implements three continuous efforts to safeguard national water security: 1) ensure water resources sustainability; 2) continuous and sufficient water supply; and 3) demand management.

2.8.3 Water Resources Sustainability

The government could realise water resources sustainability (Figure 2.16) by implementing the following strategies: increase raw water storage capacity, establish a dedicated unit to handle environmental crime, amend existing laws, and promote broader and active public participation in safeguarding water resources through a community-based programme.

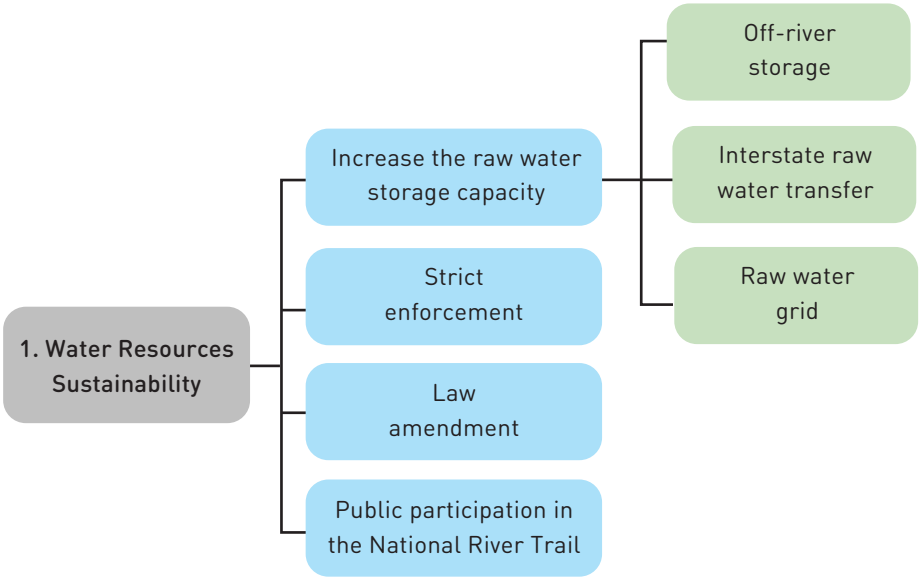


Figure 2.16. Water resource sustainability initiatives

a. Increase the raw water storage capacity

i) Off-River Storage (ORS)

Off-river storage is a storage system built near the river to receive excessive river water, especially during the rainy season. ORS created at the downstream requires low pumping cost. It releases water into the river during low flow or channel to the water treatment plant as alternative water resources. It can also act as a flood mitigation buffer.

The Ministry of Environment and Water (KASA) plans to build more ORS, especially in water-stressed states. Under the 11th MP, the government approved four ORS projects, namely ORS Jernih, ORS Melaka, ORS Sungai Johor and ORS Linggi, with a total cost of RM1.4 billion. The ministry proposes another 16 such projects in the 12th MP with a total cost of RM 7 billion.

ii) Interstate Raw Water Transfer

Raw water transfer between states brings a win-win solution to the supplier and receiver of raw water resources. States with abundance and excess water - Pahang, Perak, Johor - can reap higher income from water sales; meanwhile, water-stressed states – Selangor, Penang, Melaka - can optimise their water resources for various applications.

In this regard, KASA will develop the raw water pricing mechanism – a pricing framework to guide state governments in setting the raw water price based on the four grades of the raw water quality index (WQI).

It is hoping that the pricing mechanism can drive the state to take the initiative to conserve and preserve their catchment areas. It must also ensure rivers in its boundary are free from pollution through effective monitoring and enforcement of the state regulatory body.

iii) Raw Water Grid

A water grid system connecting various storage systems into an integrated network could serve as an alternative water source in pollution or low river flow due to prolonged hot weather. It ensures fewer water disruptions caused by lack of available raw water for supply.

b. Strict Enforcement through the setting up of the Environmental Crime Prevention Unit (UCJAS)

KASA established the Environmental Crime Prevention Unit (UCJAS) on 1 October 2020 to prevent and curb criminal activities against the environment through intelligent gathering and case profiling methods. The unit consists of officers from the Department of Environment (DOE), Department of Biosafety (DOB), SPAN, and Royal Malaysia Police. It allows integrated enforcement to improve monitoring and prevention of pollution.

The involvement of various departments and agencies, especially the police force, is crucial in this effort. Environmental pollution is considered an organised crime that requires intelligence, forensic, and better coordination for effective enforcement.

As of March 2021, the unit successfully charged two workers at the premise suspected of polluting Sungai Selangor under Section 430 Penal Code.

c. Law amendments

The law provision in the Environmental Quality Act 1974 (Act 127) and Water Services Industry Act 2006 (WSIA) are insufficient to prevent pollution or make a case for conviction. To some extent, the laws , have not been able to address water pollution effectively.

For example, the penalty for polluting the inland water under Section 25(3) Act 172 is too low as the maximum fine is RM100,000 or jail for a period, not more than five years or both. The ministry plans to increase the penalty by amending the EQA.

The other proposed amendment is to give officers the power to arrest without a warrant and authority to seize vehicles under WSIA to take swift action to curb activities that could affect the water supply or sewerage services to the people.

d. Broader public participation through National River Trail (NRT) Programme

A National River Trail (NRT) is a nature-based solution to encourage local participation in dealing with socio-environmental challenges through sustainable environmental management and utilisation.

The people can use the river trail for outdoor activities such as picnic, cycling, fishing and others. They have greater appreciation towards the environment and not make it a dumping site. They can also become the eyes and ears of the authority in monitoring pollution activities near the river.

KASA plans to build a 1,000km long river trail near the selected river reserve in 2023 and 10,000km in 2030. The government built two river trails in 2020: the Sungai Langat Phase 1 river trail (150 meters long) and the Sungai Pengkalan Datu river trail in Kota Bahru (about 1km long).

The programme is implemented through strategic partnerships between government agencies, non-governmental organisations (NGOs), private partners, and education institutions. It is financed through an allocation from the government, crowd contributions from the individual, community, corporate entity, and NGOs.

The local community is the key driver of the project to maintain the upkeep of area, plant trees and organise awareness events. Besides, students can also organise study trip or awareness programmes to appreciate rivers and cultivate a sense of shared responsibility and belonging towards the environment.

More importantly, the programme provides a more significant opportunity for the various stakeholders from the local community, local government, education institution, and federal government agencies to work together for one cause. It achieves the programme objectives to increase communication, education participation, and awareness (CEPA) amongst the stakeholders.

2.8.4 Continuous and Sufficient Water Supply

Continuous clean and safe water supply is vital for well-being of the people, environment, and economic development (Figure 2.17). An efficient, well-functioned and integrated water supply system could ensure the water flow into all the segments of the socio-economy. Increasing reserve margins, reducing water loss and constructing a water grid to improve the connectivity of water supply reticulation systems are the necessary initiatives under this effort.

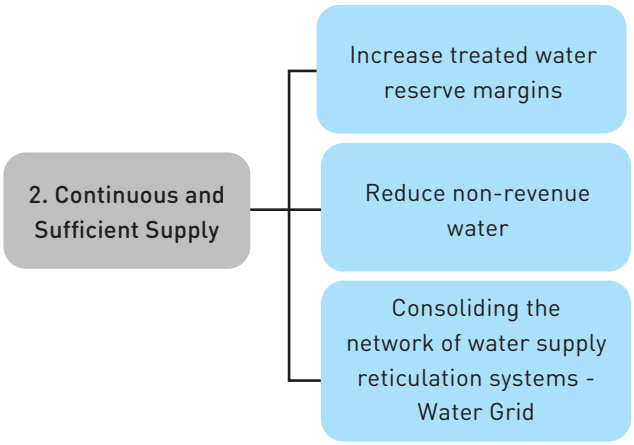


Figure 2.17. Continuous and Sufficient Water Supply Initiatives

a. Increase Treated Water Reserve Margin

Reserve margin defines as the design capacity of a water treatment plant (WTP) ascompared to production and demand. A comfortable reserve margin set by SPAN is between 10% and 15%. However, several states – Selangor, Kelantan, Kedah and Perlis have low reserve margin to as low as 0%, whereas Johor and Sabah recorded a thin reserve margin of below 10% (Table 2.6). These states face high water disruption risk if the WTP stops work for maintenance or due to pollution.

SPAN sets the reserve margin target at 20% of all time, a level that would be able to withstand the demand during a crisis, scheduled or unscheduled water disruptions.

For this purpose, the government and PAAB have planned various projects to upgrade existing water treatment plants or build new facilities for states with low reserve margins.

b. Reduce non-revenue water (NRW)

Non-revenue water refers to the difference between water production from the WTP and water billed to the consumer. A high level of NRW impacts the water supply continuity and reflects the water operator's operational incompetence. Besides, it also caused financial loss to water utilities.

At the Asian level, the Asian Development Bank reported that the NRW rate amongst water operators was 35% (Frauendorfer & Liemberger, 2010). NRW hurts all water operators - operating at low levels of efficiency, increasing treatment and distribution costs, and reducing water sales, and thus affecting revenue.

Table 2.6. Reserve margin percentage, 2019

No.	States	Reserve Margin (%)
1	Selangor	0
2	Kelantan	0
3	Kedah	1.4
4	Perlis	1.9
5	Johor	7.8
6	Sabah	8.3
7	Melaka	15.8
8	Pahang	19.3
9	Sarawak	19.7
10	Negeri Sembilan	21.1
11	Terengganu	24.6
12	Labuan	24.6
13	Perak	28.1
14	Pulau Pinang	31.6
Average		**14.59**

Source: Suruhanjaya Perkhidmatan Air Negara (SPAN), 2019

From another perspective, high NRW also indicates inefficient water supply management. Continuous NRW incidents without any corrective action cause water operators to lose revenue that can be used to make improvements to other services.

The national NRW level increased year-on-year from 35.5% in 2017, 35.7% in 2018, 36.2% in 2019 and 36.8% in Q2 2020. It is far from achieving the target of 33% set for 2020. Several states recorded NRW level as high as 60%, and the total financial loss amounted to more than RM2 billion. The NRW level in Q2 2020, as in Table 2.7**.**

NRW reduction programme is a capital extensive initiative and requires a considerable investment. It is estimated that between RM800 million to RM1 billion is needed to reduce 1% of NRW. It means the government must invest RM3 billion to achieve its 30% target in 2030.

Under 11MP, the federal government implemented the National NRW Reduction Program 2018-2020 with an initial allocation of RM1.9 billion. The government has been implementing the said programme in two approaches.

Table 2.7. NRW level in Q2 2020

State	Production	Billed usage	NRW	
	Million litres per day (MLD)			(%)
Perlis	261	93	168	64.50%
Sabah	1,298	527	772	59.40%
Pahang	1,227	562	665	54.20%
Kelantan	506	239	267	52.80%
Kedah	1,485	764	720	48.50%
Negeri Sembilan	789	478	311	39.40%
Sarawak	905	559	347	38.30%
Labuan	82	52	31	37.50%
Terengganu	671	428	243	36.20%
Selangor	4,981	3,490	1,492	29.90%
Perak	1,367	960	407	29.80%
Johor	1,916	1,406	510	26.60%
Melaka	493	373	120	24.30%
Penang	1,115	869	245	22.00%
Total	**17,096**	**10,798**	**6,298**	**36.8%**

Source: SPAN, 2020

Approach 1 focuses on water utilities with an average NRW exceeded 40%. Under this approach, the federal government provides direct grants to water utilities in Perlis, Pahang, Kelantan, Sabah, Sarawak, Kedah, and Labuan. The grants cover four works scope: SIV and individual water meters replacement, establishing a geographic information system (GIS), and water reservoir repairing work.

The government also introduced an incentive-based Approach 2 to incentivise water utilities to reduce or achieve better NRW result. It is targeted at water utilities with an average NRW of less than 40% in Perak, Penang, Selangor, Terengganu, Melaka, Negeri Sembilan and Johor. Under this approach, water utilities that manage to meet the reduction target (mutually agreed upon by them and SPAN) get back 50% of their investment made in that year. If water utilities manage to double the reduction targets, they can get a higher reimbursement at 75%.

Under the migration framework, PAAB has approved 485 NRW projects totalling RM1.97 billion for five water utilities.

Moving forward to realising the 25% target under 12 MP, the KASA envisages a more significant investment. It is estimated that RM 10 billion is needed for various projects and measures. Due to the government's budgetary constraint, it is tenable to consider alternative financing models to complement the public funding. In this regard, KASA is seriously considering an active private investment that could come in many forms: performance-based contract, build-operate-transfer (BOT), build-own-operate-transfer (BOOT), public-private participation (PPP) and so on.

c. Consolidating the Network of Water Supply Reticulation Systems Through the Construction of a Water Grid

Constructing a water grid can increase and consolidate the inter-connectivity of the water supply systems. The grid connects the districts' water supply reticulation systems within a state to supply water to the residents.

It can improve the resilience of water supply systems, as it can channel water from other districts to the district facing a water disruption. For instance, the water grid can minimise the impact of service disruption caused by the pollution in Sungai Selangor, which supplies water to 60% of the Klang Valley population by bringing water from the Semenyih and Langat corridors.

The ministry proposes implementing the first water grid project in Klang Valley under 12th MP for RM 2 billion to improve water security.

The water grid project could also support the water highway used in many countries worldwide to ensure sufficient water supply from identified sources for continuous supply.

2.8.5 Water Demand Management

Water demand management ensures the consumer uses water efficiently, fairly, and sustainably. It reduces water demand and optimises the use of water infrastructure through operational efficiency. The government implements several measures to manage water demand (Figure 2.18). It includes carrying out water tariff revision, implementing water-efficient products labelling to encourage adoption of water-efficient products, by using reclaimed water produced from the sewerage treatment plant.

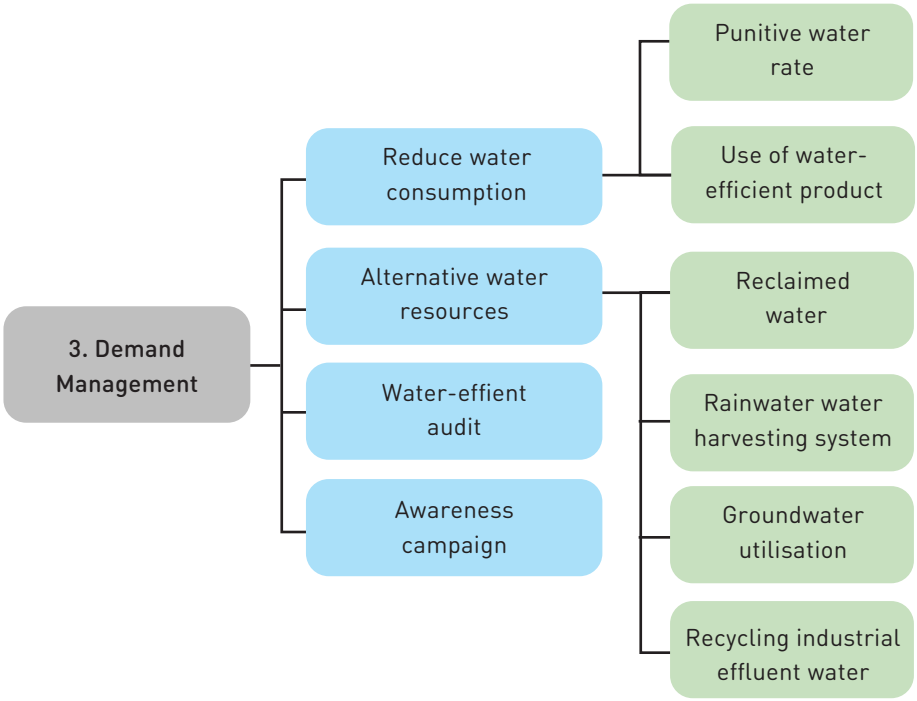


Figure 2.18. Demand management initiatives

a. **Reduce water consumption**

On average, a Malaysian uses 220 litres of water a day as compared to 140 litres in Singapore and 165 litres in the Philippines. The target was to reduce the daily water consumption per capita to 180 litres in 2020. Factors such as low tariff rates, the free water policy, and the lack of appreciation over water value drive up consumption.

One way to rectify the situation is to implement a punitive tariff rate and encourage water-efficient products adoption.

i) Punitive Water Rate

Implementing a punitive water rate can educate the public on the actual water supply cost to avoid unnecessary wastage. It means setting a higher rate for heavy water users who consume over 35 m^3

per month. But it does not affect usage below 20m^3 per month. The tariff rate also accounted for the high rehabilitation cost of water resources.

The measure encourages water savings and indirectly increase the water reserve margin to 15%–20% set by SPAN and ensures continuous supply.

The average water tariff is RM1.38/m^3 does not reflect the actual cost of RM2.35/m^3. Based on SPAN's projection, seven of the 12 operators recorded loss in 2020. It hampers the operators' ability to invest in improving their services, such as developing new water assets and expanding supply coverage.

ii. Use of Water-Efficient Products

SPAN drives the initiative to reduce water demand. One of the key measures is the mandatory use of water-efficient products through a labelling scheme.

Currently, there are five water-efficient products in the market: showerhead, water tap, dual-flush toilet, urinal flush valve and washing machine. The government enforced the mandatory use of dual-flush toilets with a capacity of 3 litres and 6 litres in 2008, urinal flush valves in February 2014 and showerheads in 2019 for a new building.

Considering this, SPAN introduced the Water-Efficient Products Labelling Scheme (WEPLS) in 2013 to certify the products. In 2021, participation in the scheme is mandatory with the enforcement of Water-Efficient Products Labelling Rules.

KASA planned to launch an initiative to use water-efficient products in government and public facility premises in Putrajaya for RM50 million under 12MP. The new government buildings at the federal, state and local level are encouraged to adopt the same initiative.

b. Alternative Water Resources

i) Use of Reclaimed Water from Sewage Treatment Plant

Reclaimed water produced from the sewage treatment plant (STP) operated by Indah Water Konsortium (IWK) is an alternative water source to meet water demand, especially in the industrial sector. IWK's 8,000 STP produce approximately 5,800 MLD of high-quality reclaimed water, but the usage is merely 20MLD.

IWK initiated a small-scale pilot project in Pantai 1 STP between 2017 and 2019, and the result showed an increasing appetite from the manufacturing industry. Currently, IWK is implementing several reclaimed water projects, such as the project in Setia Alam, Selangor, which produces 5 MLD of reclaimed water. IWK plans to expand its reclaimed water project in Pantai STP to create 100MLD. In contrast, a Bayan Baru STP project, Pulau Pinang, produces 50MLD reclaimed water for the industrial area in Bayan Lepas.

Under Strategic Plan 2020–2030, KASA aims to increase reclaimed water as an alternative water source to 1,500 MLD by 2030. The government plans to construct several water reclamation plants (WRP) under 12th MP in industrial areas in Pasir Gudang, Johor, Bayan Lepas, Penang, and so on to supply industrial-grade reclaimed water to industries.

The use of reclaimed water in the industrial sector can reduce the demand for drinking water. It can be used in irrigation, housing development projects, business development projects, and flushing toilets.

ii) Rainwater Harvesting System (RWHS)

Rainwater harvesting and utilisation is one of the best management practice (BMP) in an effective water management system. It is used in many regional countries to reduce the impact of flood caused by climate change.

It is a sustainable water supply source and uses less energy input for treatment and pumping for supply. It can serve as a water source in the event of water disruptions. It reduces the water bill as well.

Malaysia introduced rainwater harvesting system installation following the water crisis in Kuala Lumpur in 1998. The first phase of policy to encourage the RWHS installation began in 1999 when the then Ministry of Urban Wellbeing, Housing and Local Government published the Guidelines for installing a Rainwater Collection and Utilisation System.

The government subsequently amended the Uniform Building By-Laws 1984 (UBBL) and passed it on 23 May 2011. The UBBL mandated RWHS installation in any new development project and must

appear in the building plans for residential buildings (bungalow and semi-detached) with roof area equivalent to or over 100m^2 and detached building with roof area equal to or over 100m^2.

The National Water Research Institute of Malaysia (NAHRIM) actively study on hydrology and hydraulic design, system design and performance, installation and operation cost and water quality aspect of the system. The study found that a system can save up to 40% of public water usage a day and can reduce treated water consumption in the long run.

The Department of Irrigation and Drainage (JPS) also installed the RWHS in several locations, such as the JPS's headquarter, the National Zoo, Institute of Land and Survey (INSTUN) in Tanjung Malim, Perak and bungalows in Gombak Selangor.

iii) Groundwater Utilisation

The utilisation of groundwater in Malaysia remains low at below 5% of total water resources as the country has many rivers flowing all year long. The cost of extracting surface water is also cheaper.

Groundwater is clean surface water that seeps into the aquifer. The permeability of the aquifer layer determines the water extraction rate and the period for aquifer recharge.

The Department of Minerals and Geoscience is the lead agency responsible for developing groundwater as an alternative water source. It is particularly essential in urban areas and rural areas facing difficulties in accessing clean water from WTP during prolonged hot weather.

iv) Recycling Industrial Effluent Water

Recycling industrial effluent water can reduce the reliance on the water supply. It is also a resource recovery effort in mitigating the risk of an insufficient water source during prolonged drought.

Countries such as Australia uses industrial effluent water for non-potable use and industrial use. These countries have laws and comprehensive guidelines to encourage the usage of the recycled resource.

However, industrial users may compare the cost of the treated water and setting up their private recycling system before invest in the latter. The initiative is likely to be attractive after a tariff revision.

c. Water Efficiency Audit

SPAN must carry out water efficiency audit on significant water users such as glovemakers, hotel, business complex, college and higher education institutions, camp and so on to test the level of water usage and identify water-saving measures to avoid wastage.

SPAN has carried out water efficiency audits and helped several hotel operators to save up to 20%–30% water usage.

d. Awareness Campaign

Education and awareness campaigns are great ways to increase the public's appreciation of water and encourage them to conserve and preserve water resources. A continuous targeted education programme can be a platform to drive behavioural change.

SPAN has carried out water-efficient tap replacement programmes for B40 households and Masjid Hijau; launched Water Sustainability Campaign, Water Saving Campaign and Compliance of Water Services Industry Act (Act 655) on traditional media and national media platforms, Sekolah Rakan SPAN programme, Importance of Water and Saving Water Campaigns on social media platforms quarterly and organising webinar for the public and college students.

2.8.6 Strengthening the Governance of the River Basin Management

Malaysia has 189 river basins; 17 are shared between two or more states (Table 2.8). Managing them involves a complex political and economic consideration as the power over water resources and rivers is with the state governments as enshrined under Schedule 9 of the Federation Constitution. Political incompatibility between state governments and the need to ensure water sustainably shared between all users to support economic development have called for better management of inter-state river basins. For instance, the ongoing saga between Penang and Kedah over the Muda River basin has proved that both states cannot resolve it amicably for mutual benefits. As a result, the economic development in the Northern corridor (Perlis-Kedah-Penang) might have to be compromised as more than 4 million inhabitants rely on water for the Muda River basin to fuel the economic growth. Other river basins that need equal attention include

Sg. Muar (Johor-Melaka-Pahang-N. Sembilan), Sg. Linggi (N. Sembilan-Melaka) and Sg. Bernam (Perak-Selangor).

Clause 11 (b) in Schedule 9, Federal List of Federal Constitution gives power to Federal Government to enact laws concerning inter-state rivers. It does not include land alongside the river, and thus this provision does not apply to river basins that include land under the power of the state government.

The National Water Resources Council (MSAN) - now renamed National Water Council (MAN) - has been established to deliberate matters related to inter-basin water management. However, MAN has not been effective for several reasons. MAN has been established as an 'administrative' arm at the federal level with no legal backing in the form of an act of Parliament. As such, its decisions have no legal binding. Furthermore, matters related to rivers are sensitive to the state government. MAN also has no financial means to implement some of its decisions.

KASA has proposed the setting up an interstate river authority (iSRA) to manage interstate rivers more efficiently. Formed by and reporting to the Ministry responsible for water management, iSRA will be entrusted to manage the development and management of water resources shared between two or more states. In addition, iSRA will be the secretariat for Federal-states engagement on water resources governane and other matters of mutual interests. Main functions of iSRA will include (i) to identify and formulate action plans for efficient interstate river management based on IRBM; (ii) to review the effectiveneness of existing measures; (iii) to coordinate with other interested stakeholders, including State Governments and (iv) to manage water allocation amongst various economic sectors in a fair and efficient manner. However, active engagement with state governments is paramount to realise the formation of iSRA.

Table 2.8. Transboundary river basins in Malaysia

River Basin	States
Sg Perlis	Perlis/Kedah
Sg Muda	Kedah/Penang
Sg Perai	Penang/Kedah
Sg Jawi	Penang/Kedah
Sg Kerian	Penang/Kedah/Perak
Sg Bernam	Perak/Selangor
Sg Buloh	Selangor/Federal Territory
Sg Klang	Selangor/Federal Territory
Sg Langat	Selangor/Federal Territory/Negeri Sembilan
Sg Sepang	Selangor/Negeri Sembilan
Sg Linggi	Negeri Sembilan/Melaka
Sg Melaka	Negeri Sembilan/Melaka
Sg Kesang	Melaka/Johor/Negeri Sembilan
Sg Muar	Johor/Pahang/Melaka/Negri Sembilan
Sg Endau	Johor/Pahang
Sg Pahang	Pahang/Negri Sembilan
Sg Semerak	Kelantan/Terengganu

2.8.7 Conclusion

In conclusion, safeguarding national water security is an ongoing endeavour that requires the whole country to take responsibility. It is pertinent to view water resources as a strategic asset and the nation's greatest priority and plan. An inclusive institutional setup with ample resources and capacity is essential to achieve the aspiration.

Appendix 2.1

Updated NIWRMP Roadmap

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
1	NIWRMP	Water as a Resource	People	Holistic training to O&M personnel		Training courses	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	N/G	N/G	N/G
2	JPS	Water as a Resource	People	Enhance Capacity Building & Training Programmes	Modules & Trainings	Collaboration & Trainings	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	5	5	5
3	NIWRMP	Water as a Resource	People	IWRM Awareness & participatory modules		Set up One-stop Training centres	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	N/G	N/G	N/G
4	JMG	Water as a Resource	People	Strengthen Partnerships	Smart Partnership Development Programmes	Smart Partnership Development Project	KeTSA, KASA, Sabah State Govt & Sarawak State Govt.	JMG	New	12MP & Beyond	6	30	30	30
5	JPS	Water as a Resource	People	Strengthen Partnerships	Collaboration with NGOs, IPT & Community	Programme	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	5	5	5
6	NIWRMP	Water as a Resource	People	Community participation in lakes & rivers watch programmes		MSANg or equivalent to work with appropriate NGOs nationwide	MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
7	JPS	Water as a Resource	People	Increase Community-based Participatory Management	Development of framework for holistic public participation	Empowering local communities	MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
8	NIWRMP	Water as a Resource	People	Local Action Community based groups		Facilitated by RBCs	MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
9	DOE	Water as a Resource	People	Increase Community-based Participatory Management	Community-Driven Conservation Programmes	To expand community driven river rehabilitation programmes	KASA & State Govts	DOE	New	12MP	2.52	1.5	1.5	1.5
10	NIWRMP	Water as a Resource	People	Advocacy modules on IWRM		Set up One-stop Training centres	MAN/MSANg or equivalent	Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	N/G	N/G	N/G
11	NIWRMP	Water as a Resource	People	Formation of "rakan sungai" & "rakan tasik" groups		MSANg or equivalent to work with appropriate NGOs nationwide	MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
12	IWK +NIWRMP	Water for Livelihood	People	Holistic training to O&M personnel	Capacity building enhancement	Structured trainings	KASA, Sabah State Govt & Sarawak State Govt.	KASA, MAFI, KPLB MPIC	New	12MP & Beyond	50	100	100	100

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
13	MPIC	Water for Livelihood	People	Enhancing Quality of Agricultural Output	Implementation of new post harvest technology	-	MPIC	MPB	New	13MP & Beyond	N/G	0.2	0.2	0.2
14	JPP Sabah	Water for Livelihood	People	Strengthening the Human Capital of the .Department's Staff		Training & Programmes	KKR Sabah	JPP Sabah	On-going	12MP & beyond	N/G	N/G	N/G	N/G
15	JPP Sabah	Water for Livelihood	People	Enhancing the Importance of Sewerage in Creating an Environmentally Friendly Community		Public Awareness & Programmes	KKR Sabah	JPP Sabah	New	12MP & beyond	N/G	N/G	N/G	N/G
16	JPS + NIWRMP	Water for Livelihood	People	Advocacy modules on WDM	Modules & Trainings	Collaboration with Stakeholders	KASA, Sabah State Govt & Sarawak State Govt.	JPS	New	12MP & Beyond	N/G	N/G	N/G	N/G
17	JPS + NIWRMP	Water for Livelihood	People	WDM & participatory management	Modules	Collaboration with Stakeholders	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & Beyond	N/G	5	5	5
18	JPS + NIWRMP	Water for Livelihood	People	Water User Groups	Water user group initiative	To collaborate with other state agencies	State Governments	Line Agencies	New	12MP & beyond	N/G	N/G	N/G	N/G
19	JPS + NIWRMP	Water for Livelihood	People	Water Conservation Initiatives	Water Conservation Initiatives	To collaborate with other state agencies	KASA, MAFI, Sabah & Sarawak State Governments	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
20	MAFI + NIWRMP	Water for Livelihood	People	Water Conservation Initiatives		Program Pembangunan Dan Transformasi Komuniti Perikanan	MAFI	DOF	On-going	12MP & beyond	6	N/G	N/G	N/G
21	MAFI	Water for Livelihood	People	Agricultural Water Services	Participatory Management	Pembangunan Kumpulan Pengguna (Air (KPA	MAFI	BPSP	On-going	12MP & beyond	4.7	N/G	N/G	N/G
22	JMG	Water as a Resource	Governance	Strengthening Governance at all levels	To harmonise water related legislations	To enact the "National Groundwater Policy "((NGP	KeTSA	JMG, State Water Authority	New	12MP	11.1	5	N/G	N/G
23	JMG	Water as a Resource	Governance	Strengthening Governance at all levels	To mitigate water pollution	Guideline on groundwater contamination	KeTSA	JMG & State Governments	New	13MP	5.2	N/G	N/G	N/G
24	JMG	Water as a Resource	Governance	Strengthening Governance at all levels	To regulate & promote sustainable groundwater governance	Setting up National & State Groundwater Coordinating (Committee (SGCC	KetSA & State Water Authority	JMG, State Water Authority	New	12MP & Beyond	2.1	2.5	N/G	N/G
25	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	Majlis Air Negara ((MAN	To support KASA on MAN input regarding water resources		KASA, Sabah State Govt & Sarawak State Govt.	Water-related ministries & all State Governments	On-going		N/G	N/G	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
26	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	National Steering Committee on IWRM	To Support KASA on National Steering Committee on IWRM		KASA, Sabah State Govt. .& Sarawak State Govt	Water-related ministries & MSANg or Equivalent	New	12MP	N/G	N/G	N/G	N/G
27	JPS + NIWRMP	Water as a Resource	Governance	National Technical Committee		Establish TOR & collaborate with other agencies	KASA, Sabah State Govt. .& Sarawak State Govt	Line Agencies	New	12MP	N/G	N/G	N/G	N/G
28	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	Department of Water Resources ((Restructured	Establishment of National Water (Department (JAN	Combination of DID, BBA dan JPP as technical department	KASA, KeTSA	KASA, KeTSA	New	12MP	N/G	N/G	N/G	N/G
29	JPS + NIWRMP	Water as a Resource	Governance	IWRM Training Centre	Training Centers	Develop & upgrade existing training centres	.KASA & State Govts	Line Agencies	New	12MP & Beyond	N/G	N/G	N/G	N/G
30	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	Majlis Air Negeri	JPS States will support Majlis Air Negeri		MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	On-going	12MP	N/G	N/G	N/G	N/G
31	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	State IWRM Technical Committee	JPS States will support State IWRM Technical Committee		State Governments	UPEN	On-going	12MP	N/G	N/G	N/G	N/G
32	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	River Basin Organisation		Dedicated unit to address water & environmental needs	MSANg or Equivalent	Implementing Arm of MSANg or equivalent	On-going	12MP & beyond	N/G	N/G	N/G	N/G
33	BSASH,KASA + NIWRMP	Water as a Resource	Governance	National Integrated Natural Resources Policy			KeTSA	KeTSA	New	13MP	N/G	N/G	N/G	N/G
34	JPS + NIWRMP	Water as a Resource	Governance	WFE Nexus Policy Framework	WFE Study for each River Basin under NAWABS	To Establish the Term of Reference	KASA, KeTSA & MAFI	State Governments	New	12MP	N/G	N/G	N/G	N/G
35	JPS&BSASH,KASA + NIWRMP	Water as a Resource	Governance	National Water Policy	Review of National Water Resources (Policy (2012	To review National Water Resources Policy	KASA	KASA	On-going	-	N/G	N/G	N/G	N/G
36	JPS + NIWRMP	Water as a Resource	Governance	Integrated River Basin Management Policy		To encourage states to adopt IRBM in water management	KASA	KASA	On-going	12MP	N/G	N/G	N/G	N/G
37	BSASH,KASA + NIWRMP	Water as a Resource	Governance	National Water Resources Act			KASA	KASA	On-going	12MP	N/G	N/G	N/G	N/G
38	BSASH,KASA + NIWRMP	Water as a Resource	Governance	State Water Resources Enactments		States without SWR enactments	MSANg or Equivalent	MSANg or Equivalent	On-going	12MP	N/G	N/G	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
39	NIWRMP	Water as a Resource	Governance	Review Streets, Drainage & Buildings Act 1974		Incorporate IUMW principles & practices	KPKT	KPKT	New	12MP	N/G	N/G	N/G	N/G
40	JPS + NIWRMP	Water as a Resource	Governance	Rules for specific purpose management	Gazettement of Water Catchment Areas	State should gazette water catchment area & river reserved	MSANg or Equivalent/ KASA/Sabah/Sarawak	MSANg or Equivalent/ KASA/Sabah/Sarawak	On-going	12MP	N/G	N/G	N/G	N/G
41	JAS	Water as a Resource	Governance	Water resources management	Expansion of EQMP monitoring .stations	Revision of current Concession Agreement & existing Prescribed Activities in EIA Order .2015	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	New	12MP & beyond	10.04	48	48	150
42	JPS	Water as a Resource	Governance	Water resources management	Water catchment areas gazetted for protection	IRBM Plans use as planning reference at National, State & Local Level	KASA, Sabah State Govt & Sarawak State Govt.	KASA, Sabah State Govt & Sarawak State Govt.	On-going		N/G	N/G	N/G	N/G
43	JAS	Water as a Resource	Governance	Water resources management	To mitigate Water Pollution	To expand TMDL studies & strengthen enforcement capacity of agencies	KASA, Sabah State Govt & Sarawak State Govt.	DOE, Sabah State Govt. & Sarawak State Govt.	On-going	12MP & beyond	18.93	TW)) 162 (1.5 (BB	N/G	N/G
44	JPS + NIWRMP	Water as a Resource	Governance	Water-related disaster risk management	Integrated Shoreline Management Plans	Establish integrated shoreline management plan	KASA, Sabah State Govt & Sarawak State Govt.	KASA, JPS Sabah & JPS Sarawak	On-going	12MP & beyond	49.5	N/G	N/G	N/G
45	JPS	Water as a Resource	Governance	Water-related disaster risk management	National Flood Forecasting Warning Programme developed	National Flood Forecasting & Warning (System (NaFFWS	KASA, Sabah State Govt & Sarawak State Govt.	JPS, Sabah State Govt. & Sarawak State Govt.	On-going	12MP & beyond	38	23	N/G	N/G
46	JPS + NIWRMP	Water as a Resource	Governance	Foresight studies on IWRM & its sub-sets	Enhancement of enforcement .activities	Application of smart enforcement equipment	KASA, Sabah State Govt & Sarawak State Govt.	Line Agencies	New	12MP & Beyond	N/G	N/G	N/G	N/G
47	JPS + NIWRMP	Water as a Resource	Governance	Development of management guidelines	Facilitate implementation of IRBM	Implementation of Integrated Dam Management	KASA, Sabah State Govt & Sarawak State Govt.	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
48	JPS + NIWRMP	Water as a Resource	Governance	River Basin Studies & Management Plans		New study for 25 river basin	KASA, Sabah State Govt & Sarawak State Govt.	Line Agencies	Ongoing	12MP & Beyond	130	130	130	130
49	JPS + NIWRMP	Water as a Resource	Governance	Networking & links with regional & international institutions	Increase networking at international, regional & domestic level	Attend & be part of international organisations	KASA, KeTSA	Line Agencies	Ongoing	12MP & Beyond	0.235	0.355	0.355	0.355

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
50	JPS + NIWRMP	Water as a Resource	Governance	Strategic alliances with renowned regional & international water research & training centres	Increase networking at international, regional & domestic level	Training & Conferences	KASA, KeTSA	Line Agencies	Ongoing	12MP & Beyond	0.66	0.72	0.72	0.72
51	JPS + NIWRMP	Water as a Resource	Governance	Regular participation in reputed water-related international water fora related to resource management	Increase networking at international level	To join international conferences, workshops, seminars & short courses	KASA, KeTSA	Line Agencies	Ongoing	12MP & Beyond	0.25	0.25	0.25	0.25
52	JPS	Water as a Resource	Governance	JPS Strategic Planning	Water concepts	Empowering Engineering Services	KASA, Sabah State Govt & Sarawak State Govt.	Line Agencies/JPS	New	12MP & Beyond	4.1	N/G	N/G	N/G
53	JAS + NIWRMP	Water as a Resource	Governance	Review EQA 1974 & its subsidiary .Regulations	To enhance DOE's position in terms of .legal conduct	Formulating new regulations	KASA	DOE	Ongoing	12MP	1.85	163.3	0.5	0.5
54	JAS + NIWRMP	Water as a Resource	Governance	Enforcement of water related laws & regulations	Enhancement of enforcement .activities	Application of smart enforcement equipment	KASA, MSANg, Sabah State Govt. & Sarawak State Govt.	DOE	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
55	IWK + JPP Sabah	Water for Livelihood	Governance	Increasing Efficiency & Productivity of Water & Sewerage Services	Energy efficient & green technology process in new or upgraded STPs	Disconnect & rationalise multipoint STPs	KASA, Sabah State Govt & Sarawak State Govt.	SPAN, Sabah State Govt. & Sarawak State Govt.	New	12MP & beyond	7694	7250	6850	5300
56	IWK + JPP Sabah	Water for Livelihood	Governance	Strengthening Regulatory & Institutional Frameworks of the Water Services Industry	Water Efficient Labelling Product Scheme (Green (products	Prioritise the sewerage . development plan	KASA	SPAN, Sabah State Govt. & Sarawak State Govt.	Ongoing	SCC fund	20	20	25	25
57	IWK + NIWRMP	Water for Livelihood	Governance	Develop alternative water supply sources of water supply	Promote Resource recovery technology at Regional Sewage Treatment Plants ((RSTP	Water Reclamation (Plants (WRP	KASA, Sabah State Govt & Sarawak State Govt.	SPAN, Sabah State Govt. & Sarawak State Govt.	Ongoing	12MP	N/G	N/G	N/G	N/G
58	IWK + JPP Sabah + NIWRMP	Water for Livelihood	Governance	Evaluate Centralised versus Decentralised Wastewater Treatment System	Related to sewerage development plan study	Review & update/ finalise all priority sewerage catchment studies to prioritise the sewerage development plan.	KASA, Sabah State Govt & Sarawak State Govt.	SPAN, Sabah State Govt. & Sarawak State Govt.	Ongoing	SCC fund	N/G	N/G	N/G	N/G
59	IWK + NIWRMP	Water for Livelihood	Governance	Review Scope & Coverage of Sewerage Services	Compliance to EQSR 2009	Upgrading programme of all public sewage plants	KASA, Sabah State Govt & Sarawak State Govt.	SPAN, Sabah State Govt. & Sarawak State Govt.	Ongoing	SCC	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
60	MPIC	Water for Livelihood	Governance	Strengthening Governance	Development of standard irrigation system	Conducting Workshops	MPIC	Line Agencies	New	13MP & Beyond	N/G	0.1	0.1	0.1
61	JPP Sabah	Water for Livelihood	Governance	SSE 2017, Rules & .regulations		Gazetting of enactments & preparation of rules & .regulations	KKR Sabah	JPP Sabah	Ongoing		15	N/G	N/G	N/G
62	JPP Sabah	Water for Livelihood	Governance	Review Scope & Coverage of Sewerage Services			KKR Sabah	JPP Sabah	New		15	N/G	N/G	N/G
63	JPP Sabah	Water for Livelihood	Governance	Strengthening Regulatory & Institutional Frameworks of the Water Services Industry	Legislate & amend specific rules & regulation to strengthen regulatory framework of water service .industry		KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.			N/G	N/G	N/G	N/G
64	JPP Sabah	Water for Livelihood	Governance	Waste to Wealth Initiative	Water for Economic Development	1. Amount of bio-effluents recycled 2. Amount of bio-solids reused as fertilizers	KASA, Sabah State Govt. & Sarawak State Govt.				N/G	N/G	N/G	N/G
65	JPS + JPP Sabah + NIWRMP	Water for Livelihood	Governance	Regular participation in reputed water-related international water fora	To collaborate with top international water center in the world	Technical visits & Knowledge sharing session	KASA, MAFI & State Governments				1	1	1	1
66	JPP Sabah	Water for Livelihood	Governance	Strengthening Governance at All Levels	To establish the Water-Food-Energy Nexus	Institutionalise the WFE Nexus	KASA, Sabah State Govt. & Sarawak State Govt.				N/G	N/G	N/G	N/G
67	BAP, KASA + NIWRMP	Water for Livelihood	Governance	WSIA 2006 & SPAN 2006	Amendment of Act 654 & 655	Consider extending legislation to Sabah & Sarawak	KASA, Sabah State Govt. & Sarawak State Govt.	SPAN, Line Agencies & Water Operators		12MP	0.5	0.1	0.1	0.1
68	BAP, KASA + NIWRMP	Water for Livelihood	Governance	Safe Drinking Water Act	Enforcement of Safe Drinking Water Act	Review the standards of drinking water	KASA & MOH	MOH		12MP	1	0.01	0.01	0.01
69	BAP, KASA + JPP Sabah + NIWRMP	Water for Livelihood	Governance	Rules for specific application pertaining to potable Water Supply & Sewerage Services	Review, amend & legislate, rules, regulation & guidelines under Act 655	Water Services Industry	SPAN	Water Operators	On-going	12MP	N/G	N/G	N/G	N/G
70	JAS + JPP Sabah + NIWRMP	Water for Livelihood	Governance	Enforcement of water supply & sewerage services related laws & regulations	Enhancement of enforcement .activities	Application of smart enforcement equipment	KASA	Line Agencies	On-going	12MP & Beyond	1.85	163.3	0.5	0.5

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
71	MPOB	Water for Livelihood	Governance	Managing Palm Oil (Mill Effluent (POME	A holistic approach to managing palm oil mill effluent ((POME	Transforming the POME	MPIC	MPOB	On-going	2025	N/G	N/G	N/G	N/G
72	MPOB	Water for Livelihood	Governance	Managing Palm Oil (Mill Effluent (POME	POME valorisation	N/G	MPIC	MPOB	N/G	N/G	N/G	N/G	N/G	N/G
73	NIWRMP	Water for Livelihood	Governance	National Steering Committee on Water Safety Plan		Jointly managed by KASA, MOH & MSANg or equivalent	KASA & MOH	KASA, MSANg or Equivalent, Line Agencies & Water Operators	New	12MP	N/G	N/G	N/G	N/G
74	NIWRMP	Water for Livelihood	Governance	Water Supply & Sewerage Services Department		Integration of water supply & sewerage services	KASA	SPAN, Water Supply & Sewerage Operators	New	12MP	N/G	N/G	N/G	N/G
75	NIWRMP	Water for Livelihood	Governance	Agricultural Water Services Department ((AWSD		Reinstatement of a dedicated department for AWS	KASA & MAFI	BPSP (MAFI), KADA, MADA & IADA	New	12MP	N/G	N/G	N/G	N/G
76	NIWRMP	Water for Livelihood	Governance	Agricultural Water Services Department ((AWSD		Realignment of current State DID	State Governments	Line Agencies	New	12MP	N/G	N/G	N/G	N/G
77	NIWRMP	Water for Livelihood	Governance	Water Demand Management Division in all Federal water supply service agencies		Consistent with WDM report recommendations	KASA & MAFI	Line Agencies & MSANg or Equivalent	New	12MP	N/G	N/G	N/G	N/G
78	NIWRMP	Water for Livelihood	Governance	AWS divisions in IADAs		To be renamed AWS from Project Engineer's Office	MAFI	Line Agencies	On-going	12MP	N/G	N/G	N/G	N/G
79	NIWRMP	Water for Livelihood	Governance	Water Demand Management Section in all State		Institutionalising WDM	State Governments	Line Agencies	New	12MP	N/G	N/G	N/G	N/G
80	NIWRMP	Water for Livelihood	Governance	Water Demand Management Units in water supply		Institutionalising WDM	State Governments	Water Supply Agencies & Water Operators	New	12MP	N/G	N/G	N/G	N/G
81	NIWRMP	Water for Livelihood	Governance	National Integrated Water Supply Services Policy		Policy to encompass both consumptive use	KASA, MAFI, KeTSA, MOTAC, MOT, KPKT, KWP, MOH, & State Governments	Line Agencies & Water Operators	New	12MP	N/G	N/G	N/G	N/G
82	NIWRMP	Water for Livelihood	Governance	Promulgate Agricultural Water Services Act			MAFI	Line Agencies	New	12MP	N/G	N/G	N/G	N/G
83	NIWRMP	Water for Livelihood	Governance	AWS Enactment		Adoption of AWS Act	State Governments	State Line Agencies	New	12MP	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
84	NIWRMP	Water for Livelihood	Governance	Rules for specific application pertaining to AWS			MAFI	Line Agencies	New	12MP	N/G	N/G	N/G	N/G
85	NIWRMP	Water for Livelihood	Governance	Gazetting of AWS areas & enforcement		Proposed AWSD (MAFI) to work with state AWSD & IADAs	MAFI	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
86	NIWRMP	Water for Livelihood	Governance	Networking & links with regional & international institutions			KASA, MAFI & State Governments	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
87	NIWRMP	Water for Livelihood	Governance	National research & Capacity Building institutes			KASA, MAFI & State Governments	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
88	NAHRIM + NIWRMP	Water as a Resource	Information & RDIC	National Water Research & Development Centre	Establish National research & Capacity Building institutes	One-stop centre for .all water R&D	KASA & State Governments	NAHRIM	New	12MP & Beyond	N/G	15	15	15
89	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on climate change & sea level rise	Research & Studies	Research Programmes on Vulnerability, Adaptation & Hydroclimate DRR	KASA	NAHRIM	On-going	Beyond 12MP	10	15	15	15
90	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on climate change & sea level rise	Research & Studies	Geomorphology Research Programmes	KASA	NAHRIM	On-going	Beyond 12MP	14	10	10	10
91	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on climate change & seas level rise	Research & Studies	R&D for Storms in Coastal	KASA	NAHRIM	New	Beyond 12MP	5.5	5.5	5.5	5.5
92	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on water quality management	Studies	Research Program on Water Health Forensics	KASA	NAHRIM	On-going	Beyond 12MP	17.1	20	20	20
93	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on water quality management	National Water Grade	Potential Assessment Research & Risk of pollution of surface water quality	KASA	NAHRIM	New	Beyond 12MP	2.2	3	3	3
94	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on water quality management	Environmental risk (index (ERI	Environmental risk index research	KASA	NAHRIM	New	Beyond 12MP	0.7	1	1	1
95	NAHRIM	Water as a Resource	Information & RDIC	Niches water research on water quality management	Ballast Water studies & coastal	Ballast water pollution threat assessment study	KASA	NAHRIM	New	Beyond 12MP	1.6	2	2	2

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
96	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Clean river	Study on Applications of Wastewater Management & Water Pollution	KASA	NAHRIM	New	Beyond 12MP	15.45	15	15	15
97	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Reserve Margin ((RM	Research to increase reserve margin of raw water resources	KASA	NAHRIM	New	Beyond 12MP	5	5	5	5
98	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Reserve Margin Constructed - wetland	Research on Water reclaimation	KASA	NAHRIM	New	Beyond 12MP	0.5	1	1	1
100	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Smart Water Turbine -	Research on Smart Water System	KASA	NAHRIM	New	Beyond 12MP	1.8	2	2	2
101	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Disaster Risk Reduction IR4.0 -	Research on classifications of River Health	KASA	NAHRIM	New	Beyond 12MP	5.9	6	6	6
102	NAHRIM	Water as a Resource	Information & RDIC	National Water Innovation Roadmap (2040 (NWIR	Disaster Risk Reduction Water Sediment - Equilibrium	Research on River Morphological & Ecosystem balance	KASA	NAHRIM	New	Beyond 12MP	4.85	5	5	5
103	NAHRIM	Water as a Resource	Information & RDIC	Integrated Lake Basin Management	Development of Lake Briefs, & Integrated Lake Basin Management Plan	Lake Briefs program - 10 lake brief per year; one ILBM Plan every two years	KASA	Relevant States	On-going	12MP & Beyond	2	3	3	3
104	NAHRIM	Water as a Resource	Information & RDIC	Integrated Lake Basin Management	Implementation of lake Research & development blueprint	R&D to support Integrated Lake basin Management plan	KASA	Relevant States	New	12MP & Beyond	6	10	10	10
105	NAHRIM	Water as a Resource	Information & RDIC	Integrated Lake Basin Management	Lake water quality monitoring	Lake water quality monitoring for research & management	KASA	Relevant States	New	12MP & Beyond	9	15	15	15
106	NAHRIM	Water as a Resource	Information & RDIC	Integrated Lake Basin Management	Lake rehabilitation technology	Rehabilitation/ conservation of lake	KASA	Relevant States	New	12MP & Beyond	9	15	15	15
107	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	To harmonise & centralised all groundwater data/information repository	National Groundwater Hub Centre	KeTSA	JMG & State .Governments	New	12MP & Beyond	2	35	45	25
108	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Establishment of NaGMiS as monitoring & early warning system to enable effective disaster response	Expand integrated weather & sea level rise forecasting & early warning systems	KeTSA	JMG & State .Governments	New	12MP & Beyond	3.5	30	40	50

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											12 MP	13 MP	14 MP	15 MP
109	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	To develop & establish NaGWiS with state-of-the -art information system	Groundwater data inventory development & management	KeTSA	JMG & State .Governments	New	12MP & Beyond	10	25	35	45
110	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	To develop & establish NaGCE as national groundwater centre of excellent	Outline & establish code of practice, guidelines, manual, SOPs & standard for groundwater industry	KeTSA	JMG, IGM & SIRIM	New	12MP & Beyond	0	20	20	20
111	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	To implement evidence-based & risk-informed actions	Vulnerability & risk assessment for climate change-related disasters	KeTSA	JMG & NADMA	New	12MP & Beyond	0	35	35	35
112	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Groundwater information management system	Provide comprehensive & updated groundwater potential & well field area information on tubewell development	KeTSA	JMG, NADMA, JAKOA, State Water Authority	New	12th MP & Beyond	10	15	15	15
113	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Groundwater information management system	National/State Groundwater Development Action Plan	MAN	JMG, NADMA, JAKOA & State Gov	New	12th MP & Beyond	10	15	25	10
114	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Groundwater centre of excellent for stakeholder & industry; human capital & .investment	Capacity building of groundwater industry players & .geoscientists	KeTSA	JMG, IGM, CIDB & University	New	13th MP & Beyond	16	15	25	35
115	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Information management system	Intensify groundwater industry potential	KeTSA	JMG, UPEN	Ongoing	12th MP & Beyond	10	10	10	10
116	JMG	Water as a Resource	Information & RDIC	National Groundwater Hub Centre	Information management system for agriculture; food & .economic growth	One-Stop-Centre for groundwater information to .agriculture	KeTSA	LKIM, JMG & Line Agencies	Ongoing	12th MP & Beyond	6	10	10	10
117	JPS	Water as a Resource	Information & RDIC	Enhancing Capacity for Data-Driven Decision-Making	To strengthen Water Data & Research Centre	Strengthen the existing research institute towards becoming one-stop centre for water-related data & RDIC	KASA	KASA	On-going	NAHRIM • - 12MP • NAWABS - 12MP & beyond	N/G	N/G	N/G	N/G
118	JPS	Water as a Resource	Information & RDIC	Enhancing Capacity for Data-Driven Decision-Making	To enhance Early Warning Systems	Big Data Analytics & artificial intelligence	KASA, Sabah State Govt. .& Sarawak State Govt	Sabah State Govt, Sarawak State Govt & MOHE	On-going	12MP & beyond	50	50	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
119	JAS	Water as a Resource	Information & RDIC	Water quality management	River water quality status nationwide	Enhancement of enforcement & monitoring .programmes	KASA, Sabah State Govt. & Sarawak State Govt.	DOE		Beyond 12MP	6.14	N/G	N/G	N/G
120	NIWRMP	Water as a Resource	Information & RDIC	Central IWRM database be established at KASA			KASA	Line Agencies	New	12MP & Beyond	N/G	N/G	N/G	N/G
121	JAS	Water as a Resource	Information & RDIC	Central IWRM database be established at KASA	Establishment of National Water Quality Data Center at DOE	Enhancement of human capital & ICT- .knowledge	KASA	DOE		12MP & Beyond	10	48	48	150
122	NIWRMP	Water as a Resource	Information & RDIC	State of the Waters Annual Report			KASA	Line Agencies	New	12MP & Beyond	N/G	N/G	N/G	N/G
123	JAS	Water as a Resource	Information & RDIC	State of the Waters Annual Report	Annual EQR .published by DOE	Upgrading ICT infrastructure to support digital EQR report	KASA	DOE		12MP & Beyond	0.5	1	1	1
124	JMG	Water as a Resource	Information & RDIC	Increase National Groundwater Usage	Hydrogeological mapping on regional scale	National Hydrogeological Mapping	KeTSA	JMG	On-going	13th MP	277	250	N/G	N/G
125	JMG	Water as a Resource	Information & RDIC	Increase National Groundwater Usage	Comprehensive information in visual form	National Groundwater Profile & Modelling	KeTSA	JMG	On-going	13th MP	51	N/G	N/G	N/G
126	JMG	Water as a Resource	Information & RDIC	Increase efficiency & productivity of Groundwater	Groundwater Suitability .Indicators	National Groundwater Index for Groundwater Quality Mapping & Assessment	KeTSA	JMG	New	12th MP & Beyond	56	10	N/G	N/G
127	JMG	Water as a Resource	Information & RDIC	Increase efficiency & productivity of Groundwater	National .Groundwater Index	National Groundwater Index for Groundwater Quality Mapping & Assessment	KeTSA	JMG	New	12MP & Beyond	0.5	1	N/G	N/G
128	NIWRMP	Water as a Resource	Information & RDIC	IWRM Tool Box of Malaysian Case Studies & BMPs		Styled on similar lines as the GWP IWRM Tool Box	KASA	Line Agencies	New	12MP & Beyond	N/G	N/G	N/G	N/G
129	NIWRMP	Water as a Resource	Information & RDIC	Buffer zones around water bodies			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
130	NIWRMP	Water as a Resource	Information & RDIC	Interceptor buffers along rivers			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
131	NIWRMP	Water as a Resource	Information & RDIC	Artificial Wetlands			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
132	NIWRMP	Water as a Resource	Information & RDIC	River Bank Filtration			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
133	NIWRMP	Water as a Resource	Information & RDIC	Protection of groundwater recharge areas			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
134	NIWRMP	Water as a Resource	Information & RDIC	Periodic review of river basins			MSANg or Equivalent	Implementing Arm of MSANg or Equivalent	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
135	NIWRMP	Water as a Resource	Information & RDIC	Integrated research on 14 thematic areas			KASA	NAHRIM	New	12MP & Beyond	N/G	N/G	N/G	N/G
136	IWK + NIWRMP	Water for Livelihood	Information & RDIC	Dedicated information management systems for O&M	Use of IR 4.0 with remote surveillance . technology	Automated monitoring & control system	KASA			SCC Fund	50	50	50	50
137	JPS + NIWRMP	Water for Livelihood	Information & RDIC	Dedicated information management systems for O&M of water supply & sewerage services	Integration information management systems for O&M of water supply & sewerage services integrate with NAWABS	Real Time water supply demand to NAWABS System	KASA			12MP & Beyond	N/G	N/G	N/G	N/G
138	JPS + NIWRMP	Water for Livelihood	Information & RDIC	Dedicated information management systems for O&M of for Agriculture Water Supply Services	Integration information management systems for O&M of water supply & sewerage services integrate with NAWABS	Real Time Agricultural demand to NAWABS System	MAFI			12MP & Beyond	N/G	N/G	N/G	N/G
139	IWK + NIWRMP	Water for Livelihood	Information & RDIC	Water conservation measures	WRPs at Regional .STPs	Construct WRPs complete at all existing & new RSTPs	KASA, Sabah State Govt. & Sarawak State Govt.			12MP & beyond	N/G	N/G	N/G	N/G
140	IWK	Water for Livelihood	Information & RDIC	Enhancing Capacity for Data-Driven Decision-Making	To enhance Early Warning Systems	Big Data Analytics & artificial intelligence	KASA, Sabah State Govt. & Sarawak State Govt.			SCC Fund	50	50	50	50
141	JPS	Water for Livelihood	Information & RDIC	To enhance Early Warning Systems	Big Data Analytics & artificial intelligence						50	50	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
142	IWK + NIWRMP	Water for Livelihood	Information & RDIC	Development of SOPs for all process-related operations	Optimisation of all process & energy related operations with green technology .considerations	Usage of energy efficient system & equipment	KASA, MOH, Sabah & Sarawak State Governments			SCC Fund	50	50	50	50
143	IWK + NIWRMP	Water for Livelihood	Information & RDIC	Development of maintenance manuals	Optimisation of all process control system & energy .related operations	Manage process & maintenance in the enhanced maintenance .manuals	KASA, MAFI, Sabah & Sarawak State Governments			12MP & beyond	N/G	N/G	N/G	N/G
144	IWK + NIWRMP	Water for Livelihood	Information & RDIC	SOPs to address emergencies	To mitigate Water Pollution	Autonomous sensor*	KASA, MAFI, Sabah & Sarawak State Governments			SCC Fund	50	50	50	50
145	JPS + NIWRMP	Water for Livelihood	Information & RDIC	SOPs to address emergencies		SOP for Flood & Drought will be revise from time to time	KASA, MAFI, Sabah & Sarawak State Governments	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
146	MPIC	Water for Livelihood	Information & RDIC	Enhancing Data & Information	Establishment of water consumption data for rubber processing	Survey on the water usage for SMR & latex concentrates production 2015-2020	MPIC	MRB, DOA	New	2022	N/G	N/G	N/G	N/G
147	MPIC	Water for Livelihood	Information & RDIC	Enhancing Data & Information	Establishment of water consumption data for rubber cultivation	Compile the data with regards to rubber cultivation (to be done by technical expertise (of MRB	MPIC	MRB, DOA	New	2024	N/G	N/G	N/G	N/G
148	MPIC	Water for Livelihood	Information & RDIC	R&D on Irrigation & Water System Technology	Implementation of IoT & sensor technologies	-	MPIC	MPB, DOA	On going	12MP & beyond	0.14	N/G	N/G	N/G
149	MPIC	Water for Livelihood	Information & RDIC	R&D on Irrigation & Water System Technology	Implementation of IoT & sensor technologies	-	MPIC	MPB, DOA	On going	12MP & beyond	0.11	N/G	N/G	N/G
150	MPOB	Water for Livelihood	Information & RDIC	Gauging the environmental performance specifically water use through water .footprint	Establishment of water footprint profile	To evaluate water usage (direct & indirect) of the oleochemical .processes	MPIC	MPOB	On going	2024	N/G	N/G	N/G	N/G
151	MPOB	Water for Livelihood	Information & RDIC	Gauging the environmental performance specifically water use through water .footprint		To establish cradle to gate water footprint for palm based oleochemical supply chain	MPIC	MPOB	On going	2024	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
152	MAFI + NIWRMP	Water for Livelihood	Information & RDIC	Modify agronomic practices	Development of Paddy Technology	Study on efficiency of Alternate-Wetting-(Drying (AWD	MAFI	MARDI	On-going	12MP & Beyond	0.7	1	0.8	0.8
153	MAFI	Water for Livelihood	Information & RDIC	Agricultural Water Services	Agricultural Water R&D	Water Resources Management & Irrigation Efficiency Study	MAFI	BPSP	On-going	12MP & beyond	20	N/G	N/G	N/G
154	MAFI	Water for Livelihood	Information & RDIC	Agricultural Water Services	Monitoring, Control & Surveillance	Control & Protection of Fisheries Resources	MAFI	DOF	On-going	12MP & beyond	1.162	N/G	N/G	N/G
155	NIWRMP	Water for Livelihood	Information & RDIC	Reduction of water losses			KASA, MAFI, Sabah State Govt. & Sarawak State Governments	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
156	NIWRMP	Water for Livelihood	Information & RDIC	Integrated research on seven thematic areas			KASA & MAFI	NAHRIM	New	12MP & Beyond	N/G	N/G	N/G	N/G
157	NIWRMP	Water for Livelihood	Information & RDIC	Implementation of Water Safety Plans (WSPs) nationwide conforming to WHO guidelines			KASA, MOH, Sabah & Sarawak State Governments	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
158	NIWRMP	Water for Livelihood	Information & RDIC	Water conservation measures through rainwater harvesting			KASA, MAFI & KPKT	Line Agencies	Ongoing	12MP & Beyond	N/G	N/G	N/G	N/G
159	JAS + NIWRMP	Water as a Resource	Finance	Application of "polluter pays" principle	To better manage the pollution load discharged into the rivers.	Contravention License for effluent discharging premises.	KASA, MSANg	DOE		12MP & Beyond	N/G	5	5	
160	KeTSA + NIWRMP	Water as a Resource	Finance	Federal funding to continue water-related activities			KASA, KeTSA			12MP & Beyond	141.2	150	150	150
161	JPS + NIWRMP	Water as a Resource	Finance	Federal funding to continue water-related activities			KASA, KeTSA				1.6	1.6	1.6	1.6
162	NIWRMP	Water as a Resource	Finance	Payment for ecosystem services			KASA	MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
163	NIWRMP	Water as a Resource	Finance	Uniform Pricing Model for Water Resources			MAN & KASA	MSANg or Equivalent	New	12MP & Beyond	N/G	N/G	N/G	N/G
164	IWK	Water for Livelihood	Finance	Waste to Wealth Initiative	Water for Economic Development	Incorporating green technology in all new & existing RSTP for resource recovery.	KASA			12MP & beyond	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
165	IWK	Water for Livelihood	Finance	Strengthening Financial Capacity	To reform the Water Services Industry		MoF, KASA, Sabah State Govt. & Sarawak State Govt.			12MP & Beyond	N/G	N/G	N/G	N/G
166	IWK	Water for Livelihood	Finance	Strengthening Financial Capacity	To strengthen Financial Sustainability of Water & wastewater Services Providers	To implement tariff revision	KASA, Sabah State Govt. & Sarawak State Govt.				N/G	N/G	N/G	N/G
167	UPEN Selangor	Water for Livelihood	Finance	Strengthening Financial Capacity		Implementation of the Tariff Setting Mechanism (TSM)	KASA	KASA	New	12MP & beyond	N/G	N/G	N/G	N/G
168	IWK	Water for Livelihood	Finance	Strengthening Financial Capacity	To enhance innovative financing	To encourage the private sector to invest in mutually beneficial water	MoF, KASA, Sabah State Govt. & Sarawak State Govt.				N/G	N/G	N/G	N/G
169	BAP,KASA	Water for Livelihood	Finance	Strengthening Financial Capacity		To consider establishing an entity licensed to develop sewerage infrastructure					N/G	N/G	N/G	N/G
170	UPEN Selangor + NIWRMP	Water for Livelihood	Finance	Federal funding to continue for those states that have migrated. Funding discussions need to be continued for those states that have yet to migrate		Sg Rasau Water Supply Scheme	KASA	Selangor State Govt.			1424.4	N/G	N/G	N/G
171	UPEN Selangor	Water for Livelihood	Finance	Strengthening Financial Capacity	To reform the Water Services Industry	Consider expanding matching grants					N/G	N/G	N/G	N/G
172	NIWRMP	Water for Livelihood	Finance	Federal funding for AWS to continue in all agricultural areas			MAFI	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
173	MPIC	Water for Livelihood	Finance	Providing Federal Funding to Support Technology Development & Technology Transfer (ToT)	Subsidization of irrigation system	Provide sufficient fund for adoption & implementation of new technologies	MPIC	MPB, DOA	New	12MP & beyond	N/G	1	1	1
174	BAP,KASA + NIWRMP	Water for Livelihood	Finance	Equitable tariff setting	Systematic tariff setting mechanism for water & sewerage services	Develop tariff setting mechanism for water services	KASA, MAFI, Sabah & Sarawak State Govt.	Line Agencies, water operators	On-going	12MP & Beyond	2	1	1	1

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
175	IWK	Water for Livelihood	Finance	Raising Financial Sustainability of Water Services Industry	Rationalisation of multipoint STPs	Implement the sewerage tariff increase & initiate program to introduce volumetric sewerage tariff	KASA			12MP & beyond	N/G	N/G	N/G	N/G
176	BAP,KASA	Water for Livelihood	Finance	Raising Financial Sustainability of Water Services Industry		New financing model to upscale the business	KASA	KASA	On-going	12MP & beyond	N/G	N/G	N/G	N/G
177	BAP,KASA + NIWRMP	Water for Livelihood	Finance	Federal funding to states that have migrated. Discussions & policy on permissible funding need to be addressed to those states that have migrated.		Water Financing for several states in Malaysia	MOF, KASA	KASA	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
178	NIWRMP	Water for Livelihood	Finance	WDM instruments			KASA, MAFI, Sabah & Sarawak State Govt.	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
179	NIWRMP	Water for Livelihood	Finance	Mechanisms for optimal cost recovery			KASA, MAFI, Sabah State Govt.& Sarawak State Govt.	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
180	NAHRIM	Water as a Resource	Infrastructure & Technology	R&D Infrastructure	Physical Modelling Infrastructure	Upgrading physical modelling facilities & equipment	NAHRIM, KASA	NAHRIM	New	12MP & Beyond	6.4	5	5	5
181	METMalaysia + NIWRMP	Water as a Resource	Infrastructure & Technology	Flood Mitigation	Flood forecasting centre	Increased the number of surface & weather radar observation station.	KASA, NADMA & Relevant States	Relevant States, MET Malaysia	On-going	12MP & Beyond	157	N/G	N/G	N/G
182	METMalaysia + NIWRMP	Water as a Resource	Infrastructure & Technology	Drought Mitigation	Develop drought infrastructure & alternative water sources	Cloud seeding technology, mesoscale esemble prediction & fire danger rating system	KASA, NADMA, Relevant States	Relevant States, MET Malaysia	On-going	12MP & Beyond	11.59	N/G	N/G	N/G
183	METMalaysia + NIWRMP	Water as a Resource	Infrastructure & Technology	Earthquake & Tsunami Readiness	To be identified by line agencies	Increased the number of seismic station,	KASA, NADMA, Relevant States	Relevant States, MET Malaysia	On-going	12MP & Beyond	14.314	N/G	N/G	N/G
184	KKR + NIWRMP	Water as a Resource	Infrastructure & Technology	Landslides & Sinkholes Mitigation	Construct repair work to reduce hazard & risk of .landslides		KASA, KKR & KeTSA		On-going	12MP	144.021	N/G	N/G	N/G
185	KeTSA + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Aquifer System Management	Groundwater mapping & assessment		KeTSA			12MP & Beyond	67.2	70	70	70

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
186	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Upgrading drainage system according to priorities of flash flood hotspot location by :State	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	N/G	N/G	N/G	N/G
187	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Johor (1	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	72.8364		68.4	N/G
188	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Kelantan (2	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	59.49	N/G	N/G	N/G
189	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Melaka (3	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	5.94	N/G	N/G	N/G
190	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Negeri Sembilan (4	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	5.85	N/G	N/G	N/G
191	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Pahang (5	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	2.43	N/G	N/G	N/G
192	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Pulau Pinang (6	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	5,19	N/G	N/G	N/G
193	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Perlis (7	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	1.84	N/G	N/G	N/G
194	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Perak (8	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	25.61832	N/G	N/G	N/G
195	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Selangor (9	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	95.4	N/G	N/G	N/G
196	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Terengganu (10	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	22.4	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
197	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Sabah (11	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	3.7344	N/G	N/G	N/G
198	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Upgrading drainage system	Sarawak (12	KPKT	JKT, Local Authorities, JPS	New	12MP & Beyond	25.450048	N/G	N/G	N/G
199	KPKT + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management : EPP : Urban Drainage System	Centralised Information for Urban Drainage System at Local .Authorities	Upgrading current database e-Profile	KPKT, JKT	Local Authorities	New	12MP & Beyond	1	2.5	N/G	N/G
200	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated River Basin Management (4 EPPs)	Setup River Basin Organisations	37 IRBM Plans completed.	KPKT/KASA	Local Authorities	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
201	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Catchment Management (1 EPP)	Watershed management/ restoration programmes	New facility to support downstream water resource management	KASA	Water-related & Ministries MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
202	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Lake Basin Management (8 EPPs)	Develop information management & decision support system	Suggest to combine with IRBM	KASA	Relevant States	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
203	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Coastal Zone Management (6 (EPPs	ICZM/ ISMP Network for all Malaysian States	Increase length of coastline protected	KASA	Water-related & Ministries MSANg or Equivalent	New	12MP & Beyond	1247	1370	1371	1372
204	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Urban Water Management (5 EPPs)	Develop integrated urban water resource management		KPKT	& DOE, MOH MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
205	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Integrated Aquifer System Management (3 EPPs)	Groundwater metering & licensing		KASA, JPS, KeTSA & JMG	MOTAC, KWP & Local Authorities	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
205	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Water-related Hazards (1 EPP)	Develop catastrophe insurance industry	Integrated Flood Management (IFM)	KASA	Relevant States	On-going	12MP & Beyond	7.6	N/G	N/G	N/G
207	JPS + NIWRMP	Water as a Resource	Infrastructure & Technology	Water-based Recreation & Tourism (3 EPPs)	Water tourism products events &	JPS-Coastal protection design with combination with tourism elements	MOTAC/KASA/JPS	MOTAC, KWP & Local Authorities	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
208	NIWRMP	Water as a Resource	Infrastructure & Technology	Ecosystem Services (4 EPPs)	PES framework & mechanism for Malaysia		KASA	Water-related & Ministries MSANg or Equivalent	New	12MP & Beyond	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
209	JAS + NIWRMP	Water as a Resource	Infrastructure & Technology	Water Pollution Monitoring & Rehabilitation (6 EPPs)	River Basin Pollution Management Programme	Application of smart enforcement equipment	KASA	DOE		12MP & Beyond	1.85	163.3	0.5	0.5
210	IWK + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector (12 EPPs)	Water reclaimation	Incorporating green technology in all new & existing Regional STPs	KASA, KeTSA, MAFI, KPKT, MOTAC, MOT, Sabah Govt, Sarawak Govt			12MP & Beyond	N/G	N/G	N/G	N/G
211	IWK + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector (12 EPPs)	Exp& sewerage infrastructure & regionalisation of sewerage networks	Implement regionalisation/ sub regionalisation sewerage system in cities	KASA, MAFI, Sabah & Sarawak State Governments			12MP & Beyond	N/G	N/G	N/G	N/G
212	IWK	Water for Livelihood	Infrastructure & Technology	Optimise water resources	To implant Water Reclamation Plant for non-portable supply.		KASA, Sabah & Sarawak			12MP & Beyond	N/G	N/G	N/G	N/G
213	NIWRMP	Water for Livelihood	Infrastructure & Technology	Agricultural Water Services (6 EPPs)	Water for Food, Agriculture & Rural Development	Water metering for irrigation areas	MAFI	MSANg or Equivalent & Ministries of Agriculture & Sabah Sarawak	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
214	MPIC	Water for Livelihood	Infrastructure & Technology	Increasing agricultural productivity	Implementation of new water management technology	-	MPIC	MPB	New	13MP & Beyond	N/G	1	N/G	N/G
215	MPOB	Water for Livelihood	Infrastructure & Technology	Increasing agricultural productivity	Development of water management strategies	Techniques to understand the process of roots & fluid movement of oil palm	MPIC	MPOB	On going	12MP	N/G	N/G	N/G	N/G
216	MPOB	Water for Livelihood	Infrastructure & Technology	Increasing agricultural productivity	Enhancement of oil palm water	Evaluate the effects of silica application	MPIC	MPOB	On going	2030	N/G	N/G	N/G	N/G
217	MPIC	Water for Livelihood	Infrastructure & Technology	Enhancing Agricultural Water Services	Development of fertigation system	-	MPIC	MCB	On going	13MP	0.5	N/G	N/G	N/G
218	MPIC	Water for Livelihood	Infrastructure & Technology	Enhancing Agricultural Water Services	Development of auto-control system	-	MPIC	MCB	New	2030	N/G	1	N/G	N/G
219	MPIC	Water for Livelihood	Infrastructure & Technology	Enhancing Agricultural Water Services	Development of water recycle system for kenaf bio-retting processing	Kenaf programme	MPIC	LKTN	On going	2030	5	6	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
220	MPIC	Water for Livelihood	Infrastructure & Technology	Enhancing Agricultural Water Services	Development of water recycle system	New planting of Kenaf programme	MPIC	LKTN	On going	2025	4	N/G	N/G	N/G
221	MPIC	Water for Livelihood	Infrastructure & Technology	Enhancing Agricultural Water Services	Development of waste water treatment system	IECS Study & Building of waste water treatment system	MPIC	MPB		2024	7	N/G	N/G	N/G
222	KeTSA	Water for Livelihood	Infrastructure & Technology	Providing Quality Infrastructure	Water for People, Food, Agriculture, Rural Development & Environment	Regional & centralised sewage treatment plants (STPs)	KASA, KeTSA, MAFI, Sabah & Sarawak Govt.			12MP & Beyond	74	80	80	80
223	NIWRMP	Water for Livelihood	Infrastructure & Technology	Development of Alternative Water :Sources		Consumptive Use (6 EPPs)	KASA, KeTSA, MAFI, KPKT, MOTAC & MOT	Line Agencies	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
224	KeTSA + NIWRMP	Water for Livelihood	Infrastructure & Technology	Development of Alternative Water :Sources (Consumptive Use)	Groundwater infrastructure & service sector development		KASA, KeTSA, MAFI, KPKT, MOTAC, MOT, Sabah State Govt., Sarawak Govt			12MP & Beyond	74	80	80	80
225	KeTSA + NIWRMP	Water for Livelihood	Infrastructure & Technology	To increase groundwater utilisation	Water for People	To map groundwater aquifers	KeTSA, KASA, Sabah & Sarawak			12MP & Beyond	141.2	150	150	150
226	UPEN Selangor + NIWRMP	Water for Livelihood	Infrastructure & Technology	To increase groundwater utilisation		Identify large volume of underground water for climate change					N/G	N/G	N/G	N/G
227	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Loji Rawatan Kumbahan Serantau Dan Rangkaian Paip Pembetungan Miri (Fasa 1)	.Sarawak State Govt	JPP Sarawak	On-going	12MP	1.4	N/G	N/G	N/G
228	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Sistem Pembetungan Bersepadu Kuching (Zon 1 Pakej 3)	.Sarawak State Govt	JPP Sarawak	On Going	12MP & Beyond	298.9	83	0	N/G
229	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Loji Rawatan Kumbahan Serantau dan Rangkaian Paip Pembetungan Miri (Fasa 2)	.Sarawak State Govt	JPP Sarawak	On Going	12MP & Beyond	191.08	259	N/G	N/G
230	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Provision of a septic (sludge treatment plant	.Sarawak State Govt	JPP Sarawak	From 11MP, were put on hold & to be restart in 12MP	12MP	N/G	31	0	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
231	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Projek Rasionalisasi dan Menaiktaraf Kolam-Kolam Oksidasi dan Package Plant	Sarawak State Govt.	JPP Sarawak	New	12MP & Beyond	68.55	282	N/G	N/G
232	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised Sewerage System-Kota Samarahan	Sarawak State Govt.	JPP Sarawak	New	12MP & Beyond	78	498	N/G	N/G
233	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised Sewerage System- Sibu	Sarawak State Govt.	JPP Sarawak	New	12MP & Beyond	4.49	7.04	443	N/G
234	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system-Kuching	Sarawak State Govt.	JPP Sarawak	New	14MP & beyond	N/G	16.65	400	N/G
235	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system- Samarahan	Sarawak State Govt.	JPP Sarawak	New	14MP & beyond	N/G	178	500	N/G
236	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system- Sibu (Package (2 & beyond	Sarawak State Govt.	JPP Sarawak	New	14MP & beyond	N/G	7	500	N/G
237	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system- Sarikei - Bintangor	Sarawak State Govt.	JPP Sarawak	New	14MP & beyond	N/G	7	459	N/G
238	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system- Mukah	Sarawak State Govt.	JPP Sarawak	New	14MP & beyond	N/G	10	450	N/G
239	JPP Sabah	Water for Livelihood	Infrastructure & Technology	Providing Quality Infrastructure	Regional & centralised sewage treatment plants ((STPs		KASA, KeTSA, MAFI, Sabah & Sarawak	Line Agencies	On-going	Continued from 11MP	N/G	N/G	N/G	N/G
240	JPS + NIWRMP	Water for Livelihood	Infrastructure & Technology	To increase groundwater utilisation	To map groundwater aquifers	To enhance or integrate NAWABS system	KeTSA, KASA, Sabah & Sarawak	KeTSA, Sabah & Sarawak	On-going	12MP & beyond	N/G	N/G	N/G	N/G
241	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Loji Rawatan Kumbahan Serantau Dan Rangkaian Paip Pembetungan Miri (Fasa 1)	Sarawak State Govt.	JPP Sarawak	On-going	12MP	140	N/G	N/G	N/G
242	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Sistem Pembetungan Bersepadu Kuching (Zon 1 Pakej 3)	Sarawak State Govt.	JPP Sarawak	On-going	12MP & Beyond	298.9	83.05	N/G	N/G
243	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Loji Rawatan Kumbahan Serantau dan Rangkaian Paip Pembetungan Miri (Fasa 2)	Sarawak State Govt.	JPP Sarawak	On-going	12MP & Beyond	191.08	258.98	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
244	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Provision of a septic sludge treatment plant	Sarawak State Govt.	JPP Sarawak	On-going	12MP	N/G	N/G	N/G	N/G
245	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Projek Rasionalisasi dan Menaiktaraf Kolam-Kolam Oksidasi dan Package Plant	Sarawak State Govt.	JPP Sarawak	On-going	12MP & Beyond	68.55	281.45	N/G	N/G
246	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Kota Samarahan Centralised Sewerage System Phase 1	Sarawak State Govt.	JPP Sarawak	New	13MP & Beyond	78	498	N/G	N/G
247	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Sibu Centralised Sewerage System Package 1	Sarawak State Govt.	JPP Sarawak	New	13MP & Beyond	7.04	442.96	N/G	N/G
248	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Future package for centralised sewerage system in Kuching (Package 4 & beyond)	Sarawak State Govt.	JPP Sarawak	New	14MP & Beyond	N/G	16.65	400	N/G
249	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Future package for centralised sewerage system in Samarahan (Phase 2 & beyond)	Sarawak State Govt.	JPP Sarawak	New	14MP & Beyond	N/G	178	500	N/G
250	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Future packages for centralised sewerage system in Sibu (Package 2 & beyond)	Sarawak State Govt.	JPP Sarawak	New	14MP & Beyond	N/G	7	500	N/G
251	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system in Sarikei - Bintangor	Sarawak State Govt.	JPP Sarawak	New	14MP & Beyond	N/G	7	459	N/G
252	JPP Sarawak + NIWRMP	Water for Livelihood	Infrastructure & Technology	Water Supply & Wastewater Services Sector	Expand sewerage infrastructure & networks	Centralised sewerage system in Mukah	Sarawak State Govt.	JPP Sarawak	New	14MP & Beyond	N/G	10	450	N/G
253	MAFI	Water for Livelihood	Infrastructure & Technology	To increase the adequacy of air gumbaan from the Kelantan River	New pumps	Pump station system improvement	MAFI	KADA	On-going	12MP	N/G	N/G	N/G	N/G
254	MAFI	Water for Livelihood	Infrastructure & Technology	To increase the adequacy of air gumbaan from the Kelantan River	To increase the water level of Kelantan River	Low Weir Repair	MAFI	KADA	On-going	12MP	60	N/G	N/G	N/G
255	MAFI	Water for Livelihood	Infrastructure & Technology	Preserve the use of river water & drainage	Construction of recycling pump	Recycling Pump Stations	MAFI	KADA	On-going	12MP	16	N/G	N/G	N/G
255	MAFI	Water for Livelihood	Infrastructure & Technology	Increase paddy production capacity	Upgrading existing dams & irrigation systems	Upgrading the Seligi-Berangan Lepah Scheme	MAFI	KADA	On-going	12MP	10	N/G	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
256	MAFI	Water for Livelihood	Infrastructure & Technology	Improve the efficiency of the irrigation system	Upgrading "taliair tanah" to "taliair "konkrit	Upgrading KADA irrigation & drainage infrastructure	MAFI	KADA	On-going	12MP & beyond	39.6	60	70	80
257	MAFI	Water for Livelihood	Infrastructure & Technology	Systematic management of irrigation & drainage water	Installation of online & automated monitoring & operation systems	Pemodenan Sistem Pengurusan Pengairan dan Saliran Padi (SCADA)	MAFI	KADA	On-going	12MP & beyond	11	2	N/G	N/G
258	MAFI	Water for Livelihood	Infrastructure & Technology	Improve the efficiency of the irrigation system	Reshape Taliair Utama dimensions	Reshape Taliair Utama & Sludge Removal	MAFI	KADA	On-going	12MP & beyond	52.5	20	20	30
259	MAFI	Water for Livelihood	Infrastructure & Technology	To increase the adequacy of air gumbaan from the Kelantan River	To increase the water level of Kelantan River	Barrage Construction	MAFI	KADA	New	13MP & beyond	N/G	400	200	N/G
260	MAFI	Water for Livelihood	Infrastructure & Technology	Agricultural water Services	Development of irrigation & drainage infrastructure to improve irrigation .efficiency	Upgrading Irrigation & Drainage Infrastructure for Jelapang	MAFI	BPSP, IADA & JPS	On-going	12MP & beyond	N/G	N/G	N/G	N/G
261	MAFI	Water for Livelihood	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	Development & Upgrading of the Operating System	IR4.0 System Development	MAFI	MADA	On-going	12MP & beyond	N/G	60	N/G	N/G
262	MAFI	Water for Livelihood	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	Improving the Efficiency of Dam Catchment	Capacity Study of Capacity Increase & Construction "Check "Dam	MAFI	MADA	On-going	12MP & beyond	N/G	3	N/G	N/G
263	MAFI + NIWRMP	Water as a Resource	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	ILBM	ILBM	MAFI	MADA, LSANK	On-going	12MP & beyond	N/G	2	N/G	N/G

	Updated NIWRMP Roadmap													
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
264	MAFI	Water for Livelihood	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	Dam Safety Management & Monitoring Efficiency Improvement Program	Upgrading of equipment	MAFI	MADA, LSANK & CGSO	On-going	12MP & beyond	N/G	1.1	N/G	N/G
265	MAFI	Water for Livelihood	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	Upgrading of Security Control System in Prohibited Areas	Installation of Security Camera Surveillance (System (CCTV	MAFI	MADA	On-going	12MP & beyond	N/G	0.17	N/G	N/G
266	MAFI	Water for Livelihood	Infrastructure & Technology	To increase sustainability by advancing the operation, maintenance, safety & security of dams in MADA	Large Scale Paddy (planting (PPSB	Establishment of PPSB	MAFI	MADA	On-going	12MP & beyond	628.36626	1245	N/G	N/G
267	MAFI	Water for Livelihood	Infrastructure & Technology	Increasing Agricultural Productivity	Water for Food, Agriculture & Rural Development	Upgrade facilities & Physical Pemerkasaan Industri Akuakultur	MAFI	DOF	On-going	12MP & beyond	24	N/G	N/G	N/G
267	MAFI	Water for Livelihood	Infrastructure & Technology	Increasing Agricultural Productivity	Water for Food, Agriculture & Rural Development	Aquaculture Industry Synergy	MAFI	DOF	On-going	12MP & beyond	17	N/G	N/G	N/G
268	MAFI	Water for Livelihood	Infrastructure & Technology	Increasing Agricultural Productivity	Water for Food, Agriculture & Rural Development	Empowerment of the National Seaweed Industry	MAFI	DOF	On-going	12MP & beyond	12.975	N/G	N/G	N/G
269	MAFI	Water for Livelihood	Infrastructure & Technology	Increasing Agricultural Productivity	Water for Food, Agriculture & Rural Development	Aquaculture Integration Development	MAFI	DOF	On-going	12MP & beyond	45	N/G	N/G	N/G
270	MAFI	Water for Livelihood	Infrastructure & Technology	Increasing Agricultural Productivity	Water for Food, Agriculture & Rural Development	Development of Deep Sea & Tuna Commercial Fisheries	MAFI	DOF	On-going	12MP & beyond	10.35	N/G	N/G	N/G
271	NIWRMP	Water for Livelihood	Infrastructure & Technology	Commercial water to shipping (4 EPPs)	Urban water transport		MOT	MSANg or Equivalent & Local Authorities	On-going	12MP & Beyond	N/G	N/G	N/G	N/G

	Updated NIWRMP Roadmap												
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority/ (Collaborating (Partner	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)			
											12 MP	13 MP	14 MP	15 MP
272	NIWRMP	Water for Livelihood	Infrastructure & Technology	Energy Sector (2 (EPPs	Hydropower, thermal power plants		KETSA	TNB, SEB, SESB, Sabah Local Authorities, Sarawak Local Authorities & MSANg or Equivalent	On-going	12MP & Beyond	N/G	N/G	N/G	N/G
273	IWK	Water for Livelihood	Infrastructure & Technology	Mitigation of Pollution	To mitigate Water Pollution	Smart technologies in monitoring & enforcement activities	KASA, Sabah State Govt. & Sarawak State Govt.			SCC Fund	50	50	50	50
274	NIWRMP	Cross-cutting	Infrastructure & Technology	Meetings, Incentives, Conference & (Exhibition (MICE	Develop Malaysia as Water Hub		KASA			12MP & Beyond	N/G	N/G	N/G	N/G

ACRONYMS APPEARING IN THE ROADMAP

BAP	Bahagian Perkhidmatan Air dan Pembentungan
BSASH	Bahagian Sumber Air, Saliran dan Hidrologi
BPSP	Bahagian Pengairan dan Saliran Pertanian
BBA	Bahagian Bekalan Air
CIDB	Construction Industry Development Board
CGSO	Chief Government Security Office
DOE	Department of Environment
DOA	Department of Agriculture
DOF	Department of Fisheries
EPP	Entry Point Project
EQA	Environmental Quality Act
EQR	Environmental Quality Report
GWP	Global Water Partnership
IWK	Indah Water Konsortium
IUWM	Integrated Urban Water Management
INTAN	Institut Tadbiran Awam Negara
IADA	Integrated Agriculture Development Area
IGM	Institut Geologi Malaysia
IoT	Internet of Things

IUWM	Integrated Urban Water Management
IWRM	Integrated Water Resources Management
IECS	Industrial Effluent Characteristics Study
JPS	Jabatan Pengairan dan Saliran
JMG	Jabatan Mineral dan Geosains
JPP Sabah	Jabatan Perkhidmatan Pembentungan
JKT	Jabatan Kerajaan Tempatan
JAKOA	Jabatan Kemajuan Orang Asli
KPKT	Kementerian Perumahan dan KerajaanTempatan
KASA	Kementerian Alam Sekitar dan Air
KKR	Kementerian Kerja Raya
KADA	Lembaga Kemajuan Pertanian Kemubu
LKTN	Lembaga Kenaf dan Tembakau Negara
LSANK	Lembaga Sumber Air Negeri Kedah
MAFI	Ministry of Agriculture and Food Industries
MSANg	Majlis Sumber Air Negeri
MPB	Malaysian Pepper Board
MOH	Ministry of Health
MOHE	Ministry of Higher Education

MADA	Muda Agricultural Development Authority
MPIC	Ministry of Plantation Industries and Commodities
MPOB	Malaysian Palm Oil Board
MRB	Malaysia Rubber Board
MOTAC	Ministry of Tourism, Arts and Culture
NAWABS	National Water Balance Management System
NAHRIM	National Water Research Institute of Malaysia
NaGMiS	National Groundwater Monitoring System
NaGWiS	National Groundwater Information System
NIWRMP	National Integrated Water Resources Management Plan
O&M	Operations & maintenance
RSTP	Regional Sewage Treatment Plant
SPAN	Suruhanjaya Perkhidmatan Air Negara (SPAN)
SIRIM	Standard and Industrial Research Institute of Malaysia
STP	Sewage Treatment Plant
SCC	Sewerage Capital Contribution
TSM	Tariff Setting Mechanism
UPEN	Unit Perancang Ekonomi Negeri

Appendix 2.2

ASM 2016 NIWRMP Conclusions and Recommendations

Preamble: The following set of conclusions and recommendations were extracted from the ASM NIWRMP Volume 1 and is included here to reflect the necessity when implementing the WST2040 Agenda, to consider the earlier sub-thematic studies and the conclusions and recommendations arrived at by each of those studies as undertaken by ASM and to consider them as a prequel to the eight sub-sector studies commissioned to ASM. It is pointed out here that the ministries mentioned here were existing at the time of publication of the report in 2016.

This initiative undertaken by ASM is a critical review of water resources and water supply services development and management in the country as seen from an IWRM perspective. Why IWRM? Because it has been the central paradigm and thrust adopted by the government and embodied in the National Water Resources Policy (NWRP) 2012 document.

Conclusions

The comprehensive assessment initiated by ASM in the year 2008 enabled the gaining of valuable insights into a wide range of IWRM water-related thematic areas and topical issues nation-wide so as to be able to draw a number of significant conclusions as highlighted hereunder:

- **Water Availability:** Blessed with abundant rainfall, the adequate provision of quality water to meet the country's short- term, medium- term and long-term needs is not one of water resources availability but more of sound management and good governance both at national and state levels.

  Malaysia has hitherto largely depended on surface water for its water supply needs. Recurring crises of potable water shortages due to prolonged droughts in recent years affecting several states had led to water rationing. It is imperative now that alternative sources of water and water demand measures be actively pursued to ensure that the national water stock has adequate reserves to effectively deal with the vagaries of weather and reinforce adaptive capacities to address the potential impacts of climate change. Groundwater, rainwater harvesting and wastewater reuse (with or without treatment) are the more obvious sources to consider for use singly or conjunctively. For island states and coastal areas, recent advances in membrane technology have made desalination of sea or brackish water of both surface and groundwater, viable options.

- **Ecosystems Degradation and Water-related Hazards:** Extensive land and industrial development has changed the urban and rural landscape which has had its toll on both the terrestrial and aquatic ecosystems. The recent launch of the revised National Policy on Biodiversity aimed at "sustainable utilisation of biodiversity in the country" and stressing "safeguarding ecosystems" as one its five goals, is a timely intervention for championing this cause nationally.

  River water quality continues to be on the decline. Comparing the Environmental Quality Reports for 2013 and 2014, out of the 473 rivers monitored, the percentage of clean rivers has dropped from 58% to 52%, slightly polluted rivers have increased from 37% to 39%, while polluted rivers have also increased from 5% to 9%.

  Water-related hazards are on the rise and have become major national issues. Some of the tell-tale signs experienced of late are the wide-spread floods in December 2014 and January 2015, affecting Kelantan, Terengganu, Perak, Pahang, Johor, Sabah and Sarawak. Studies have shown that 9% or 29,800 sq. km of the total area of Malaysia lies in flood prone areas, whereby 22% of the country's total population lives.

  Yet another hazard is the increase in occurrence of severe land-slides and debris flows, the most recent being in the resort area of Cameron Highlands in November 2014.

  In 1997, 1998, 2014, and more recently in 2016, low rainfall and hot temperatures associated with the El Nino phenomenon affected many parts of northern and central Peninsular Malaysia, and Sabah. These extreme events cause depletion in storage levels in many of the country's reservoirs, prompting

the need for cloud-seeding operations while causing disruptions to potable water supply and paddy farming activities, especially in the northern granary areas.

Periodic occurrence of water-borne diseases is also a threat to human health in the country. Cases of cholera, typhoid, leptospirosis and dengue are invariably linked to water.

- **IWRM, MDG and SDG:** Subscribing to international water related conventions, Malaysia has adopted IWRM since the mid-1990s. IWRM is essentially about pursuing balanced development between "Water as a Resource" and "Water for Livelihoods". Malaysia has also joined the global community in committing to earlier Millennium Development Goals (MDGs), and more recently to the post-2015 Sustainable Development Goals (SDGs).

  However, only minimal and sporadic success has been realized to-date on IWRM implementation nation-wide. Fragmented management, a legacy from the past, still prevails at national level and the situation in the states is no better with few exceptions.

- **Majlis Sumber Air Negara (MSANg)**[7], established in 1998, provided an important platform in ensuring uniformity in the provision of integrated programmes and solutions regarding water development and resource management issues and challenges nation-wide. It has also promoted Federal-State and inter-state cooperation and assisted in resolving conflicts that may arise from time to time. What was observed is that many MSAN national relevance decisions made that are of and application do not get expeditiously implemented due to the absence of complementary and effective structures or mechanisms in most states which have the ability to timely execute the programmes and directives.

- **NWRP 2012**: The successful launch of the much-awaited NWRP in March 2012 following the endorsement by MSAN, was a major milestone accredited to the NRE[8] Ministry. While an earlier commitment to preparation of a National IWRM Plan 2005 had not materialised, the NRE Ministry is currently actively pursuing the preparation of a NWRP Action Plan.

- **Establishment of MSANg**: A 1997 Federal Cabinet decision directing the Ministry of Agriculture and the state of Selangor to initiate early action for the holistic management of the state's water resources was an important initiative under the national IWRM agenda to enable penetration to reach grass root levels of management. The directive led to the passing of the SWMA enactment by Selangor in 1999 and subsequent establishment of Selangor Water Management Authority (LUAS) in 2000. It provided the enabling environment to pioneer the shift away from past fragmented approaches to the adoption and application of more contemporary IWRM principles and practices in the state. Selangor through LUAS has made great advances in institutionalising IWRM in the management of its water resources. Sabah and Kedah have progressed on similar lines. The remaining states have not actively pursued this initiative. MSANg 08 that met in October 2013 has since reminded and urged State Governments for early establishment of State Water Resources Councils (MSANg).

- **IRBM, ILBM, IASM and IUWM**: MSAN 02 that met in July 2003 had endorsed Integrated River Basin Management (IRBM) to ensure that the use of land and water resources can be managed in a sustainable manner. Holistic adoption and implementation by states complete with the legal and institutional framework structures set in place, has only taken root to-date in the state of Selangor and to a certain extent in Sabah and Kedah.

  MSAN 04 held in July 2008 had approved a National Strategy Plan for Groundwater Resources Management, which has since been renamed as Integrated Aquifer System Management (IASM) based on an ASM-led study entitled "Strategies for the Sustainable Development and Management of Groundwater Resources in Malaysia".

  MSAN 07 that met in November 2012 had endorsed Integrated Lake Basin Management (ILBM) for the management of lentic systems based on the recommendations of yet another ASM-led study report entitled "Strategy Plan for the Sustainable Management of Lakes and Reservoirs in Malaysia".

  ILBM, IASM, IFM (related to floods), IDM (related to droughts), ICM (related to catchment areas spanning the upper reaches of rivers) and ICZM (related to the coastal zone spanning the interface

7 MSAN was renamed Majlis Air Negara (MAN) in 2019 after the change in the Government
8 NRE's ministerial functions have been taken over by KASA, Ministry of Water and Environment

between freshwater and brackish/ sea water) are, all sub-sets of IRBM. They fall under the purview of the NRE Ministry to oversee their implementation nationwide.

Urban water management, falling under the Ministry of Urban Well-Being, Housing and Local Government, involves ensuring access to water and sanitation infrastructure and services to an ever-growing urban population. It also entails the management of rainwater, wastewater, storm water drainage, and runoff pollution; control waterborne diseases and epidemics; and reduce the risk of water-related hazards, including floods, droughts, and landslides. Conventional urban water management systems that manage each of the above listed services as separate entities and de-linked from land-use planning and economic development would not be able to deal with the issues and challenges in an effective and efficient manner. Integrated urban water management (IUWM), another sub-set of IRBM, promises a better approach than the current system. The EPP, entitled River of Life Project (RoL) being implemented under NKEA 12 - Greater Kuala Lumpur/ Klang Valley, is an excellent example how a holistic solution can restore the river-front landscape while also returning aquatic life back to the rivers, a programme worthy of replication for urban rivers flowing through major cities and towns in the country.

- **Water Supply & Wastewater Management:** The introduction of Water Services Industry Act (WSIA) together with the SPAN Act in 2006 and the concurrent constitutional amendment to place water supply on the Concurrent List was an important milestone in the transformation of water supply and wastewater management services in the country. However, it is observed that there are shortcomings and setbacks in implementation, notable amongst which are: water supply and sewerage has yet to be fully integrated; WSIA does not extend to Sabah and Sarawak; only 6 Peninsular states have migrated so far to the new WSIA regime; absence of a water supply services policy that is aligned to NWRP 2012; reduction of NRW still lagging in most states; optimal legal/financial instruments and mechanisms for cost recovery of utility services and for equitable tariff setting still pending; and a pressing need to raise competence of O&M personnel at all levels of management.

- **Agricultural Water Management:** Drainage and irrigation for agriculture has all along been on the Concurrent List under the Federal Constitution. This has enabled the Federal Government, through its Ministry of Agriculture and Agro-based Industries (MOA), to make huge investments over the years in drainage and irrigation infrastructural works to support the growing of food crops to meet self-sufficiency/security targets set by prevailing National Agricultural/Food Policies. Despite the major share (64.3%) of the country's water resources going to agricultural use, its importance has not been sufficiently emphasised by the current Dasar Agromakanan Negara (DAN) 2011–2020. Reference is made only to infrastructure provision but more critical is sound water management to sustain optimum yields which applies also to plantation crops. Low-cost flood irrigation is the norm for water use in rice cultivation, while precision irrigation systems, including some under glass house or rain shelter conditions, are mainly used in horticulture and floriculture for the production of high value food crops, such as fruits and vegetables and non-food crops, such as flowers and ornamental plants. Other water needs under MOA are for livestock, fisheries and aquaculture.

  Recognising the symbiotic relation between water, land, and farm management, integrated agriculture management under MOA has been practised since the 1970s. All the relevant implementing agencies are placed under one roof to manage the larger agricultural project areas in an integrated manner. The forerunners were MADA and KADA, followed by IADAs, and largely Federal funded.

  On its road to Vision 2020, the country's agriculture policy has shifted more towards agribusiness and wealth creation. Propelling this change is the ETP launched in September 2010. Under the ETP, 16 EPPs and 11 BOs under the Agriculture NKEA 11 is expected to deliver an incremental GNI impact of RM 28.9 billion and 74,600 additional jobs by 2020. EPP10 and EPP11 are aimed at strengthening productivity of paddy Farming in MADA and seven other "granary areas". Adopting more efficient estate farming systems and introducing land amalgamation schemes, they seek to enhance the national productivity of paddy, establish long-term food security and increase the income of paddy farmers. Good progress has been reported to-date on these two EPPs thereby justifying its potential of replication in the other granary areas. Agriculture is water sensitive; hence, effective and efficient agricultural water services (AWS) is an essential prerequisite to ensure returns on investments and sustainability in agriculture.

  Plantation crops that include oil palm, rubber, timber, cocoa, pepper and tobacco come under the jurisdiction of the Ministry of Plantation Industry and Commodities (MPIC). Hitherto, these crops have

largely depended on provision of drainage facilities. Oil palm is recognised as an NKEA and its eight EPPs and three BOs is expected to provide an incremental GNI impact of RM 125.3 billion and generating an additional 41,600 jobs in 2020. Supplemental irrigation for oil palm cultivation is being actively pursued noting its potential of being catalytic to substantive increase in crop yields.

- **Information Management:** Decision Support System (DSS) for the management of water as a resource and for the provision of various utility services depend on reliable data and information readily available on a centrally managed database with appropriate links to customised systems by sectoral users for open access. Following MSAN 02 (July 2003) decision endorsing Integrated River Basin Management (IRBM) for the management of land and water resources in a sustainable manner, the river basin following hydrological boundaries provides an appropriate platform for the collation and dissemination of all data and information for common use.

- **Integrated Water Research:** Past and current research on water in Malaysia had been largely ad-hoc and fragmented more to address engineering infrastructural concerns while at IHTs, research conducted have had a narrow focus to meet academic interests. This has been borne out by an ASM study completed in 2014. The study recommended an integrated water research framework comprising need-based strategic themes that seek and provide sustainable solutions to Malaysia's water resources development and management programmes. MSAN 10 held in October 2015 considered and endorsed the ASM report entitled "Setting of a National Agenda for Integrated Water Research" for implementation by NRE.

- **Awareness-raising, Advocacy and Capacity Building:** A common but important feedback received from the many stakeholder consultations held was that personnel at Federal and State levels are ill-equipped both in capability and numbers to deal with the holistic management of water as a resource and for livelihoods. Similarly, despite past efforts undertaken on awareness raising regarding IWRM largely by water-related NGOs, its spread amongst communities and the public is minimal.

- **Gender Issues:** In many societies including Malaysian societies, women are largely responsible for reproductive work that includes household tasks and caring for the family. In terms of water, the tasks of ensuring enough water for the household generally rest on the shoulders of women. Added to this, is the use of water for small businesses and informal sector economic activity that have higher levels of women's participation. Changes in the availability of water including also the issue of drought, heavy rainfalls and frequency of floods increase women's burdens.

- **Climate Change**: Recently, increase in extreme climate variability is already felt in the country. Shift in rainfall patterns, escalating floods and drought occurrences of increased intensities (accompanied by forest fires and haze) are some of the ominous signs. In 2014, a study by ASM on water and climate change reviewed national capacities from various facets of water resources management and had endorsed IWRM approach/processes as a "no regret measure" in building up local resilience in climate change adaptation. MSAN 10 held in October 2015 considered and endorsed the ASM Advisory Report entitled "Strategic Plan for addressing the impacts of climate change on water-related issues in Malaysia" for incorporation by NRE into the overall strategies and action plans to combat climate change over the short-term and long-term in line with the National Policy on Climate Change.

- **Transboundary Issues:** Some of the trans-boundary issues highlighted by the expert reviews commissioned by ASM on IWRM-related topical issues are as follows:
  - Water supply security, energy security and food security are inextricably linked under a *Water-Food-Energy* nexus, whereby all the three components are dependent on the availability of water resources. "Information gap, silo-based governance and technology lock-in are the forces that hinder the translation of water, energy, food nexus into operational objectives and programmes".
  - Global trends, and Malaysia is no exception, show there is a "disconnect" between *land use planning and water resources planning* due to a variety of factors mainly the differing levels of governments and decision-making for land use planning and for water planning. Water quality is often compromised from incompatible location of land uses such as landfills at proximity to groundwater sources. Upstream

pollution from conversion of land, clearing of forests or activities on massive tracts of agriculture land is also averse to water quality and conservation, besides increasing the risk of disasters such as flash floods and landslides.

- **Emerging Concepts and Solutions:**
  - *Virtual Water (VW) and Water Footprint (WF)*: WF is the amount of water embedded in products. VW is defined as the volume of water required to produce a commodity or service. VW and WF are closely linked. The term WF is usually used to reflect the perspective from the standpoint of consumers or producers of products, whereas the term VW is mostly used in the context of international or interregional trade. The global WF is estimated at 1240m3 per capita in average. Malaysia's WF is around 2344 m3 per capita per year, rendering it higher than the global WF average, largely due to higher water usage patterns amongst Malaysians.
  - Wealth Creation: The ASM Mega Science Study report on Water (2011-2050) has added "wealth creation" as an objective for the water sector over the long-term identifying some 10 areas of products and services as opportunities for creating new wealth.
  - *Green Growth and Water Demand Management*: After Rio+20, the goal to sustainable development is repackaged via the "green economy" concept and Malaysia has subscribed to it. For the water sector, Water Demand Management (WDM) and the 3Rs (namely reduce, reuse, and recycle) are important green instruments that can substantially contribute to sustainable water resources management. There is an urgent need for the water consumers to play a more active role in helping to reduce their water demand. Water supply management (WSM) is not green and needs to embrace green building codes and use green processes and products.

- National Transformation Programme: In renewed efforts for timely achievement of Vision 2020 and to help fast-track the process, the country has, since 2010, launched the National Transformation Programme, of which one of the component programmes is the Economic Transformation Program (ETP). The ETP comprises 12 National Key Economic Areas (NKEAs) representing economic sectors considered significant in contributing to GNI and job creation. Unfortunately, the water sector was not included despite its importance nationally as a resource and for livelihood supporting all sectors of the economy.

Recommendations

Drawing from the conclusions above, it is clear that there is an urgent need for integrated solutions and concerted efforts that are able to permeate across all sub-sectors and penetrate all hierarchical levels of management down to the grass roots.

Under the GTP, the Malaysian government has adopted the National Blue Ocean Strategy (NBOS) in its strategic planning and operations which has to-date led to the formulation and execution of a number of creative blue ocean strategy initiatives that are transforming the country. For the Transformation of the Water Sector, ASM recommends to government the adoption and implementation of the **National IWRM Plan: Strategies and Road Map** contained in this report as the way forward in ensuring a better water future. The strategy formulation process for the Plan is akin to NBOS and was developed conforming to the internationally accredited IWRM General Framework that aims at balanced development between "water as a resource" and "water for livelihoods". The Framework is founded on the 3E's principle of economic efficiency, equity and environmental sustainability

The recommended strategies under the plan have been listed under four categories based on the elements prescribed by the framework as follows:

1. Enabling environment (Appendix 6.1[9])
2. Institutional framework (Appendix 6.2)
3. Management instruments (Appendix 6.3)
4. Investments in water infrastructure (Appendix 6.4)

Some of the highlights and essential features of the recommended plan are:

9 Appendices 6.1 to 6.4 are available in the downloadable ASM NIWRMP Volume 1 Report, listed in the References and available on-line

- The plan is a synthesis of the strategies recommended by the component, state and NKPA study reports and intended for implementation over a 15-year time frame spanning three Malaysia plans until 2030, and coinciding with target year set for the realisation of the UN endorsed Sustainable Development Goals (SDGs).

- Component and state plans and programmes included in the report shall be concurrently implemented nationwide and lead by the key ministries and relevant state administrations identified in the plan according to their entrusted responsibilities, be it under water resource management or water utility provision.

- ***Appendix 6.1 - Enabling Environment*** contains strategies to strengthen the policy and legal framework both at national and state levels to ensure a sound and effective implementation consistent with the provisions of the constitution.

  Natural resources comprising land, water, forests, inland fisheries, marine parks, wildlife, minerals & rock materials and the environment come under the purview of the NRE Ministry. While separate policies have to date been formulated to address and manage many of these resources, it is recommended that an over-arching National Integrated Natural Resources Policy (NINRP) be developed on a priority basis that ensures the integrity and symbiotic relations among them are safeguarded and not compromised at all hierarchical levels.

  Similarly, it is recommended that a common policy framework governing the water-food-energy nexus be formalised that would ascertain the balanced development and progress in meeting water security, food security and energy security targets.

  To complement the NWRP 2012, supporting polices were recommended to cater for sound resource management, namely a National IRBM Policy (that is inclusive of related sub-sets, such as ILBM, IASM, ICM, IFM, IDM, IUWM, ICZM).

  For utility provision, it is recommended that a National Water Supply Services Policy that encompasses consumptive and non-consumptive use be formulated to ensure equitable and efficient services to all users, including hitherto neglected ecosystem regulating service needs.

  A review of the Dasar Agromakanan Negara 2011–2020 is also recommended so as to lay greater emphasis on water as a critical component for agricultural development and for attaining optimal yields through sound water management.

  Due consideration should be accorded to mainstreaming gender issues for the sustainable management of water resources in the country.

  The legislation of a common National Water Resources Act, replacing the outdated Waters Act 1920, should be expedited to ensure uniformity in application by all states with the states enacting their respective enactments/ordinances. With the availability of the relevant state laws, this will facilitate more holistic water resource management in the states.

  A more contemporary Agricultural Water Services (AWS) Act be legislated to replace the outdated Irrigation Areas Ordinance 1953, the Drainage Works Ordinance 1954 and the combined Drainage and irrigation Ordinance 1956 applicable only in Sabah. The proposed AWS Act would be catalytic to reinforcing evolving farming systems aimed at revitalising the agriculture sector for wealth creation.
  There is a need to review the existing Streets, Drainage & Buildings Act 1974 so as to be contemporary in dealing with urban drainage issues through the application of IUWM principles and practices for holistic management.

  Potable water supply was on the State List prior to the year 2006 when WSIA was legislated. With its inclusion in the concurrent list, water utility services for all users are now financed from both federal and state resources. It is not the same for water resources management. Ownership of water being vested

with the state, funding for its management rests with the state, except when the water source involves an internationally shared river. It is recommended that following current norms, federal finances continue to be provided to fund some of the resource management related activities such as water resources assessment; information management; river basin and coastal zone management planning; integrated water R&D; awareness raising, advocacy and capacity building; mitigation of water-related hazards (such as floods, droughts, tsunamis, coastal erosion and land-slides). It is further recommended that ecosystem rehabilitation and restoration measures be included in the list of federal funded activities.

- ***Appendix 6.2 - Institutional Framework*** comprises strategies to ensure greater integration within and amongst water related institutions, and to supplement or reinforce institutional structures at all hierarchical levels of management.

  At the national level, MSAN, chaired by the Deputy Prime Minister, established in 1998 is the apex body on water matters, representing leadership at the highest political level. It is recommended that a second-tier leadership in the form of a National Steering Committee (NSC) on IWRM be established, jointly chaired by the KSU of NRE and KeTTHA with membership, which comprise KSUs of the other water-related ministries and State Secretaries. The NSC would oversee the coordinated implementation of the national IWRM agenda nationwide. The NSC shall be supported by a National Technical Committee (NTC), jointly chaired by the KP of JPS and the Chief Executive Officer of SPAN with members who comprise the DGs of other water-related departments and agencies.

  In line with the World Health Organisation (WHO) requirements that Water Safety Plans (WSPs) addressing "source to tap" be implemented to ensure safe drinking water, it is recommended that a national steering committee jointly managed by KeTTHA10, MOH, NRE & MSANg be formed to oversee the development of a master plan and its implementation nationwide.

  AWS development and management by a dedicated institution was proven to be one of the key success factors for agriculture development. Following the recommended legislation earlier for a contemporary AWS Act, it would only be appropriate and justified that a dedicated department for AWS be reinstated at the MOA with adequate capacity to deal with the challenges of a revitalised agricultural sector that is able to support agribusiness while permitting and regulating private sector involvement as AWS Providers or Operators.

  Complying with the MSAN 08 directive that urge states to establish MSANg, it is recommended that these state level institutions be established without further delay and backed by appropriate legislations on similar lines as SWRC for Sabah, LUAS for Selangor, and Lembaga Sumber Air Negeri Kedah. They would provide the highest political leadership on water matters in the state. To ensure greater penetration and facilitate decentralisation in decision-making, the formation of river basin level committees is recommended.

  Intra-ministerial integration recommended include the merger of surface water management (currently under JPS) and groundwater management (currently under a division of JMG) to become a single agency under the NRE Ministry and to be designated as the Department of Water Resources; accelerate the integration of water supply and sewerage services at KeTTHA to ensure holistic management of water and wastewater; and the institutionalisation of demand management in all water-related institutions to expedite the cultural shift from hitherto water supply management to more water demand management.

- ***Appendix 6.3 – Management Instruments*** comprise strategies to ensure the effective use of such instruments to assist decision makers in making wise choices. Management instruments range from information management, planning, economic & financial, legal, technical, operation and maintenance, R&D, capacity building, participatory management, to international cooperation. Some of the main strategies recommended under each category are as follows:
  - *Information Management:* In line with MSAN02 directive for adoption of IRBM nation-wide, it is recommended that a centrally managed IWRM database be established at the NRE Ministry built around the 189 river basins as its platform for the collation and dissemination of all water related data

10 The Ministerial functions of KeTTHA are now with KeTSA and KASA

and information for open access. The central repository shall be appropriately linked with customised systems that are in place for sectoral use. Dissemination of real time data and information pertaining to water related hazards is an important feature of the RBIMS.

A national State of the Waters report be released periodically by the NRE Ministry, if not annually on a triennial basis, to keep all stakeholders and the public informed on the management of the country's waters, to include an assessment on the status of water availability and water quality, its accounting, allocation and use, reported according to river basins nationwide.

- *Planning:* To pursue the IWRM agenda over the long-term, foresight studies on IWRM and its sub-sets are recommended, while the preparation and distribution of appropriate guidelines would facilitate sound implementation. Early preparation of river basin management plans is recommended to assist basin managers in decision-making processes. River Basin Management Plans should incorporate IFM and IDM plans complete with early warning system, flood/drought risk assessment, emergency response, monitoring tools, inventory resources, and identification of areas and groups at risk. The River Basin Management Plans would also ensure there is 'no disconnect' between land use management and water resources management.

  Alternative water sources, such as groundwater, rainwater, stormwater, wastewater as well as brackish and sea water are possible new sources to be developed.

- *Economic and Financial Instruments:* Under this category, a wide array of water demand management strategies is recommended related to the provision of water utility services. They range from incentive schemes to encourage the use of water saving devices or systems, mechanisms for optimal cost recovery of services with provisions for targeted subsidies, and equitable tariff setting. For resource management, payment for ecosystem services (PES) and the application of "polluter pays" principle are options that merit implementation.

- *Legal Instruments:* This category is related to enforcement of water related laws and regulations. Amongst them are those pertaining to gazetting of reserves and protected areas, the issue of licenses for various uses, and imposition of penalties for committed breaches and offences.

- *Technical Instruments*: Strategies under this category are mainly aimed at water conservation measures. Apart from water reuse and recycling, technologies recommended are water saving devices (including retrofitting), leakage control, modifying agronomic practices such as adjustment of cropping patterns and adoption of dry-seeding techniques in paddy planting; and the choice of less thirsty crop varieties.

- *Green Growth and Water Demand Management (WDM):* Strategies in support of Green Growth for the water sector through the application of the 3Rs are essentially WDM instruments to ensure a cultural shift from WSM to WDM and that WSM embraces green building codes and use green processes and products.

- *Operation & Maintenance:* Under this category, strategies recommended are mainly to ensure the security, integrity, resilience and safety of water related systems. Water allocation, water accountability, and water audit undertaken at the river basin level is a priority action required of water resource managers. For utility providers, operational strategies include the implementation of WSPs nationwide conforming to WHO guidelines; the development of SOPs for all process-related operations; reduction of water losses such as NRW and the like; and the development of maintenance manuals to ensure control systems, facilities and equipment associated with water supply and drainage systems remain functional at all times. SOPs are also needed to address emergencies, such as breakdown of water supply, pollution of water sources, floods, droughts, and water-borne diseases.

- *Research and Development (R&D):* ASM report entitled "Setting a National Agenda for Integrated Water Research in Malaysia" completed in 2014 was endorsed by MSAN 10, which met in October 2015 for implementation by the lead ministry, NRE . It is recommended that the findings and recommendations to pursue integrated water research based on a set of need-based strategic themes be implemented

on a priority basis. A review of the current governance structure be undertaken based on the options proposed by the report. The appropriation of adequate human and financial resources is equally vital.

- *Advocacy, Awareness, Capacity Building and Public Participatory Platforms (AACB)*: Success of the national IWRM agenda over the long-term requires a mind-set change amongst public, private and community stakeholders.

  Awareness-raising of water issues, challenges and integrated solutions that extends to community stakeholders and the public at large are essential ingredients to the IWRM agenda.

  Similarly, political leaders are best placed to play the advocacy role in promoting IWRM, facilitate participatory management and in resolving conflicts through engagement and dialogue.

  More importantly, personnel involved in water resource management and water utility provision from both federal and state administrations at all hierarchical levels require more holistic training, comprising a blend of a common IWRM modules prior to being streamed to undergo specialised training based on their respective sectorial management and service delivery needs.

  Currently, water-related training is mainly provided by NRE, KeTTHA, MOA11 and Water Operators along sectoral lines and targeted mainly at their own personnel. In keeping with NBOS and the spirit of IWRM, it is recommended that the three ministries and water operators pool resources to establish and manage a national one-stop training centres in all states that offer integrated modules on AACB to cater for all three target groups mentioned above. It entails the development of appropriate communication and training packages working in collaboration with IHTs and environmental and community related NGOs.

- *Participatory Management:* The 2nd Dublin Principle states "Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels".

  Some examples of past initiatives to involve users and beneficiaries in water supply programmes include farmers participation in tertiary system development and O&M activities under MOA; the "water forum" mooted by KeTTHA; and "rakan tasik" or "river brigade" initiated by some states to support water resource management. It is recommended that such initiatives be intensified in the future. There is scope and potential for greater stakeholder participation when programmes such as IRBM and WDM are implemented and operational particularly at the community levels through outreach programmes. There is also the need to help create participatory capacity, and complementary AACB programmes are equally necessary.

- *International Cooperation:* The problems and challenges that beset the water sector in Malaysia are not new. They are also not unique to this country alone but experienced globally. Regional and international institutions and organisations operating both within and outside the UN system are aplenty, each with their area of special focus. These agencies are continually seeking and providing integrated solutions pertaining to a wide range of water thematic issues. Dedicated water-related R&D institutions also operate in various locations in the region and internationally.

  It is recommended that national water related organisations and agencies be proactive in networking and seek to establish links with similar subject matter focused institutions abroad. National research and capacity building institutes should endeavor to enter into strategic alliances with renowned regional and international water research and training centres for mutual benefit. International collaboration and cooperation provide spin-off benefits in the form of business opportunities for both public and private sectors. Regular participation in reputed water-related international water fora also provides good exposure, understanding of current issues and challenges, introduction to future developments, and offer opportunities for interaction and networking worldwide.

11 The Ministerial functions are now with MAFI

- ***Appendix 6.4 – Investments in Water Infrastructure:*** This fourth element would require substantial investments. The list of "Investments in Water Infrastructure" represents a consolidation of programmes and EPPs identified by an earlier ASM study published in 2015, justifying a National Key Priority Area (NKPA) on water, together with additional investments recently identified by Component Plan studies for specific programmes, now making up a total of 15 programmes and 95 EPPs that were identified. The programmes were rearranged and classified under 3 categories, namely:
  A. Cross-cutting Programmes (five programmes and 14 EPPs);
  B. Programmes related to "Water as a resource" (five programmes and 48 EPPs); and
  C. Programmes related to "Water for Livelihood" (five programmes and 33 EPPs).

A summary list of the programmes is shown in the Table 2.9 below:

Table 2.9. Summary list of programmes

INVESTMENTS IN WATER INFRASTRUCTURE	
A. Cross-cutting Programmes	
1. Central water resources database	
2. Integrated water research	
3. Climate change adaptation	
4. Awareness raising, advocacy, capacity building	
5. Meetings, incentives, conference and exhibition (MICE)	
B. Programmes related to "Water as a Resource"	**C. Programmes related to "Water for Livelihood"**
1. Integrated river basin management (IRBM) and integrated aquifer system management (IASM) 2. Water-related hazards 3. Ecosystem services 4. Water pollution monitoring and rehabilitation 5. Water-based recreation and tourism	1. Development of alternative water sources 2. Water supply & wastewater services sector 3. Energy sector 4. Agricultural water services sector 5. Commercial water to shipping

Source: ASM Advisory Report (2015): National Key Priority Areas (NKPA)

With the twin objectives of water security and water economic opportunities, it is recommended that the investments in water infrastructure contained in Appendix 6.4 be urgently incepted to cater for the national water sector needs and to spur the transformation of the water sector. The Appendix comes with an implementation roadmap.

Management Structure for Plan Implementation: Plan implementation nationwide entails mobilising resources and designing effective management structures. A recommended management structure for effective implementation of the Plan is as follows:

a) The plan shall be managed nationally at the highest political level by MSAN, which has the NRE and KeTTHA as its joint secretariat. Correspondingly, at respective state levels, it would be MSANg or its equivalent.
b) A National Steering Committee (NSC) that comprises the KSUs of all water-related ministries and the State Secretaries shall oversee the implementation of the Plan. KSUs of NRE and KeTTHA shall be the joint Chairpersons of the NSC. A strong Plan Implementation Unit (PIU) headed by a Senior Executive well versed on IWRM would be responsible to ensure the timely and coordinated implementation of the plan. The PIU would be responsible to the NSC and serve as its secretariat. At the state level the MSANg or its equivalent would undertake the corresponding role with its implementation arm being the office of the Director MWA/Water Resources as applicable for each state.
c) A National Technical Committee (NTC), reporting to NSC and comprises the heads of water related departments and agencies. They would meet frequently to resolve technical issues and assist in streamlining operational matters. It would be jointly chaired by the DG of JPS and the CEO of SPAN.

NIWRMP's Closing Remarks

Since the launching of the NWRP in 2012, ASM noted that the NRE Ministry has embarked on an initiative to develop a NWRP Action Plan and has set up an organizational structure to undertake this task. A brief summary regarding this initiative has been included as one of the appendices under Chapter 4 of this report. In lauding this effort, ASM envisages some over-lap in recommended strategies. This ASM report is from a more inclusive IWRM perspective of the water sector. Therefore, ASM would consider both the undertakings as being mutually supportive and complementary.

The United Nations World Water Development Report 2016 (WWDR 2016) launched on World Water Day is entitled "Water and Jobs". The report reiterates that "water is an essential component of national and local economies, and is needed to create and maintain jobs across all sectors of the economy". "Sustainable water management, water infrastructure and access to a safe, reliable and affordable supply of water and adequate sanitation services improve living standards, expand local economies and lead to the creation of more decent jobs and greater social inclusion. Sustainable water management is also an essential driver of green growth and sustainable development".

The early implementation of the National IWRM Plan (NIWRMP) and Road Map would go a long way in compensating for the earlier omission of "water" as an NKEA under the ETP despite its importance and being a key element in nine other approved NKEAs. The NIWRMP would not only be catalytic to the Transformation of the Water Sector, but would contribute to meeting the SDGs by 2030. Through its coordinated policy and investments, it would also serve as yet another timely intervention to address the water-jobs nexus, a pre-requisite to sustainable development.

While the report has recommended a management structure for plan implementation, it is equally vital that "champions" emerge to carry the agenda forward. Appropriately, the onus must fall upon the Honourable Ministers of the three key water-related ministries, namely NRE, KeTTHA and MOA to team up in the true spirit of IWRM to champion this initiative and the transformation process.



CHAPTER 3.0

NATIONAL AGENDA FOR THE TRANSFORMATION OF THE WATER SECTOR 2040

The water sector should be transformed holistically to ensure secure and sustainable water supply. The Water Sector Transformation 2040 agenda will be introduced in the 12th MP to enhance management efficiency, optimise potential to generate wealth as well as create new job opportunities. The implementation of the agenda will encompass four phases and the first phase, Acceleration of the Adoption of Integrated Water Resources Management, will be implemented at the federal, state and district levels. Gazettement and conservation of water catchment areas will be expedited to improve water resources management and integrated waste water treatment plants will be constructed to control pollution

– Ms. Audrey Azoulay, Director-General of UNESCO (March 2021)

3.1 MEETING GLOBAL AND NATIONAL TARGETS BY 2030

3.1.1 Global Targets

At the global level, Malaysia's current commitment to meet the three major targets pertaining to the water sector are as follows:

i) Sustainable development goals 2030
ii) Sendai framework for disaster risk reduction (2015–2030), and
iii) Malaysia's climate commitment at COP15 (2009)

3.1.1.1 Sustainable Development Goals (SDGs) 2030

The United Nations had declared that the Sustainable Development Goals are a "universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere" (https://www.undp.org/content/undp/en/home/sustainable-development-goals.html downloaded on 22 July 2020). The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. Although SDG 6 on "Clean Water and Sanitation" ("Ensure availability and sustainable management of water and sanitation for all") (Box 3.1) relates particularly to the water sector, all the other 16 SD Goals are related as not achieving one target invariably affects the other targets.

SDG6 is to ensure availability and sustainable management of water and sanitation for all with 6 Outcome Targets to be achieved (Box 3.1). Amongst the targets under SDG No. 6 to "Ensure availability and sustainable management of water and sanitation for all" is Item 6.5 which states that ***"By 2030, implement integrated water resources management at all levels, including through trans-boundary cooperation as appropriate".***

Box 3.1. Sustainable development Goal 6

Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all	
6.1.	By 2030, achieve universal and equitable access to safe and affordable drinking water for all
6.2.	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
6.3.	By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
6.4.	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
6.5.	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
6.6.	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
6.a.	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
6.b.	Support and strengthen the participation of local communities in improving water and sanitation management

In two national surveys, first conducted in 2017 and subsequently again in 2020 (GWP-UNEP-DHI, 2021) to fulfil UNEP's requirements of monitoring global achievements in IWRM, the results achieved, shown in Box 3.2, indicate a vast improvement in sectional average scores as well as in the national score in 2020 over those achieved in 2017. The 2020 average score of 63 places Malaysia in the "medium-high" Category (51 – 70) interpreted as "Capacity to implement IWRM elements under long-term programs generally adequate". There is of course room for much improvement in Malaysia's efforts to raise its global standing by 2030 to the "very high" Category (91 – 100).

The 2021 Global World Partnership (GWP) and UNEP-DHI Report, entitled "**Progress on Integrated Water Resources Management (IWRM) in the Asia-Pacific Region: Learning exchange on monitoring and implementation towards SDG 6.5.1"** recommended undertaking the following five Actions "to accelerate IWRM implementation in the Asia-Pacific region at all levels and across dimensions":

1. Develop or accelerate the passing and full implementation of critical laws for water, environment and natural resource management that reflect principles of sustainable water resources management through sensitising political leaders, prioritising legislative processes, and engaging stakeholders.
2. Harmonise and align cross-sectoral, interagency policies and coordination structures.

Box 3.2: Malaysia's Sustainable Development Goal 6 Achievements in Respect of IWRM Implementation

Section	Av. Score (2020)	Av. Score (2017)
1) Enabling environment	76	46
2) Institution and participation	65	47
3) Management instruments	58	47
4) Financing	52	32
_____	_____	_____
Indicator SDG 6.5.1 Score	**63**	**43**

3. Establish, deepen, or expand stakeholder participation in water decision-making and IWRM implementation and ensure stakeholders from all levels are engaged. For example, at the sub-national and basin level, including local water management authorities, river basin council committee members, water users, private sector, farmers, local communities, vulnerable groups, and indigenous communities.
4. Create robust, transparent, unified platforms and mechanisms for data capture, and information sharing at all levels within (and between countries)1 and ensure open access to data.
5. Build, strengthen and expand partnerships, including with the private sector, to unlock new co-financing opportunities.

The absence of a national IWRM Plan was one of the main reasons for the slow progress of IWRM national-wide. Therefore, ASM's initiative in formulating such a plan contained in the two-volume publication entitled "Transformation of the Water Sector: National IWRM Plan – Strategies Road Map", released in 2016, was indeed timely and tailored to enable the country to implement the plan to meet the SDG targets by 2030. It is noteworthy that the NIWRMP (ASM, 2016), in conforming to the IWRM General Framework, had recommended actions similar to Action 1, Action 2 and Action 3 described by GWP as listed above, especially with regard to the elements pertaining to "Enabling Environment", "Institutional Framework" and "Management Instruments".

The WST2040 initiative launched by EPU in 2020 is all the more significant because under the first phase it aims at accelerating the implementation of the IWRM Plan during the upcoming 12th MP (2021–2025) which conforms to Action 1 in the list described by GWP/UNEP-DHI above, while the two sub-sector studies on IWSDC and AWF, respectively, are focused on Action 4 ("creating robust, transparent, unified platforms and mechanisms for data capture, and information sharing at all levels within and ensure open access to data") as well as Action 5 ("Build, strengthen and expand partnerships, including with the private sector, to unlock new co-financing opportunities").

According to the DOSM website (Department of Statistics Malaysia Official Portal (dosm.gov.my), accessed on 16 Dec. 2020), in July 2015, the Department of Statistics, Malaysia, was officially appointed as the focal point to coordinate the SDG data collection during Main Users Committee No.1/2015. The main role of focal point is to coordinate the compilation of SDG indicators from various ministries/agencies.

1 The phrase "and between countries" is shown in brackets by the WST2040 Report Writer to denote that it is not applicable to Malaysia

In September 2015, the Department of Statistics, Malaysia was appointed as a member of the High-Level Groups on Sustainable Development Goals (HLG-SDGs) meeting representative of Malaysia and the Asia Pacific region. The HLG-SDGs consist of 22 countries and were established to set the strategic direction in the development of SDG.

The Department actively participated in providing the proposed indicators to the Philippines; the representative of Inter-Agency Expert Groups on Sustainable Development Goals (IAEG-SDGs) for the Asia Pacific region. The IAEG-SDGs was established with the objective of developing indicators for SDG goals and targets.

The DOSM-identified Indicators are shown in Table 3.1. In 2020, DOSM had published its overall SDG findings (DOSM, 2020) as well as those related to SDG 6 are also shown in Table 3.1.

3.1.1.2 Sendai Framework for Disaster Risk Reduction 2015–2030

The Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework (2015)) was the first major agreement of the post-2015 development agenda and provides member states with concrete actions to protect development gains from the risk of disaster (https://www.undrr.org/implementing-sendai-framework/what-sendai-framework).

The Sendai Framework works hand in hand with the other 2030 Agenda agreements, including The Paris Agreement on Climate Change, The Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda, and ultimately the Sustainable Development Goals. It was endorsed by the UN General.

Assembly following the 2015 Third UN World Conference on Disaster Risk Reduction (WCDRR), and advocates for:

i) The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.
ii) It recognises that the state has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including Local Government, the private sector and other stakeholders.

3.1.1.3 Malaysia's Climate Commitment at COP 15 (2009)

Malaysia intends to reduce its greenhouse gas (GHG) emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. This consists of 35% on an unconditional basis and a further 10% is conditional upon receipt of climate finance, technology transfer and capacity building from developed countries (INDC - Submissions (unfccc.int). The first full year of report will begin from 2021, as shown below, with assessment to begin in 2022.

Base year: 2005

- Emissions in the base year: 288,663 Gg CO_2eq[2]
- GDP in the base year (constant price at 2005): RM 543.578 billion
- Emissions intensity of GDP in the base year: 0.531 tons CO_2eq per thousand RM
- Time Frame for Implementation – 10 years (2021 –2030)

3.1.2 National Targets and Key Performance Indices (KPIs)

For the national targets, there are eight targets that fall within the time frame of WST2040. These are the Shared Prosperity Vision 2030, Green Technology Master Plan (2017 – 2030), Communications and Multimedia Blueprint (2018 – 2025), Kuala Lumpur Tourism Master Plan (2015 – 2025), Malaysia Shipping Master Plan (2017 – 2022), Malaysia Education Blueprint (2013 – 2025), National Ecotourism Plan (2016 – 2025) and National Action Plan for Nutrition of Malaysia III (2016 – 2025).

2 Emissions in the base year includes emissions from land use, land use change and forestry (LULUCF) which have been estimated at 25,667Gg CO2eq respectively

Table 3.1. SDG 6

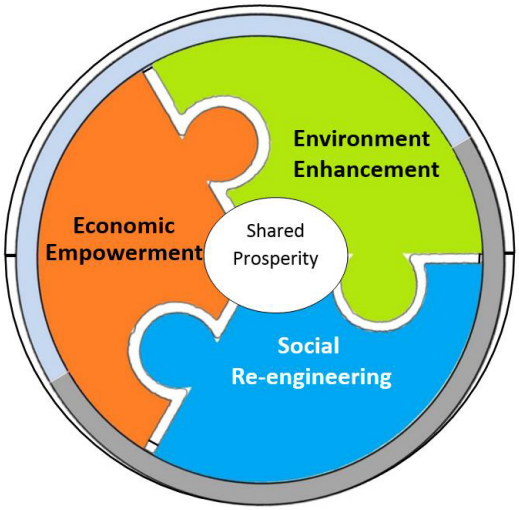
Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all			
No.	**Goal Description**	**Indicator**	**Findings**
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Indicator 6.1.1: Proportion of population using safely managed drinking water services	Total: 95.7% Urban:95.3% Rural:94.3%
6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Indicator 6.2.1: Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	2016: 99.7% 2019: 99.7%
6.3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Indicator 6.3.1: Proportion of wastewater safely treated Indicator 6.3.2: Proportion of bodies of water with good ambient water quality	*Partially Available, Need Further Development 2017: 90.0% 2018: 95.0%
6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Indicator 6.4.1: Change in water-use efficiency over time Indicator 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	*Partially Available, Need Further Development *Partially Available, Need Further Development
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	Indicator 6.5.1: Degree of integrated water resources management implementation (0-100) Indicator 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation	*Partially Available, Need Further Development 2018: 3.4% 2019: 3.4%
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Indicator 6.6.1: Change in the extent of water-related ecosystems over time	*Partially Available, Need Further Development
6a	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	Indicator 6.a.1: Amount of water-and sanitation-related official development assistance that is part of a government-coordinated spending plan	*Not relevant
6b	Support and strengthen the participation of local communities in improving water and sanitation management	Indicator 6.b.1: Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	*Partially Available, Need Further Development

* Remarks in DOSM (2020)
Source: DOSM (2020)

i) Shared Prosperity Vision 2030 (SPV 2030)

The launching of Malaysia's new development blueprint of SPV 2030 (MEA, 2019) on 6 Oct. 2019 by YAB Prime Minister is aimed at developing a fair and equitable distribution of economic development at all levels by 2030 and will be operationalised through the 12th MP (2021–2025) and the 13th MP (2026–2030). The launching of SPV 2030 therefore reaffirms Malaysia's continued commitment in implementing SDG 2030 in tandem with the next chapter of development towards becoming a competitive and inclusive high-income nation, emphasising a people-centric approach as one of the most vital elements towards pursuing sustainable economic growth (Figure 3.1).

Figure 3.1. SPV 2030 and the three Primary Objectives



The operative word here is "sustainable" and the Transformation of the Water Sector dovetails clearly into the SPV 2030. The SPV 2030 had identified 15 Guiding Principles with "sovereignty and sustainability" as one of them, directly related to the water sector. Underpinning the 15 Guiding Principles are seven strategic thrusts. The key Strategic Thrust 7 on "social capital" is relevant to the water sector, whereby the target to be achieved is the "environmental and climate change index".

SPV 2030 aspires to have the following directions which directly impacts the water sector:

a. Better structuring of and improving the nation's business and industry ecosystems such as via adoption of IR 4.0
b. Application of digital economy and adding more high skilled jobs and competent workers
c. Strengthening social well-being through needs-based policies
d. Reforming human capital, to improve labour market and wages, thereby improving society income
e. Exploring new growth sectors, and turning Malaysia from a consumer nation to one that produces international standard products
f. Inclusive territorial development

ii) Green Technology Master Plan (2017 – 2030)

The Green Technology Master Plan (GTMP) is fundamentally an outcome of the 11th MP(2016–2020) which has earmarked green growth as one of six game changers altering the trajectory of the nation's growth. The GTMP creates a framework which facilitates the mainstreaming of green technology into the planned developments of Malaysia while encompassing the four pillars set in the National Green Technology Policy (NGTP) i.e. energy, environment, economy and social.

The first edition of the GTMP focuses on six key sectors, namely energy, manufacturing, transportation, building, waste and water and attempts to harmonise the policy directions of each sector towards a common goal of sustainable utilisation of natural resources.

The green technology goals established for each of these sectors will be progressively realised and fine-tuned in the policies and actions developed in every five-year National Development Plan period (GTMP 2017 – 2030).

For the water sector, the GTMP document states that the government has put into place several initiatives to address the whole water continuum from resource use to distribution, utilisation, recovery and treatment. Emphasis has been on shifting towards a closed water loop system, water efficient products and services, as well as intensification of R&D&C on water conservation, treatment, distribution and rainwater harvesting.

Some of the challenges highlighted include the lack of funding for R&D&C, slow shifting of the industry and consumers towards water efficient products and services, inadequate use of analytical tools and detection technologies to address issues related to inefficient network distribution and end-user consumption. Recommendations have focused on the adaptation and adoption of suitable technology to facilitate efficiency and optimisation of scarce water resources, improved and cheaper treatment options and migration to a closed water loop system. The targets and KPIs affecting the water sector in GTMP are shown summarised in Box 3.3.

Box 3.3. GTM plan targets and KPIs affecting the water sector

SECTORS /AREAS	INITIATIVES		
	2020	2025	2030
Integrated river basin management	-	10% (freshwater abstraction rate)	15% (freshwater abstraction rate)
Water treatment and distribution technology	-	25% (NRW)	-
Water harvesting technology	60% of towns in Malaysia installed with Rainwater Harvesting Systems	-	-
Wastewater treatment	-	-	100% (sludges to be recycled) 33% treated effluent to be recycled

Source: GTMP (2017 – 2030)

iii) Communications and Multimedia Blueprint (2018 – 2025)

The Communications and Multimedia Blueprint (2018 – 2025), launched by the Ministry of Communications and Multimedia, covers the period from 2018 to 2025 (essentially until the end of the 12th MP). The objectives of C&M Blueprint are 3-fold:

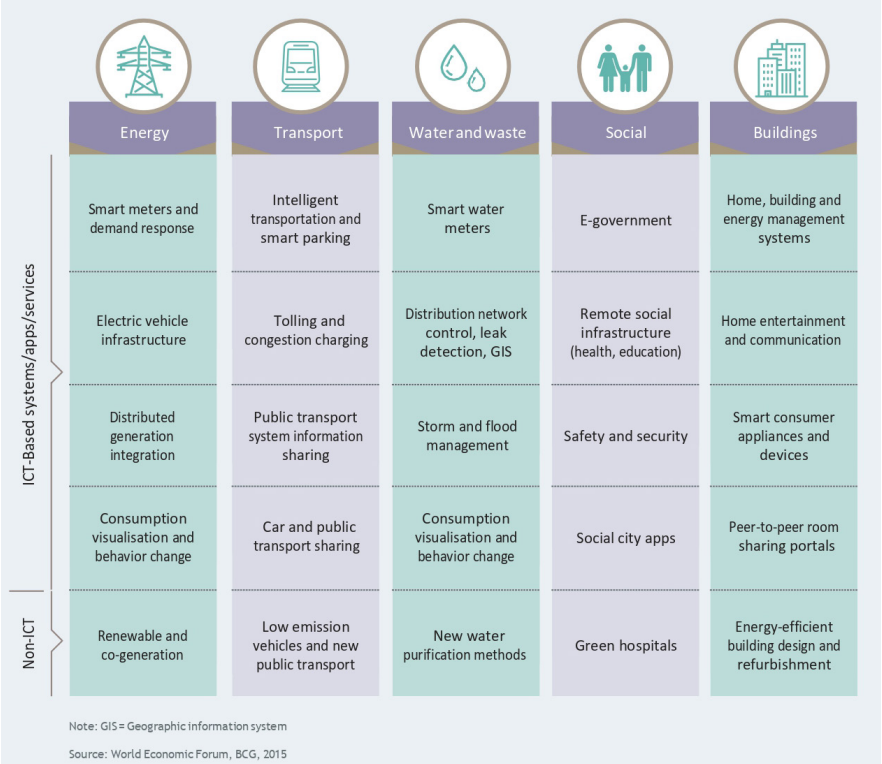
a. To position the C&M sector for sustainable growth amid digital disruption and broader technological advancement;
b. To accelerate the growth and transformation of other sectors of the economy; and
c. To create a connected, informed and empowered society.

It is noteworthy that these three C&M Blueprint Objectives dove-tell fairly closely with the twin Objectives of the WST2040 (that is, Water Security and Sustainability and Water as an Economic Opportunity) as well as the Strategic direction of the 13th MP ("uplifting indigenous technologies at part with international standards").

Of the six strategic thrusts, the second strategic imperative addresses "strengthening trust". This thrust looks at the risks to the Critical National Information Infrastructure (CNII) sectors of which "water" is one such sector of nine sectors. The third strategic imperative is intensifying engagement, whereby smart services is the focus of this imperative, which encompass "smart cities, smart communities, and smart waste" and other government and private sector-delivered services (Figure 3.2). Amongst the smart city

applications, the use of ICT-based systems/apps/services is shown in Figure 3.2 for "water and waste" while non-ICT service is cited for "new water purification methods".

Figure 3.2. An example of smart city application in the water and waste sector



(*Source*: C&M Blueprint 2018 – 2025)

iv) Kuala Lumpur Tourism Master Plan (2015 – 2025)

In the Kuala Lumpur Tourism Master Plan (2015 – 2025), nine tourism segments and enablers were identified, of which the water-related segment was the "Nature and Adventure" segment. Four Initiatives were identified as follows:

a. Enhancing city parks to become tourist attractions
b. Building and promoting industry capabilities and joint promotions
c. Preserving, nurturing and promoting nature and biodiversity, and
d. Building eco-adventure clusters and offerings

As part of these four initiatives, the Titiwangsa Lake Gardens and Kepong Metropolitan Park (with its large lake) for water-based activities were identified. It should be noted that both lakes were actually former tin mining ponds. The River of Life (Sg. Kelang) was cited as nature and adventure tourism offerings.

v) Malaysia Shipping Master Plan (2017 – 2022)

In perusing the Master Plan, it was noted that, under its Chapter 4, laying the foundation for the future, "water" was only mentioned, under governance, as "discharge of ballast water". This is an important matter nevertheless because ballast water is a potential carrier of pollutants and invasive species. No mention unfortunately was made on the sale of treated water (a massive economic potential) to ships calling into Malaysian ports.

vi) Malaysia Education Blueprint (2013 – 2025)

The Malaysia Education Blueprint (2013 – 2025) highlights in its Shift 6 ("Empower Jabatan Pendidikan Negeri, Pejabat Pendidikan Daerah and schools to customize solutions based on needs") an important target of "Ensuring 100% of schools meet basic infrastructure requirements by 2015, starting with Sabah and Sarawak" which is "access to clean treated water, along with sufficient toilets".

vii) National Ecotourism Plan (2016 – 2025)

In the National Ecotourism Plan, five focus areas were identified. The first focus area, "investment in ecotourism" had identified three strategies. The third strategy ("Refining existing investment facilitation programmes comprising fiscal incentives, one-off grants and micro credit facilities specific to the needs of ecotourism operators") had identified eight actions. The fourth action is relevant to the water sector in that it endeavours to recognise eco-lodges that"recognises innovations and adherence to sustainability principles". In this part of detailed Action 4, eco-lodges by using green technology criteria, (such as, "by using electricity and water-saving equipment", "Utilising sustainable technology for water and electricity", and "by using environmentally-friendly sewage and solid waste system) will be recognised for eco-lodges star rating".

Under detailed Action 5, development in areas adjacent to keystone sites that are facing significant development pressure, such as mangroves, wetlands and rivers, need to have "design briefs and design guides for non-protected areas".

vii) National Action Plan for Nutrition of Malaysia III (2016 – 2025)

The Ministry of Health's National Coordinating Committee on Food and Nutrition (NCCFN) had identified one of their six enabling strategies as "Promoting Healthy Eating and Active Living". It was reported that, in the National Health and Morbidity Survey study 2015, only 44.3% of adults drank 6 – 8 glasses of water a day. It is the aspiration of this action plan to raise at least 65% of adults meeting the target of drinking 6 – 8 glasses of water a day by 2025.

ix) Summary of Findings of the Master Plans/Blueprints

Except for the Green Technology Master Plan ending in 2030 (end of 12th MP), the other six MPs/blueprints/action plans expire in or before 2025. The targets described in each of the MPs/blueprints/action plans can be achieved with the full cooperation of all concerned as well as sufficient resources are made available and the actions to achieve the targets are monitored closely and regularly, not just by the Ministry concerned, but also by EPU (Table 3.2).

Table 3.2. Summary of targets to be achieved by year targeted

No.	Master Plan/Blueprint/ Action Plan	Target(s) Listed	Target Year
1	Green Tech MP (2017 – 2030)	(i) Rainwater harvesting installed in 60% of towns (ii) 10% abstraction rate (iii) 15% abstraction rate (iv) 25% NRW (v) 20% NRW (vi) 100% wastewater sludge to be recycled (vii) 33% treated effluent to be recycled	(i) 2020 (ii) 2025 (iii) 2030 (iv) 2025 (v) 2030 (vi) 2025 (vii) 2025
2	Communications and Multimedia Blueprint (2018 – 2025)	(i) Smart water meters (ii) Distribution network control, leak detection, GIS (iii) Storm and Flood Management (iv) Consumption Visualisation and Behavior Change (v) New Water Purification Methods	2025
3.	Kuala Lumpur Tourism Master Plan (2015 – 2025)	(vi) Water-based Activities in Lakes (vii) River of Life Nature and Adventure Tourism Offerings	2025
4.	Malaysia Shipping Master Plan (2017 – 2022)	(i) Control of ballast water discharge	2022
5.	Malaysia Education Blueprint (2013 – 2025)	(i) Ensuring 100% of schools meet basic infrastructure requirements by 2015, starting with Sabah and Sarawak" which is "access to clean treated water, along with sufficient toilets".	2015
6.	National Ecotourism Plan (2016 – 2025)	Eco-lodges for star rating if using Green Technology criteria: such as: (i) water-saving equipment (ii) Sustainable technology for water and electricity (iii) Environmentally friendly sewage and solid waste system (iv) Mangroves, wetlands and rivers to have "design briefs and design guides for non-protected areas"	2025
7.	National Action Plan for Nutrition of Malaysia III (2016 – 2025)	It is the aspiration of this Action Plan to raise to at least 65% of adults meeting the target of drinking 6 – 8 glasses of water a day by 2025.	2025

3.2 A WHOLE-OF-GOVERNMENT AND WHOLE-OF-SOCIETY APPROACH IN THE WATER SECTOR: AN INTEGRATED APPROACH

Preamble: This write-up is included in line with the request made by EPU to describe the 8i's ecosystem approach. In addition, ASM decided to include descriptions on the 8R's, 5S's and the 10-10 *My*STIE as they apply to the Water Sector. The 10-10 *My*STIE technology mapping is applicable to any studies by ASM.

3.2.1 Introduction

A Whole-of-Government and Whole-of-Society approach to the water sector requires strong linkages between the three main aspects of the water ecosystem: (i) the enablers of the supply and demand of water; (ii) the water use mind-set of water suppliers and end-users; (iii) and the alignment of the sector's technological landscape with national development goals. Each of these aspects have been integrated into the water sector transformation process, whereby the enablers of the supply and demand of water are captured by the 8i innovation framework and five focus areas; the water use mindset is captured by the 8R Water Philosophy; 5Ss; guide the outcomes of the water ecosystem and the technological landscape of the water sector is captured by the 10-10 *My*STIE framework. Section 3.2.2 to Section 3.2.5 will first examine each of these aspects and the role they play in the water sector transformation. Finally, Section 3.2.6 will look at the intersection of these aspects and how their integration is key to turning the water sector into a dynamic economic sector.

3.2.2 8i Innovation Framework

To strengthen all eight enablers of the water ecosystem into a dynamic one, that is capable of being a vibrant economic sector, it is important to first understand the current challenges of the water ecosystem. The following is an overview of the gaps and potential solutions for each of the eight enablers raised by the sub-sectors that need to be addressed before the water ecosystem can be transformed into a viable and competitive economic sector.

i) Infrastructure

Current State of Play:

Many natural water ecosystems in the country do not use advanced technologies to manage and monitor the quality of water supply. As such, many of them are poorly managed and this impacts the quality of water supply and the down-stream industries that are dependent on the water supply. Lack of sophistication in the water infrastructure and fragmentation of the national water grid system also have several negative externalities and they include: lack of flexibility in meeting water shortage in many parts of the country, managing natural disasters, and mitigating risks associated to water contamination and pollution.

In rural areas and island communities, there is a lack of access to quality water services due to poor infrastructure. There are frequent disruptions of service due to limited water treatment plants. With the prevalence of flooding in Malaysia, drainage from sewage leads to bacterial contamination in wells, emphasising the importance of catchment management to ensure protection of current and alternative water supplies. In terms of water usage, there is low water use efficiency in irrigation which is important in ensuring food security while reducing greenhouse gas emissions. Poor application of recycle and reuse technologies in industries is also a major challenge where many are unwilling to invest in water efficient technologies due to low water tariffs and the high cost of adopting these technologies.

Way Forward:

The water infrastructure needs major upgrading and expanding new sources of water supply to meet the basic needs of the people and industry. This will require many of the water basins to adopt advanced technology and knowledge management systems to derive better return on value (ROV) and return on investment (ROI). In this context, IWSDC will establish linkages to integrate data from various providers, set data quality standards and produce systems efficiency reports as well as incorporate space technology (with MySA) and data analytics technology to assist in decision-making.

Environmental policies also need to consider climate variability and the long-term impacts of climate change, including infrastructure such as dam construction and design. Initiatives that can be taken in academia include establishing websites related to water resources management, showcasing project-based learning (PBL) activities leveraging on the advanced technology infrastructure. Higher education institutions (HEIs) and research institutions can develop interactive tools that intensify the development and adoption of smart water infrastructure.

Priority should also be given to developing the service sector for groundwater, including the mineral water industry. It is important to utilise groundwater as a supplement for surface water to prevent disruption of services. Smart infrastructure forgroundwater mapping and assessment, metering, licensing, monitoring of groundwater extraction and recharge, hard-rock aquifer delineation needs to be deployed to support the integrated aquifer system management. Furthermore, measures to improve safe drinking water supply include upgrading water treatment plant and improving water quality parameters monitoring instruments. Alternative water sources should be improved in all states and more facilities for a better capture of water, particularly rainwater harvesting. Storm-water reuse could lead to a significant reduction in consumption. Groundwater utilisation for agriculture use and emergency use should also be developed. To make this a reality, detailed groundwater assessment studies should be conducted to allow groundwater use in emergency situations with priority given to major urban areas in relatively dry regions. Approaches such as innovation of planting techniques that use less water and adopting more water efficient technology especially in industry, agriculture and mining sector are important. There should be greater investments in smart farms and intelligent farming methods to ensure consistent quality of crops planted, requiring

less water usage. Lastly, attractive schemes to upgrade technology and the review of water tariff by state governments should be conducted to encourage the usage of technology in enhancing careful water utilization. A competitive water tariff will also increase greater private investments in the sector, particularly, jointly developing the water smart grid infrastructure with government.

ii) Infostructure

Current State of Play:
The digital architecture is becoming increasingly important for ensuring greater efficiency and enhancing greater network externalities in the water sector. The digital ecosystem in the water sector is still in its infant stage; hence, will require major investments to raise the quality of service and economic outcomes. The water infostructure is still not integrated and not designed to produce seamless flow of information for strategic decision-making and effective management of the water ecosystem. Data are scarce and scattered, lack of coordinating mechanism (no data repository) and accessibility. This impacts the quality of the data, and decision-making process. Hence, there is an urgent need for a review of the digital ecosystem in the water sector. This includes ensuring a systematic and integrated development of the water infostructure across all the water basins. Lack of an integrated digital plan for the water ecosystem has rendered managing natural disasters such as floods, landslide, including man-made disasters such as pollution a challenge. These challenges in developing a comprehensive digital ecosystem for the water sector can be traced back to the absence of partnership between government agencies, private sector, community organisations, institutions of learning and local communities that reside near the water basins of the country. Weak digital ecosystem has resulted in poor surveillance system and early warning system and lack of preparedness in facing flood and climate-related events, especially in the least developed states.

Way Forward:
IWSDC aims to establish linkages between the databases developed by different departments to integrate data and produce strategic reports to fill the gaps in water management spectrum. IWRM approach entails the creation of a comprehensive data sharing framework to ease decision-making processes. Other potential initiatives towards infostructure enhancement include the development of a common platform for government officials and relevant stakeholders' engagement. Furthermore, continuous RDIC (research, development, commercialisation, and innovation) for National Integrated Data Bank will be the key driver to accelerate the implementation of IWRM and effectively facilitate decision-making.

Data sharing with built-in security will be useful for complex analysis and relations between multiple stakeholders to mitigate risks that impact water supply systems. There is a strong need to develop a national groundwater database with a well distribution map, from regulator, state, federal and government agencies. Although groundwater is an alternative water source, it is susceptible to deterioration/pollution during flood events, thus similar studies are needed for other parts of Malaysia, especially those that are flood-prone to substantiate vulnerability assessment. A dedicated Groundwater Research Centre to study impact of climate change on aquifer depletion, saltwater intrusion, and aquifer recharge, should be established to collect data, study on aquifer recharge, develop groundwater innovation and industry clusters as well as develop centres of groundwater excellence in local academia. The groundwater quality monitoring network should also be capable to detect saltwater intrusion in coastal aquifer and act as mitigation and rehabilitation for impacted aquifers. These initiatives will be a significant contributor to the National Integrated Data Bank for groundwater knowledge.

In addition, environmental health indicators should be developed to identify pollutants and measure water quality during water crisis and disasters with real time monitoring and the introduction of a surveillance system to detect environmental burden. Initiatives that can be taken include to establish real-time flood forecast hazard map, introduce impact base forecast as a new tool for early warning for public and frequent update of land use and state of rivers and other water resources in the country. Emerging risks from pollutant mobilisation in flood-susceptible areas can be overcome by identifying catchment areas that are susceptible to legacy pollutants and inclusive adaptation measures through potential risk assessment. It is essential to analyse climatic data to determine the potential impact of floods, dry spell or sea level rise so adaptation measures can be developed. To curb water issues during dry spells for irrigation, a guideline and early warning system should be developed for the reservoir operation for water demand management.

Overall, the digital ecosystem is critical to ensure seamless flow of information to all stakeholders in the water ecosystem for strategic decision to ensure the water resources of the country is managed effectively, translating to better return on value (ROV) for society and industry.

iii) Intellectual Capital

Current State of Play:
Access to information and knowledge are important drivers for sustainable development of communities and industries. While Malaysia has embraced a knowledge intensive society, the water sector has remained a low user of knowledge. There is a lack of understanding of the value of water amongst all segments of the population. As such, water resources in the country have been taken for granted and has been prone to wastage and the water basins have been a source of contamination and pollution. In many instances, the water resources have been treated as a garbage dumping ground by people and industry. Lack of civic consciousness on the value of these water basins have resulted in many rivers and other water resources being contaminated and source of constant water disruptions. The state of the current water sector is attributed to low investments in education and training to nurture the next-generation leaders who will harness, manage and derive better return on value from the water resources of the country. In the nation's endeavour to transform the Malaysian water sector into viable economic sector, "knowledge", which includes civic consciousness on the value of water, innovative ideas, information and best practices related to water must be capitalised. However, Malaysia is currently facing a talent shortage in the water sector, characterised by a lack of high-skilled labour force in key focus areas that are essential to transform the water sector into a knowledge-driven sector.

A knowledge intensive water sector will require talent with sound understanding of the value of water to society aligned to the 8R Water Philosophy[2]; the types of technologies required to improve efficiency in the management and delivery of water supply to all stakeholders; undertake risk assessment to address climate change, natural and man-made disasters to the water supply; and, develop innovative regulations, standards, incentive systems, financial and business models to derive better return on value and investment (ROV and ROIs) from the water resources in the country. Due to the lack of investment in the above skillset, there has been a mismatch in the supply and demand of talent in the water sector. As such, the water sector has remained at the lower end of the innovation and economic value chain. This mismatch can also be attributed to the lack of specialised training that has increasingly require multidisciplinary skills, encompassing expertise in engineering, information technology, bioscience, business management and entrepreneurship.

One of the major challenges that the public sector faces in retaining institutional memory and building deep and strong knowledge capabilities in the water sector, is the regular movement of expertise across government ministries and agencies. Further, the problem is exacerbated by inability of the sector to attract some of the best talent and potential for brain-drain to other sectors in the economy or more attractive overseas employment opportunities.

Way Forward:
To promote intellectual capital development, the training programmes in the water sector should be kept current and tailored based on the role of firms, consumers, and other stakeholders aligned to the 8R Water Philosophy and Circular Economy framework. The different taskforces in this study have put forward training programmes that aims to address the issue of talent deficit in the water sector. Given the close linkage between the water, food, and agriculture sectors in terms of security and sustainability, WFE Nexus has called for education on the nexus approach to be provided to all stakeholders. AACB has proposed programmes such as IWRM training and disaster risk reduction which are mainly targeted at civil servants. Besides, AACB also stressed on the importance of capacity building and continuous improvement in areas such as communication skills, river care knowledge, environmental subjects such as ecology, general organisation and management skills and others in related fields. IWSDC aims to develop dedicated personnel in the data technology and water sector while CCIA envision for skill and knowledge sharing between different government agencies, academician, groundwater users and international experts.

2 See Section 3.2.4 for description of 8R Water Philosophy

Lastly, water footprint also needs to be promoted as a priority research area by showcasing its potential socioeconomic benefits. Educators should also include the importance of rivers and river basins, inculcate local values in promoting sustainable water resources management in their teachings aligned to the 8R water philosophy.

vi) Integrity

Current State of Play:
In Malaysia, fragmented and siloed water resources management, and lack of digitalisation of water resources management systems led to low transparency and accountability in the water industry. These data conundrum can be attributed to the absence of a 'Rights to Information Policy and Law' in Malaysia. Besides data availability, the lack of a quantifiable water governance tools such as water accounting also poses significant challenges towards ensuring the integrity of water activities.

Way Forward:
The current AACB training module aims to enhance leadership roles of civil servants to facilitate enforcement of policies and laws for better water governance with an aim to digitalise its training modules moving forward. Some strategies that can be taken in academia to aid in closing the gaps include the development of a guidebook on water sustainability, compile local and international case studies on the best practises of river/water management and success stories related to water resources management in HEIs (public and private). In the future, key legislations and regulations related to IWRM/IRBM should be improvised and publicised. There should be an Interim Data Sharing Agreement between IWSDC and data providers while proposing water data to be included in Amendment of Statistics Act 1965. It is also essential to implement rights to information policy and produce Annual Water Security Report and Annual Water Accounting Report.

Lack of specific policy that support Water Footprint (WF) in Malaysia, whereby WF is not perceived as a priority issue amongst industries, is a reflection that many basic water issues have remained unresolved. These can be overcome by conducting review on WF studies and global policy and initiatives, inclusion of WF components *in Dasar Air Negara*, formulating appropriate policies, incentives, and penalties. There also exists different school of thoughts in conducting WF research which leads to fragmentation of various WF initiatives and a lack of interest amongst industries to implement WF labelling scheme. A water manager certification programme and initiatives to accommodate different school of thoughts in WF by adopting hybrid methods alongside awareness enhancement programmes are steps that can be taken to address this challenge.

Although the National Water Resources Policy (2012) has incorporated actions to protect surface and groundwater connectivity, these measures taken thus far are insufficient in addressing these issues. Therefore, appropriate plans drawing on a comprehensive inventory are required for protection of the groundwater resources and recharge areas. Groundwater Policy needs to be developed and adopted nationwide. Moreover, there is a lack of standard and guideline to refer to, making it important to develop a standard on groundwater quality. With priorities shifting towards maintaining the environment, environmental considerations need to be integrated into policies, programmes, plans and project formulation as well as implementation. This can be done via conducting a comprehensive assessment process, considering social, ecological and health effects. Other water sources such as coastal ecosystems are vulnerable to climate change as the rise in sea level will lead to damage of infrastructure, degradations of agricultural areas, contamination of surface and groundwater and loss of biodiversity, and thus it is essential for continuous enhancement of existing policies and guidelines with latest findings from scientific studies.

The lack of integration of climate change adaptation and disaster risk management in national and sector policies and development plans are major hurdles in ensuring a secured and sustainable water supply. As a country dependent on surface water, many of the climate change issues are starting to have adverse impact on the quality and the supply of water in Malaysia. An integrated national policy on Disaster Risk Management (DRM) that takes into consideration the water security for the country will mitigate water-related disasters, disruptions, and risks. Therefore, it is essential to incorporate DRM into national development planning, evaluation, and implementation of the nation's IWRM framework.

v) Incentives

Current State of Play:
Incentives or the lack thereof determines the commitment level of the players in the water sectors particularly the water operators and industry players involved in the development and management of water resources. The two main disincentives facing the players in the Malaysian water sector are the suboptimal water tariff rates and the lack of funding for water-related R&D. Tariff is an important economic tool in regulating the behaviour of producers and consumers. Consumers are not motivated to use water efficiently given the low cost of water. On the supply side, due to the suboptimal water tariff rates, most of the water service providers in Malaysia are having difficulties even to recover their cost of operation. Infrastructure investments in water and wastewater projects are known to be highly capital intensive. Due to the low water tariff rates which in turn leads to a low rate of return of investment, investors do not find the water sector to be an attractive investment avenue. As a result, capital spending to upgrade or maintain water and wastewater treatment infrastructure in the country is inadequate.

On the issue of lack of R&D funding, there are very few research grants dedicated to water research despite the high socio-economic benefits that can be gained from contemporary research on water such as water footprint and WFE nexus. Funding from government and private sectors for water projects are either fragmented or event-based. These have resulted in lack of long-term research strategy and investment to nurture local scientific and technological developments. Moreover, there is also a lack of reward and recognition program for sustainable practices and adopting circular economy approaches such as the implementation of water recycling and reuse technology and the use of water-efficient products that could potentially reduce overall water demand.

Way Forward:
To ensure the sustainable operation of water service providers and quality water service, water tariffs must be adjusted to cover both operating and capital expenditures. The government must implement the Tariff Setting Mechanism (TSM) that leads to tariff rates increase and give an immediate boost to the water operator's revenue. It also sends a positive signal to the market that the water sector is on the path to full-cost recovery, and investment opportunities are emerging in the industry. Besides setting the optimal water tariff rate, other instruments such as payment for ecosystem services (PES), application of "polluter pays" principle, uniform pricing model for water resources and pollution taxes could incentivise consumers to be more cautious of the environmental impact of their consumption behaviours. More should be also done to identify financial resources and investment needs and to provide the incentives, especially to the private sectors to encourage investment in the water sector. Examples of measures that can be taken include extension of the license period of the public water supply system from three years to 10 years or more. Performance-based contract (PBC) is also an effective tool to incentivise the private sector to fund water projects, especially pipe replacement for reducing non-revenue water. The PBC model involves private investment to reduce NRW, and the recovered income from the reduced water loss pays back the project cost. The main feature of this model is that it is tied with the performance level promised by the private company.

As most water projects still depend on government funding through grants, continuous stream of funding particularly from the Federal government is crucial to ensure the successful project completion and the adoption of green economic approaches and nature-based solutions according to IWRM. A *Water Industry Fund* can be established to fund critical projects such as rehabilitation and restoration of river basin management, water resources assessment, groundwater development and management as well as training water experts to advocate IWRM and training of future water leaders. In addition, incentives such as lower interest rates or tax deductions for green certification should be awarded to organisations for the purchase and implementation of green technology and other environmental initiatives such as green water restoration. The adoption of sustainable use of water in green building and halal certifications will go a long way to modify corporate and consumer behaviour towards more responsible use of the nation's water resources.

vi) Institutions

Current State of Play:
There have been numerous institutional initiatives across academia, communities, public and private sectors to increase awareness on the importance of water management from the individual to the national level. However, understanding of the importance of water management remains low. Additionally, the existing fragmentation in institutional water governance has also weakened institutional authority, resulting in states being sceptical towards federal policies. The disconnect between state and federal government creates inconsistent regulations and enforcements such as in the case of water footprint requirements, which in turn discourages industry participation. Moreover, many state governments do not have a dedicated water regulatory body to handle matters related to water resource governance in the state and are not empowered with enforcement capability. On the issue of climate change, there is a lack of urgency and commitment from related agencies and ministries.

Way Forward:
Institutions such as local governments need to be strengthened with appropriate tools to monitor water quality and quantity aligned to the IWRM. This creates a strong on-the-ground presence that can track compliance, enforce rules and regulations, and disseminate important water management information to stakeholders at the respective localities. This bottom-up approach needs to be accompanied with a clear and consistent top-down IWRM strategy that is communicated across all water-related agencies and ministries.

If every state has a State Water Authority (along the lines of LUAS and other similar bodies in the country), this can be an effective way to integrate all the available resources from different agencies to deal with localised challenges faced by the state's river basins. Greater cooperation between Federal Government and State Government agencies at the river basin level could also build trust and officers' capacity to handle natural and financial resources.

The establishment of a water bank was also proposed due to the sheer size of funding requirement in the industry, which PAAB does not currently cover. This includes projects for water resources, flood mitigation, coastal erosion, sewerage, climate mitigation, water reclamation, amongst others. It has also been proposed that all existing water companies are to be consolidated under one operation for the purpose of cost reduction and achieving economies of scale.

Having an integrated IWSDC serve as a one-stop centre to consolidate and understand water and water-related data from all localities is also key to bridging the gaps in water management. These can be under the purview of a National Technical Water Committee that ties all water-related government agencies together and facilitate collaborations with the private sector and community organisations. Based on the discussions above, a virtual water & water footprint (VW&WF) centre that coordinates with the Department of Standards and KASA for competency programs is needed to get stronger buy in from state agencies to foster better VW&WF awareness and knowledge.

Furthermore, water needs to be prioritised as a national agenda with water-related diseases and disasters being included in discussions of health and security of the nation. The government has taken an important first step to place water resources under the National Security Policy. The next crucial step is that the measures accorded under the National Security Policy must be incorporated into the management, regulation, and legislation of all water resources in the country. This includes empowering water and environment-related agencies to take punitive actions against water polluters that endanger the public water supply. This will safeguard our national water resources, ensuring safe drinking water is always available by developing and updating clear SOPs to address emergencies such as breakdown of water supplies, pollutions, floods, droughts, and waterborne diseases. The coordinating and managing agencies for water need to also focus on future risks while responding to the current ones. There needs to be mechanisms in place to assess future risks and opportunities such as infrastructure wear and tear, more efficient water usage, water conservation and reuse, and easy access to alternative water sources such as rainwater. This will help future-ready and increase the resilience of the water supply sector.

vii) Interactions

Current State of Play:
At present, the level and quality of cooperation, collaboration and knowledge sharing between stakeholders are patchy and fragmented with overlapping roles and unclear rules of engagement. The existing interaction between industries and government in Malaysia is based on individual initiative as partnership have not been established due to a lack of coordination among state governments and there is no dedicated platform for collaboration amongst stakeholders. Fragmented interactions are also evident between stakeholders within the water sector (inter-sector, inter-jurisdictions) and ad-hoc interactions between RDIC stakeholders. Without strong inter-sectoral linkages, nexus approach which requires interaction of the water, food, and energy sectors for instance, might not be possible.

There is also a lack of awareness amongst the local community on water resource protection especially on the importance of groundwater as a water resource, whereby misconceptions about groundwater extractions are common. This problem is further exacerbated by the lack of participation of multilevel stakeholders for the governance of groundwater. There is an urgent need to foster awareness-raising activities and empowerment training in communities to inform the general public outside the water community about water-related challenges and its implications. However, educators themselves are also found to have low understanding on the issues of climate change and public health.

Way Forward:
Poor communication and linkages can be strengthened amongst stakeholders via an effective national platform. An integrated platform will facilitate partnerships between agencies and promote joint programmes amongst government sectors. These engagements will build cross-inter-and intra-organisational linkages, enhancing knowledge transfer and foster connectivity which in turn accelerate the implementation of IWRM.

There is a need for public and private sectors, civil society organisations and scientific research institutions to work closely to create opportunities for collaboration, and for business to integrate these values into their management practices. Governments should also intervene by forming strategic partnership with businesses, and industry and establish resource person directory within their regional network to enhance communication.

The successful transformation of the water sector cannot be achieved by any single party but instead requires cooperation and collaboration of multiple stakeholders. For example, participations from government agencies is required to incorporate Water Footprint (WF) agenda in laws and regulations, stronger interaction between government and WF professionals in establishing WF definition in laws and regulations, better coordination between federal and state government through IRBM's initiative and a national taskforce on WF research and implementation. To enable this, IWSDC has proposed an integrated formal stakeholder's platform, involving policy makers, government institutions and the public, provides commonly accepted data as basis for negotiations and propose linkages with all RDIC stakeholders.

A key solution to groundwater emerging issues is transitioning groundwater management to groundwater governance, which stresses the participation of multilevel stakeholders, involving scientist, policy makers, and endusers by considering each of their concerns on the freshwater supply with supervision from local governments. This reduces the burden of governments while ensuring sustainable groundwater resources management.

viii) Internationalisation

Current State of Play:
The water sector has the potential of becoming an international revenue earner for the country. This would require a mindset change in ensuring the water sector meet its international obligation on climate change and other international best practices and standards. A sound internationalisation strategy contributes to the sustainable development of the water sector through the adoption of global best practices by local players as well as supporting inward investment into the sector. Overall awareness and adherence to global best practices is low amongst key agencies, industry players and community organisation in the water

sector. At the organisational level, there is also a call for more international cooperation and capacity-building, as well as training and collaboration with the involvement of international experts. The lack of a global presence of Malaysia's water sector is also evident where participations in global platforms such as the water-food-energy network and water footprint is limited due to financial constraints.

Besides, local regulatory environment also present barriers towards the internationalisation of water sector. Due to absence of supportive regulations on open data legislation such as rights to information policy and law, adoption of open data initiatives according to international standards remains a challenge. The difficulty in establishing of a common data repository or knowledge database causes data collection and storage to be fragmented and confined by organisational structure. Local data on environmental health metrics, as well as water and climate change is also lacking causing Malaysia's records to be missing in many international databases. As the environmental and disaster risk profile is unique to a particular country, the lack of information and scenarios of individual country in public system further hinders regional cooperation and collaboration, including efforts and research to prevent climate change and disaster risks management. These challenges hinder the sector from moving up the global innovation and economic value chain.

Way Forward:
The need for a strong leadership to drive the internationalisation of Malaysia water sector is required given the large number of players in the sector. A strong leadership would provide clear direction in the implementation of standards, guidelines, or incentive structures which align the country with global best practices adopted in other countries such as the IWRM. Government officials and researchers involved in IWRM should actively participate in international networking and collaboration efforts to promote knowledge sharing and cross-country comparisons in the adoption and implementation IWRM. To this end, the National Research and Capacity Building institutes' endeavour to enter strategic alliances with renowned regional and international water research and training centres will bring mutual benefit to the involved countries. Government should also provide sufficient resources and funding to encourage Malaysian participation in reputed water-related international water fora to establish Malaysia's water agenda at international level and at the same time increasing the country's global presence.

On the policy front, establishment of Rights to Information Policy and Law is required and the adoption of Open Science concept should be promoted. National policies, legal and institutional environment should also be conducive to foreign investment with various financing instruments and mechanisms made available to foreign investors to invest in Malaysia's water sector. Other ways internationalisation can also be intensified include: (i) international cooperation in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies and (ii) Skill and knowledge sharing between different government agencies and academician with international experts. A strong commitment to meet international standards and best practices will have significant positive spill-over on the water sector in terms of intensifying multi-lateral knowledge and technology transfer, raising the quality of service and increasing opportunities for foreign investment and trade in international markets.

3.2.3 WST2040 Study Five Focus Areas

To ensure the water sector is a strong economic sector, both the supply side and the demand side of the water sector should be strengthened. A strong water ecosystem will impact the supply side in the following ways: increase the quality of water; raise the reliability of the supply of water; and improve the cost-efficiency and productivity in the water sector. On the demand side, a strong water ecosystem which produces high quality water will lead to the following: increase new markets, including virtual water markets, where economic agents are willing to pay a higher price for quality water. Further, the use of technology in the water sector will enable firms to enhance their market intelligence and market reach. This also increases the demand for locally developed water technology, education, and training programmes. Both sound supply and demand conditions can transform the water sector into an affordable and profitable sector, generating higher economic revenue and jobs for the Malaysian economy. WES sub-sector has consolidated the findings and mapped the 8i water ecosystem enablers from Section 3.2.1 onto the five Focus Areas[3] in the context of the supply and demand side of the water sector as below:

3 Refer to Figure 10: How the IWRM Focus Areas Map onto the 8i Framework in Volume 9: Water as an Economic Sector Sub-Sector Report.

1. People

Current State of Play:

Supply Side

There is a lack of people with specialised knowledge, technical, entrepreneurial and leadership skills in the sector to future-proof the sector with the rapid technological changes and increasing demand for high quality water. There is a serious shortage of graduates that have the necessary skills and many of them are not interested to work in the water sector. Many of the best talent are poached by other industries, far less, getting them to manage water basins in the rural area. As such the sector remains labour intensive and operate at the lower end of the value chain.

Demand Side

There is also a lack of awareness and civic consciousness amongst the general public on the importance of water resources in the country as a source of socioeconomic development: "*Tak tahu, maka tak cinta*" – there is a tendency for them to take the water resources for granted. There is also lack of training centres in many of the rural and remote areas which are located near the water basins. This poses problems in terms of training the local people with respect to best practices of water basin management.

Way forward:

Supply Side

Establish strong water research and training institutes to nurture the next-generation talent for the water industry. These include intensification of talent development in the STI areas that can transform the sector into a knowledge- and technology-intensive competitive economic sector. Adequate support should be given to colleges, polytechnics, technical colleges, and universities to nurture talent with specialised and multidisciplinary skills; including research capabilities and entrepreneurial acumen to transform the sector into a knowledge-driven and competitive sector. These training institutes must embed the 8R Water Philosophy[4] and the circular economy framework in their education curriculum.

To overcome the shortage of training centres across the country to support the industry, there is need to continuously review the curriculum of the courses and training programs. This is to ensure that the value of water (8R Water Philosophy and the circular economy framework[4]) is acculturated in the graduate attributes, whereby the talent competency of the next generation leaders who will develop this sector to a knowledge intensive and high-valued economic sector.

Transform the water training institutes in Malaysia to emulate that of Japan, Korea, and Singapore[5] to nurture the next-generation talent and technology for the water industry in Malaysia and other developing countries in the region.

Demand Side

The 8R Water Philosophy and circular economy framework needs to be embedded at all levels of water education, from school curriculums to public awareness and education campaigns, and industrial practices. This acculturation process is the foundation for building a more civic conscious mind-set to effectively manage end users. Instilling good civic consciousness (in all water resources and related water activities) and nature-centric values and principles will nurture a culture of cleanliness and respect for our water sources among end users - e.g., the Shinto culture from Japan on avoidance of *Kegare* (impurity or dirt)[6]. This will ensure a next generation of responsible and ethical consumers.

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4 See Section 3.2.4 for description of 8R Water Philosophy

5 Refer to Table 3.3 (page 196): Targeting the Five Focus Areas of the Water Ecosystem – Policy Strategies Comparison between Malaysia and Selected Benchmark Countries

6 The Shinto concept of *Kegare* is from Powell, S.J and Cabello, A.M. (2019), What Japan can teach us about cleanliness, BBC Travel, https://www.bbc.com/travel/article/20191006-what-japan-can-teach-us-about-cleanliness

2. Governance

Current State of Play:

Supply Side

Quality of institutions of governance (federal, state, and local council), including regulatory framework and standards bodies (that ensures transparency and accountability), and industry associations, community organisations, institutions of learning and research institutes vary significantly. Some are more advanced by using advanced technologies and digital governance systems, while others lag behind. The understanding on the value of water varies across the different institutions. These differences lead to fragmentation in policy planning and implementation.

While there are many players in the water sector, there is a lack of a **"Champion with Clout.**" Without an effective "Conductor", the water sector has been plagued by lack of coordination and harmony in policy direction, planning and execution. Politics often tend to get in the way to optimally manage the sector to be a vibrant economic sector.

Further, due to the different stages of development of the institutions (federal, state, local council, industry, and community organisations), the level and quality of cooperation, collaboration and knowledge sharing amongst the stakeholders are **patchy and fragmented**. In some instances, there exists overlapping roles amongst institutions; and rules of engagement are often not clearly articulated. As such water policy environment is rather complex and institutions tend to take a functional and silo approach, rather than a strategic and inclusive approach in managing the water resources. In some cases, turf wars amongst key stakeholder are prevalent.

The low use of digital technologies in managing the complex relations and facilitating the seamless integration of information hinders effective governance across multiple agencies, jurisdictions, and the public. Without sound governance systems underpinned by digital mechanisms, managing the complex relations between the multiple stakeholders remains a challenge. Lack of proper regulation and planning of data collection and dissemination has resulted in low levels of information sharing amongst institutions in the water sector. This further impede policy planning, implementation, and review cycles. The fragmentation in the governance system has resulted in the water sector's inability to create strong economic spill over impacts to other sector of the economy which are dependent on water for production processes. These gaps in the water governance system also led to challenges in managing and monitoring water basins, especially enforcement of pollution control of the water sources of the country. The constant water disruptions pose a major cost for firms and adversely impacts the quality of life of the people.

Weak governance systems also hinder the adherence to global best practices. This results in the water sector operating at the lower end of the global innovation and supply chain. The weak governance also adversely impacts the depth and breadth of international linkages with global centres of excellence and players from the global water markets. As such, the level of knowledge and technology transfers between local and foreign players are low. This negatively impacts the level of FDIs into the water sector. This also limits the potential for a strong export market for high value-added water-dependent products and services. Low external market innovation and market footprint have relegated the water sector to be a primarily domestic focused industry. As a result, the water sector has not been a major export earner for the country.

Demand Side

Several policies and strategies to fully transform the sector into a dynamic and competitive economic sector are not in place (e.g., competitive tariff/pricing policies, water trading rules, water footprint and virtual water, and other competitive market mechanisms) to attract private or foreign investments into the water sector. Due to the fragmented governance system in the water supply chain, the full potential of water as a vibrant economic sector has not been realised.

Way forward:

Supply Side

Establish an integrated water management institutional framework that will foster strong collaboration between government agencies (at the federal, state, and municipal levels), industry, and community organisations to work in partnership to better manage and harness the economic value of the national water resources. Fostering a **"Whole-of-Government & Whole-of-Society"** approach and establish a lead agency to champion water as a dynamic economic sector. The government has also taken an important first step to place water resources under the National Security Policy. The next crucial step is that the measures accorded under the National Security Policy must be incorporated into the management, regulation, legislation, and implementation of strategies for all water resources in the country.

Put in place an institutional architecture for a River Basin Organisation to manage the water ecosystem. Since some of the River Basin Organisation will overlap multiple states and jurisdictions, it is imperative that the complex relationships are managed using incentive-driven arrangements for federal, states, local council and industry to invest jointly in the development of river basins and obtain appropriate returns-on-investment. This **"win-win-win-win"** incentive for the federal, state, local council and industry will encourage all parties to work together to ensure more effective management of the river basin. All of which will benefit the rakyat and ensure the competitiveness and sustainability of the economic sectors that are dependent on water.

To ensure the complex relations between all stakeholders are managed effectively across the multiple jurisdictions, there is a need to intensify the governance systems using the best technology identified under the 10-10 *My*STIE framework to capture multiple spillover across the different economic sectors. These include taking a more **holistic and integrated approach** in setting the direction for the water ecosystem with respect to policy formulation and implementation to develop the enablers of the ecosystem (8i-enablers or the five focus areas).

Demand Side

The **'synergistic governance model'** should put in place strategies and policies to foster strong collaboration and partnership between government, research institutions, industry, and community organisations to create the multiplier effects in the water industry. These include ensuring the policies are business-friendly and conducive to attract foreign investment into the water sector. The governance system should also enable sharing of data and best practices by all stakeholders to effectively manage the demand for water. Other initiatives include fostering cooperation amongst key players to strengthen water-food-energy nexuses and the multiple players in other sectors of the economy to develop the virtual water markets. These include establishing a common platform (one-stop platform such as the Open Science Platform) for enhancing engagement, sharing of information and best practices amongst all players in the water sector.

Establish **'community champions'** in the various localities, who play catalytic roles to foster strong cooperation with key agencies and authorities to ensure effective management of the upstream and downstream water ecosystem of the country.

3. Finance

Current State of Play:

Supply Side

Fiscal and non-fiscal incentives are not competitive to foster R&D in the water sector. This has resulted in the low levels of development and adoption of new technology, innovation, and systems to enhance the competitiveness and sustainability of the water resources. There is a strong reliance on foreign technology by the local industry. The adoption of new technology, innovation, and systems are low and many of the firms in the industry are labour intensive. As such, this impedes the competitiveness and sustainability of water resources.

Demand Side

Further, the water tariff system is also not competitive enough to attract private sector or foreign investments into the water industry. Low water tariff rates also lead to sub-optimal use of water by consumers and

some economic sectors (e.g., agriculture and utilities). Firms and consumers are also reluctant to adopt innovative water saving technologies due to low profitability and high costs of these technologies. The water resources of the country are not used optimally and the demand for quality water and willingness-to-pay a higher premium for water remains low for the current state of the water sector. Therefore, the water sector is unable to derive higher value-added returns from the existing water resources in the country.

Way forward:

Supply Side

Increase the quantum of R&D funding for water related research aligned to the 10-10 *My*STIE framework. Priority investment should be given to the development of frontier technologies, experimental R&D, research personnel and development of collaborative platforms for research centres, industry, and community to foster strong translational STI spill over for the water industry. This will go a long way to move the industry up the global innovation value chain. The incentives should also be provided to industry to adopt locally developed non-polluting water technology and products. Further, government should be a key user of the locally developed water innovations and technologies.

Demand Side

Developing a **multi-tiered pricing/water tariff model** will also be critical for the sustainability of the water sector. A competitive water tariff system will encourage private sector participation and foreign investment into the sector, which can reduce public expenditure on water infrastructure and other related expenditures for the sector.

Other incentives include the introduction of "polluter pays" principle and pollution taxes to incentivise firms and consumers to be more cautious on the environmental impact due to their actions. Incentives in the form of tax deductions and subsidies should be given to firms and consumers who use environmentally friendly technology or products that reduce water pollution. Such financial support should be extended to economic agents who adopt the 8R Water Philosophy.

4. Information and RDIC

Current State of Play:

Supply Side

The use of ICT and Industry 4.0 technologies in the water sector is relatively low. The speed of internet connectivity in many parts of the country is slow, and thus it is not adequate to support Industry 4.0 capabilities and advanced ICT infrastructure. Obtaining real-time data is a challenge, which impedes knowledge sharing and obtaining market intelligence for strategic decision-making. Low levels of knowledge sharing using the digital platform hinders the sector from monitoring the quality of water, pollution and other negative externalities that impact the water basins in the country.

Demand Side

One of the major challenges faced by local industry is access to R&D funding to undertake research in the water industry. There is also lack of support for commercialisation of local water technology. The problem is further exacerbated by siloed research in the water industry due to weak 'quadruple-helix" (cooperation and collaboration amongst government agencies, industry, universities/research institutes and community organisations). Due to this, there is a low participation from industry in the uptake of research, development, and commercialisation of indigenous technologies.

Way forward:

Supply Side

Intensification in the use of digital technology in all segments of the water ecosystem value chain – the primary, secondary, and service sectors in the water industry is required. These include the use of technologies aligned to the 10-10 *My*STIE (which include 5G/6G, advanced intelligence systems, cyber-security and encryption technology, and augmented analytics and data discovery) to ensure that the sector has the enabling technologies to monitor, manage and obtain valuable market intelligence to create economic value for the sector. Further, the use of advanced technologies to manage the water grid and reticulation systems is required to enhance the quality and sustainability of the water delivery systems.

Demand Side

Greater alignment of R&D work undertaken in institutions of higher learning/research institutes and the water industry will go a long way to help bridge the chasm between academic research and translational outcomes that benefit the water sector. The Grand challenges funding by MOSTI is a great step in the right direction to address this gap; and institutions of higher learning should be encouraged to work with industry players to develop local technologies that meet the needs of the industry. These include technologies that are used to monitor water quality, water supply and potential risks of climate change and other natural disasters to the water basins. These initiatives have the potential to develop a strong local water-tech/aqua-tech industry. All these initiatives will have a direct impact on enhancing the demand for water services and indigenous water technologies.

The national water centre of excellence can also play a key role as a one-stop, end-to-end centre. The centre works in partnership with the National Technology and Innovation Sandbox (NTIS) and i-Connect initiatives to leverage on different stakeholder expertise and specialisations within the water sector that enable stronger synergistic innovations.

Having a water sector equivalent agency such as the Collaborative research in Engineering, Science and Technology Centre (CREST) for the electronic & electrical sector, can further build trust and enhance knowledge sharing amongst industry players, research institutions, and institutions of learning. The innovation-driven network externalities from these initiatives will lead to a stronger water-food-energy nexus and the virtual water sector. All of which will contribute to an increased demand for quality water resources and increase the economic value of water.

5. Infrastructure & Technology

Current State of Play:

Supply Side

The quality of the natural infrastructure (water basins - rivers, oceans, lakes, and other ground water sources) and physical infrastructure (dams, logistic supply chains and transportation systems) vary across the country. Many of these infrastructures are not STI-driven. The use of advanced technologies such as sensor technology, big data, data analytics systems, artificial intelligence and other technologies are low. Low use of advanced technologies amongst the water basins impedes firms from improving the productivity, efficiency, transparency, accountability, and accessing valuable market intelligence for strategic decision-making. The water grid system is also fragmented and are unable to transport water from water-rich states to states with low reserve margins. Weak infrastructure contributes to high non-revenue water (36.4%) and low reserve margins in some states in Malaysia (below 10%).

Demand Side

In many areas in the country, the infrastructures are old and fragmented. These limits the capability for the infrastructure to capture, treat and recycle rainwater. There is also a low use of technology to gather market intelligence on end users. This results in a high opportunity cost of not capturing key market data that are valuable in creating new market demand and opportunities for the water sector.

Way forward:

Supply Side

There is a need for a staged plan for the water basins in the country to adopt advanced STI (the application of 10-10 *My*STIE Framework) to raise the quality and sustainability of the water supply. These include replacing old and broken pipes with more durable and smarter infrastructure that enable water suppliers to continuously monitor and effectively manage the water supply. This includes continuously improving the quality of service and reducing NRW to below 10% by 2040.

The new infrastructure should also enable the expansion of alternative water supply, which include claimed water from sewage, rain-harvesting, ground water, recycling industrial effluent water, and more efficient water audit. All of this will increase the overall supply of water and potential revenue for the water sector.

A plan should also be in place for a more integrated national water grid system, consolidating the water supply system. These will enable more effective management of the national water supply, allowing the transfer of water from water-rich states to states that experience water shortages.

Demand Side
The downstream water system should incorporate intelligent water management systems, which enable the traceability (ability to trace the source of water and contaminants), harmony (balanced use amongst householders, industry, and the environment), sustainability (safe and reliable water services) and self-reliance (energy-efficient systems). Intelligent water apps and smart water meters are also needed to monitor real-time water usage by consumers. These technologies can help end users monitor their usage patterns and adjust their water consumption behaviours that will lead to more optimal use of water resources in the country. Effective management of the demand side of water is critical to reduce the nation's water consumption per capita from 245 litres per capita per day (LCD) in 2020 to 160 LCD by 2040.

The extension of the smart grid system to the region will open up new market opportunities for the Malaysian water sector with respect to creating a vibrant regional virtual water market by 2040. This will play a key role in transforming the water sector into a dynamic regional water hub contributing significantly to the Malaysian economy.

3.2.4 8R Water Philosophy and the Circular Economy Framework

A core philosophy that must underpin all national development plans, education and training programs is the *8R Water Philosophy*[7] that is embedded within a circular economy framework. Each of the water ecosystem enablers should carefully curate and integrate the 8R Water Philosophy and the circular economy framework to continuously strengthen the water ecosystem. Infusing the 8R Water Philosophy and the circular economy framework in every facet of the 8i Innovation Framework, the national water plans and national development plans that utilise water enables the transformation from the current weak and fragmented water ecosystem to a vibrant and dynamic one. The 8R Water Philosophy is as follows:

Respect water
Rethink the value of water
Reduce wastage of water
Re-Use used water
Recharge ground water
Recycle wastewater
Repurpose water for higher value use; and
Regenerate water.

These 8Rs will form the foundational conditions necessary for a circular economy where water is valued and respected. By incorporating the 8R Water Philosophy and circular economy framework into a cohesive demand management for water, it can nurture a population that recognises the potential threats to the country's water sources and the importance of water conservation. This people-centric foundation needs to be embedded across all the enablers of the 8i Innovation Framework and five focus areas to ensure a consistent and common philosophy for all water-related policies and decisions.

3.2.5 5Ss

The 5Ss guide the outcomes required from the water ecosystem transformation. A successful water sector in Malaysia needs to fulfil the 5Ss laid out below in order to satisfy the needs of all the stakeholders within the water sector and water-related end-users.

Safety – implies that the technology is used in accordance with global best practices, standards and regulations that ensure safe use for all stakeholders.

7 Adapted from the 8Rs of Recycling (Siegle, 2019)

Security – where it is vital for the nation to secure water as a resource and as a livelihood that satisfies basic community needs, economic opportunities, and advanced industry needs. Appropriate security protocols and measures need to be in place. Water security is designed to ensure safe use in all aspects of water, ranging from everyday water use, prevention of pollution and transboundary water related conflicts that may arise over water with water scarcity becoming one of the greatest challenges in some states in Malaysia and globally.

Safeguards – to adopt mitigative strategies that ensure quality and quantum of water which meet the needs of all stakeholders now and in future.

Seamless integration: to ensure a strong seamless institutional governance is in place, complemented with a comprehensive regulatory architecture to ensure sustainable development of the water sector. This means that there should be a collaborative platform where people and stakeholders can work together towards incorporating the 8R Water Philosophy, and thus fostering public-private-community partnerships.

Sustainable: implies the use of our water resources in a balanced manner to provide adequate water quantity and quality for multiple needs without compromising on the future needs. The enablers of the water ecosystem are developed to create positive spill over across the different sectors of the economy. This is to ensure that the water sector is a dynamic economic sector that is self-sustaining and a major contributor to the wealth of the country.

3.2.6 10-10 *My*STIE Framework

It is proposed that the water ecosystem adopt state-of-art technologies to increase its productivity and efficiency within the water sector and other sectors that are dependent on water. In this context, these technologies will not only help reduce water wastage, but also increase the value of the water and simultaneously ensure water security for all stakeholders.

In this section, the framework for transitioning the Malaysian water ecosystem to move up the socioeconomic value chain using the 10-10 *My*STIE framework is outlined. Application of the 10-10 *My*STIE within the water sector will help nurture local tech firms to lead the development of catch-up and leap-frogging technologies. Figure 3.3 and Figure 3.4 show some of the potential applications of such technologies. These *recombinant innovations*[8] will require the integration of the 10 global science and technology drivers outlined in the 10-10 *My*STIE Framework. Below are some examples[9] of how these technologies have impacted and revolutionised cross-cutting sectors and industries.

Agricultural Sector
Catch-up Technology[10]

1. **Advanced irrigation system, coupled with sensors to measure evaporation rate to establish irrigation amount, increasing productivity**

Utilising digital technologies to monitor micro-climate and soil moisture provides a simple and effective solution to enhance irrigation efficiency. The enhancement of irrigation efficiency not only conserves water and energy, but also improves the amount and quality of yield (Tabarelli, 2020). Specifically, sensor technologies are used to obtain information such as water infiltration rate (i.e., to ensure adequate drainage), crop water uptake (i.e., measured by soil moisture sensors), and evapotranspiration rate (i.e., tracked and calculated by weather station, which record measurements of temperature, wind speed, humidity, and solar radiation sensors; see Croptracker [2021] for more information on weather station mechanisms). Combined with of a clean water source and conveyance system, irrigation scheduling can then be performed.

8 Recombinant innovation is integrating existing STI drivers to create new applications and innovations.
9 Refer to Volume 9 Water as an Economic Sector Final Report for descriptions of all technologies included in Figures 3.3 and 3.4.
10 Current technologies in use by pace-setter industries and advanced countries.

With the access of important information such as daily water balance (i.e., derived from inputs such as precipitation, evapotranspiration, and irrigation data) and weather information from satellite, crop yields can be maximised (Tabarelli, 2020). For instance, corn requires ample moisture and minimal water stress within the active root zone to produce maximum yield, for example, studies have shown that diminishing root zone moisture stress can improve corn yield by 10% to 25%. Therefore, to produce optimal results from irrigated crop production, irrigators must be able to calculate water loss amount from root zone (Tabarelli, 2020). This is to deduce the optimum volume of water to be applied at the subsequent irrigation. With the ability to obtain, calculate, model, properly time and execute irrigation schedules, crop productivity can be maximised.

2. Improvement in physical-chemical water properties for magnetic treatment in agriculture

Besides reducing the amount of irrigation water needed, magnetic water treatment (MWT) is effective in improving crop yield, as well as enhancing soil quality and controlling erosion rate (Ali et al., 2014). In essence, magnetic treatment of water restructures water molecules into smaller clusters (i.e., into six symmetrical organised molecules), which is greatly different from the original form (i.e., a looser and more chaotic organisation form). In addition to enabling an easier passageway into plant cell membranes, magnetic water (MW) is a bio-friendly compound for plant cells as its packed structure does not allow the entry of toxic agents.

These benefits have been demonstrated in empirical studies – for instance, in addition to promoting water productivity, studies have shown that MWT have beneficial impacts on plant growth, especially at the rate and yield of seed germination (Ali et al., 2014). For example, MWT was found to increase both celery yield and water productivity by 12%. In addition, due to its magnetic susceptibility, soil with MW have higher amount of soil phosphorus content. Phosphorus is a vital nutrient in plant health and growth, promoting important aspects such as root development, stalk and stem strength, and resistance to plant diseases (Mosaic, 2021).

Leap-frogging Technologies[11]

3. Solar-powered desalination and water grid for remote and off-grid crop agriculture

Enhancement of performance and efficiency of solar-powered desalination will greatly benefit agricultural activities in developing regions, especially in remote areas, whereby electricity is scant, but seawater and sunlight are ample (Chandler, 2020). With the severe declining of water resources around the globe, seawater desalination has gained increasing popularity as it is regarded as one of the most effective solutions to address water scarcity (Xu et al., 2020). Coupled with simple configuration and the flexibility of off-grid operations, Passive solar desalination systems are especially attractive to developing regions with abundant sunlight and seawater. Nonetheless, the high costs involved in the desalination infrastructure, as well as the large area requirements from low conversion efficiency (approximately 35% from solar energy to water) pose great hindrance to the adoption of such technologies in developing regions. By using inexpensive and readily available materials (e.g., paper towels as a capillary wick to get water into contact with solar absorber), researchers from MIT and Shanghai Jiao Tong University in China are in the midst of developing a highly efficient solar desalination plant (Chandler, 2020). As the system utilises each stage to desalinate water – i.e., heat released at each stage is harnesses instead of wasted, the device is able to demonstrate a solar-to-vapor conversion efficiency of 385% (Xu et al., 2020). This project shows great promise as it exhibits great possibility in elevating the performance of existing passive solar desalination, which produces affordable water that can be utilised for irrigation.

Energy Sector
Catch-up Technologies

4. Sewage sludge undergo anaerobic digestion to produce biogas in existing wastewater treatment facilities

Anaerobic digestion is an integral process of waste management. This technology is oftentimes integrated within existing wastewater treatment facilities, whereby microorganisms break down wastewater solids (i.e., sewage sludge, manure, and food) to produce biogas (i.e., mixture of gases such as methane and

11 Next-generation technologies under development and experimentation.

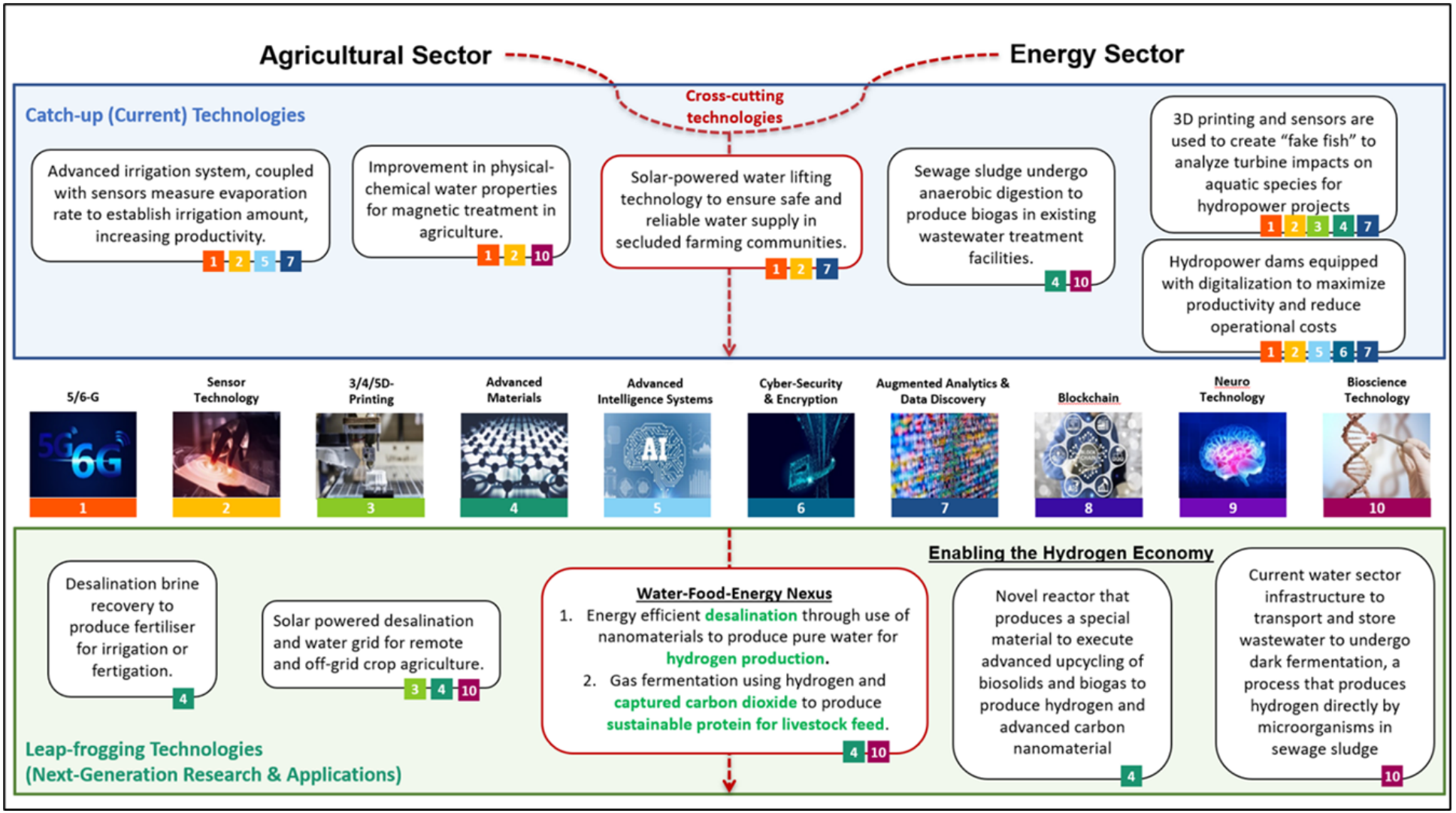


Figure 3.3. Application of the 10-10 *My*STIE framework in relation to the water sector, for agricultural and energy sector

Source: Analytics by Sunway Institute for Global Strategy and Competitiveness (2021)

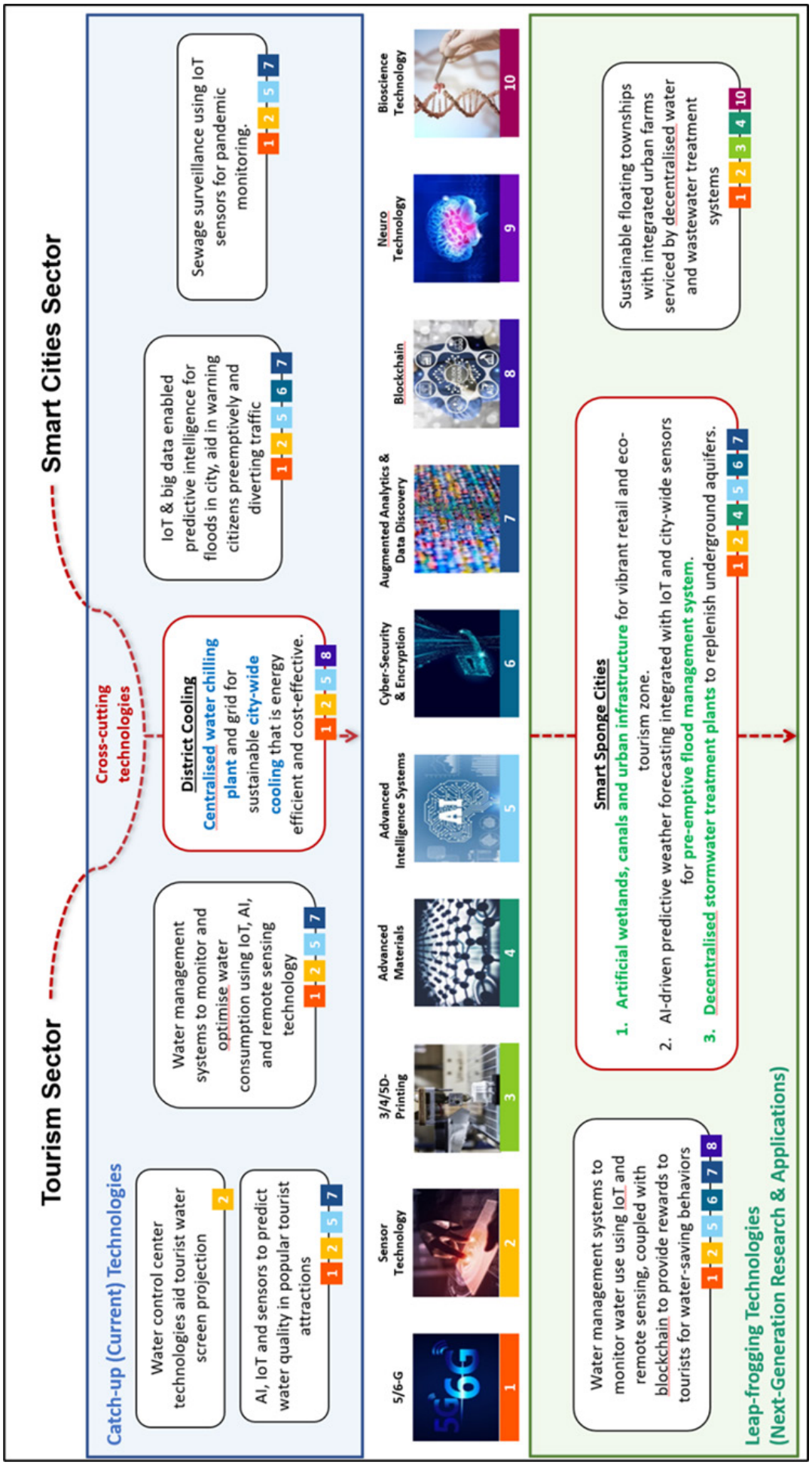


Figure 3.4: Application of the 10-10 *My*STIE framework in relation to the water sector, for tourism and smart cities sector

Source: Analytics by Sunway Institute for Global Strategy and Competitiveness (2021)

carbon dioxide; United States Environmental Protection Agency, 2021a, 2021b; University of Florida, 2019). Biogas is an important resource used to generate electricity; not only is it environmental-friendly because it does not contribute to greenhouse emissions, the use of biogas also reduces energy costs as the electricity powered is re-used for operations at the facility (University of Florida, 2019). In addition, a portion of energy produced is sold to utility grid to generate profits (United States Environmental Protection Agency, 2021a).

5. Hydropower dams equipped with digitalisation to maximise productivity and reduce operational costs

Digitalisation is becoming an integral element in the hydropower industry, as it greatly aids in maximising performance, reducing costs, and optimising asset management (International WaterPower, 2020). Hydropower is currently the largest renewable source, generating two-thirds global renewable electricity (Agostini et al., 2020). There are a few areas where AI, IoT, advanced analytics, and remote sensors are aiding to maximise the potential of hydropower plants: (i) automation of generation planning calculations using data on external (e.g., forecasts on water inflow and weather) and internal factors (e.g., reservoirs level) to optimise energy production and bidding, (ii) automation and enhancement of operations and management processes (e.g., maintenance automation and asset monitoring) to reduce maintenance costs and maximize efficiency gains, as well as (iii) real-time monitoring and inspection of remote areas within hydropower plants to elevate defense from possible attackers (Agostini et al., 2020; Alarcon et al., 2018).

Leap-frogging Technologies

6. Novel reactor that produces a special material to execute advanced upcycling of biosolids and biogas to produce hydrogen and advanced carbon nanomaterial

This novel process not only provides an efficient, sustainable, and cost-effective approach to hydrogen production, but also supports the formation of a circular economy. Researchers from RMIT University have invented a technology that utilises a special material derived from biosolids (i.e., solid organic matter recovered during wastewater treatment process) to spark chemical reactions that convert biogas into hydrogen (RMIT University, 2020; United States Environmental Protection Agency, 2021). In this process, the reactor invented and patented by the RMIT University catalyses biosolids into a carbon nanomaterial-coated biochar (RMIT University, 2020). In addition to being an efficient catalyst in decomposing hydrogen from biogas, the special carbon-nanomaterial-coated biochar can be converted into high-value advanced carbon nanomaterials, which can be used to boost agricultural soils, as well as for energy storage. As a whole, this process provides several benefits: (i) it enables the upcycling of unlimited waste resources into high-value products (i.e., circular economy), (ii) avoids the need for pricey metal-oxide based catalyst, (iii) as well as supports the production of hydrogen, a clean and renewable energy source (Patel et al., 2020). As of 2020, the process was undergoing trial in a pilot plant supported by RMIT's Enabling Capability Platforms and South.

Tourism Sector

Catch-up Technologies

7. Water control centre technologies aid tourist water screen projection

Water control centres can be used as platforms to aid water screen projections in tourist destinations (Laservision, 2020). With the main screen size of close to 900 square meters, the water screen projection in Dubai City Festival set the Guinness World Record for the "largest water screen projection" in 2017. The floating platform that houses the water screen projection is the principal location for water technology pumps, filtration, sanitation, and control systems (Laservision, 2020). Besides the utilisation of LED lighting, laser system, projectors, and audio technologies, water screen projections also utilise optical sensors, a technology that converts light rays into electronic signals (Elprocus, n.d.; Water Show, 2020).

Water management systems to monitor and optimise water consumption by using IoT, AI, and remote sensing technology

Water management systems aided with IoT, AI, and remote sensing technology can greatly assist in reducing water consumption, decreasing cost, and contribute to environmental sustainability[12]. in addition to IoT-

12 Some Malaysian firms have started incorporating sustainability practices into their operations. However, adoption rates are still low and there are still issues with incentives and regulatory consistency (WES Focus Group Discussions, 2021)

equipped water meter, smart bathrooms with smart showers are used to monitor water consumption and provide tailored water flow control that generate significant utility savings (Global Banking and Finance Review, n.d.; John, 2019; Youssef & Zeqiri, 2020). IoT and machine learning algorithms are also used to identify users' showering behaviours, who are then notified and nudged to reduce showering duration (Youssef & Zeqiri, 2020). A study on the aforementioned technology have indicated a reduction in real-time showering duration by 12.06% or 6.14 litres of water (Pereira et al., 2019, as cited in Youssef & Zeqiri, 2020). This is important as showering is the principal source of water consumption – approximately one-fourth of total water consumed in hotels per month can be attributed to showering (Youssef & Zeqiri, 2020). In addition to being the largest consumer of water in tourism accommodation, showering and bathing are also extremely energy intensive. Overall, these technologies are useful technologies in aiding the reduction of overall utility costs for hotel operators.

Leap-frogging Technologies

8. **Water management systems to monitor water use by using IoT and remote sensing, coupled with blockchain to provide rewards to tourists for water-saving behaviours**

With the aid of IoT and sensors, blockchain technology holds great potential in ensuring sustainability in tourism. A study by Thakur and colleagues (2021) proposed a blockchain-based incentive model with soft computing techniques (i.e., artificial neutral networks) to minimize water wastage among houseowners. Specifically, this framework entails the use of blockchain with edge computing (EC). In essence, EC is a process of collecting, filtering, processing, and analysing data that is executed closer to [or ideally, at] the location where data is generated instead of client endpoint (Bigelow, 2021). The benefits of EC not only include a faster and more effective response compared to traditional computing paradigm, but also the ability to provide more autonomy (e.g., restricted connectivity at remote sites) and better data sovereignty. Nonetheless, as IoT devices can be relatively insecure, EC deployment with proper device management such as security in computing and storage resources with emphasis on encryption is cardinal (Bigelow, 2021). By paring EC with blockchain, which is oftentimes described as a "immutable database" where a central authority and third-party verification is not warranted, the issue of security can be resolved while the benefits of EC can be reaped simultaneously (Knirsch, Unterweger, & Engel, 2019, p. 2; Luo, Xu, Li, & Wu, 2020). Thus, these technologies allow sensors and IoT devices at the house nodes itself to compute reward based on the preceding time series data and act as a secure predictive reward system for water-saving behaviours. In a similar vein, a concept paper by Tyan et al. (2020) proposed the use of blockchain technology to support the creation of a cryptocurrency-based reward system. The goal of this proposed system is to allocate rewards to tourists for sustainable behaviours (e.g., the act of saving water and energy in accommodation premises) within a predetermined period of time (Tyan et al., 2020). While this study did not further elaborate on the mechanisms to carry out the reward system, further research could be carried out to examine ways to incorporate the process suggested by Thakur and colleagues (2021) in hotel accommodations, which can promote water-saving behaviours amongst tourists, as described by Tyan and colleagues (2020).

Smart Cities Sector

Catch-up Technologies

10. **IoT and big data enabled predictive intelligence for floods, aid in warning citizens pre-emptively & diverting traffic**

Smart water technologies a critical component in building a strong and resilient community. With the utilisation of technologies such as IoT-enabled sensors, smart water technologies or systems enable the collection, dissemination, and analyses of water equipment and networks (Miller, 2020). In Virginia Beach, the collection and sharing of sensor data allow the forecasting of floods – by using street-level hydrodynamic modelling, information collected from sensors and crowdsourcing enable city officials to forecast floods from storm surges, rain, and sea tides up to 36 hours beforehand. This allows transport departments to pre-emptively provide warnings about forthcoming inundation and divert traffic accordingly (Hitachi, 2021).

11. Sewage surveillance using IoT sensors for pandemic monitoring

The benefits of smart water technologies extend to the epidemiology field, providing valuable resources to health officials in address public health challenges (Goldfarb, 2020). Specifically, IoT-enabled sensors allow the detection of anomalies in municipal systems – in addition to leaks and pollutants, these technologies can be utilised to detect traces of viruses in wastewater. For instance, through these technologies in sewers, Italian scientists were able to discern the arrival time of the COVID-19 virus – through the sewage samples gathered from Turin and Milan, they found that the virus was already present in Italy in December 2019, which was much earlier than previously presumed (Goldfarb, 2020). Not only can these technologies in sewers assist health officials in discerning the full degree of an outbreak; by identifying infection hotspots, they enable a targeted and localised response, which could potentially avoid the implementation of sweeping lockdown measures (Goldfarb, 2020; Minsky, 2020).

Leap-frogging Technologies

12. Sponge cities (e.g., China)

Sponge Cities was initiated in 2014 by the central government of China, with the central aims of reducing risks of natural disasters and improving water availability in urban settlements and – i.e., to achieve the goal for "70% of rainwater [to]... be soaked into the underground instead of ... discharged into the nearest rivers and lakes" (Winkless, 2021, para. 8). In essence, this project combines the use of nature-based solutions and grey infrastructure to retain run-off, which would be reused subsequently (Local Governments for Sustainability, 2017). In particular, nature-based solutions such as green roofs, pervious pavements, bioremediation, urban and peri-urban wetlands are utilised to improve water permeation, retention, storage, purification, and drainage. Importantly, these enhanced greenery sceneries also serve as attractive tourists' destinations, which further promotes tourism within the city (Zhou & Penning-Rowsell, 2021). As of 2017, 30 sponge cities were piloted across the country (Gill, 2021). These pilot programs demonstrated several implementation challenges that may impede its implementation, such as governance issues, uncertain financing, and difficulty in implementing some of the proposed designs. However, this is understandable as sponge cities is a concept ahead of its time; with proper solutions, this concept will resolve some of the major water challenges in the present time (Gill, 2021).

While the list of technologies provided in Figure 3.3 and Figure 3.4 above is not exhaustive, the 10-10 *My*STIE provides opportunities for the development of a wide range of recombinant innovations that can value-add to the water sector, and spawn new local tech industries in the water and aqua sectors.

These new recombinant technologies have the potential of raising the dynamic capabilities (absorptive, adaptive, and innovative capabilities) of the water sector, which in turn will raise process improvements and product developments within the sector, including the adoption of the home-grown innovations. This will also increase the competitiveness of the water sector and enhance economic spill over impact to other sectors such as the food sector, culture arts & tourism, smart cities and transportation. All of which are dependent on the water sector. To harness the full potential of the advanced technology in deepening the impact of the water ecosystem on socioeconomic development of the country, the enablers of the water ecosystem need to be carefully curated and developed.

An additional key aspect of water sector transformations in other countries is the exploration and experimentation with nature-based solutions. It is crucial to balance the transformation of the water sector into a dynamic economic sector with the health and sustainability of the water ecosystem. As highlighted in the Science Outlook 2020 report (2021), Malaysia has historically prioritised economic progress over environmental and societal progress. To protect, restore, and promote the health of the water ecosystem and the communities dependent on it, it is important to promote the utilisation of natural and community-based solutions.

Nature-based solutions (NBS)

There has been a growing convergence of interests around NBS in the past decades across the globe, especially in developed countries. NBS play important roles in preserving, managing, and restoring the health of water and environmental ecosystem. Specifically, they utilize natural processes to address contemporary water management challenges such as water quality and availability, as well as water-related

disasters and climate change. A key feature of NBS is that they tend to deliver groups of ecosystem services in tandem, despite only one being targeted specifically by the intervention, hence oftentimes addressing several challenges simultaneously. In many developed countries, advanced technology and innovations as outlined in the 10-10 *My*STIE are used to enhance the NBS to derive better return on value (ROV) from the natural ecosystems. The following examples illustrate some of the NBS carried out in different countries.

Gorla Maggiore Water Park, Italy. Inaugurated in 2013, the Gorla Maggiore Water Park located in Gorla Maggiore, Lombardy is an urban wetland developed based on NBS (Urban Nature Atlas, 2020). Its main goals are to shield the city against flooding, improve water quality, expand biodiversity, as well as to derive some social co-benefits (Oral et al., 2020). The Park comprises of three different sections that serve distinct functions: (i) area with water grid, sedimentation tank and vertical subsurface flow wetlands to remove pollutant, (ii) surface flow wetland that serves as pollution retention, flood buffer, and recreational zone, and (iii) a recreational park with restored riparian trees, beautiful green open spaces, cycling paths amongst others. Extensive use of bioscience technology and intelligent technology outlined in the 10-10 *My*STIE framework have been used to address some of the natural disasters and embellish the value of these ecosystem to society and the economy. A study has shown that the outcomes (i.e., costs and performance) of the park are close to or even more superior than those of grey infrastructure (Masi et al., 2017, as cited in Oral et al., 2020).

Mangrove restoration, Senegal. Launched by the Livelihoods Funds and Senegalese NGO Océanium and validated by the United Nations Framework Convention on Climate Change Board in 2011, the mangrove restoration programme in Senegal is the largest mangrove restoration program (Livelihood Funds, 2020). Mangrove forests are important tool for climate mitigation (e.g., through carbon sequestration from atmosphere), coastal protection, preservation of water quality (e.g., by trapping sediments and filtering pollutants) as well as fishery resources, which is critical for food security. According to a study by the UN Food and Agriculture Organisation, around 133,000 acres of coastal mangrove forest have disappeared in Senegal between 1980 and 2005, which heavily impacted the soil quality and aquatic resources at the coastal area (Bilskil, 2018). To mitigate this issue, Océanium and the Livelihoods Funds have provided support to carry out the mangrove restoration project, with the involvement of 250 local villages and 100,000 other individuals. Started off with 173 hectares in 2008, the plantation area now has expanded to more than 10,000 hectares; more than 79 million mangrove trees are now planted, providing 500,000 million tonnes of expected carbon offsets for its investors over 20 years (Fleming, 2019). These projects and initiatives leverage on major discoveries made in bioscience and smart engineering technologies outlined in the 10-10 *My*STIE.

Community-based water monitoring (CBWM)

In essence, CBWM involves the participation of local communities in tracking and monitoring of water quality and availability. In recent decades, it has expanded rapidly across different countries; while CBWM is especially popular in Europe and North America (including Canada), countries such as Australia, Brazil, and China have also partaken in this initiative (Carlson & Cohen, 2018). This growth in popularity can be attributed to several factors such as (i) the finite ability of monitoring by government agencies and scientists, (ii) invention of inexpensive and easily-maneuvered technologies to undertake accurate water monitoring and crowdsourcing data, as well as (iii) the emerging concerns of local communities concerning the health of their environment. Increasingly advanced technology, in particular the technologies in the 10-10 *My*STIE are being deployed by many of the countries to manage the natural ecosystem and water basins. The following examples will illustrate the use of CBWM in different countries.

The Lake Windermere Project, Canada. Lake Windermere is the most extensively utilised water source across the entire Columbia Valley. In the recent decades however, its ecology has undergone profound deterioration. For instance, its population of the freshwater fish called burbot collapsed and over 50% of its shoreline degraded (Living Lakes Canada, 2021). In face of these challenges, the 2005 Lake Windermere Project was initiated as a water stewardship programme that involved the government, local community, as well as the First Nations residents to resurrect the health and ecosystem of the lake. Some measures of its education and outreach programmes included the door-to-door outreach campaign (i.e., to increase residents' awareness on the project and ways to participate) and Lakekeepers Workshop (i.e., provided knowledge to residents on basic lake functions and sampling protocols). The initial training for water

collection samples was provided by government staff and other lake stewardship societies (Kanu et al., 2016). As the coordinator obtained the lake stewardship certification and became qualified, new community volunteers were trained to become project coordinators.

In 2010, this project was chosen as the "best practices" example for community-based environmental monitoring by the research project executed by the Environment Assessment Agency and N.T. Yap Environmental Assessment Agency (Living Lakes Canada, 2021). The stewardship of the lake has since been handed over to the local community through the Lake Windemere Ambassadors Society to enable an active and full participation of local residents (Waterbuckets eNews, 2021). This was also the inception of Living Lakes Canada – a group that builds capacity through CBWM to restore and protect the watersheds across Canada (Waterbuckets eNews, 2021).

Futaleufú community-based water monitoring, Chile. The Futaleufú River and one of its principal tributaries, the Espolón River are exposed to environment threats at an escalating rate (Waterkeeper Alliance, 2021). Examples of environmental threats include the contamination from the nearby water treatment plant and the proliferation of invasive algae (i.e., didymo) as a result of the extensive gravel extraction from the riverbanks (Futaleufú Riverkeeper, n.d.). Due to the lack of monitoring efforts from the public institutions, a community-based water monitoring programme was spearheaded by the Futaleufú Riverkeeper, an NGO established by the green energy company Enel (Futaleufú Riverkeeper, 2020). Volunteers from the local community are provided with training workshops and certifications to carry out water quality sampling at predetermined sites (i.e., physical-chemical aspects such as pH and alkalinity; Blanchet & Gonzalez, 2020). In addition to cost reduction, CBWM is an excellent method to educate and engage the local community in the water management of the country, which is especially important given that it is the only country in the world with a fully privatised water right.

3.2.7 An Integrated Water Sector Transformation Framework

Taking from all of the aspects of the water ecosystem above, an Integrated Ecosystem Approach that incorporates the 8i Innovation Framework, five focus areas, 8R Water Philosophy, 5Ss, and 10-10 *My*STIE Framework, will characterise and transform the water ecosystem. This new framework provides a comprehensive approach to the water sector transformation, viewing the issues and potential solutions from both a holistic perspective. The 8i Innovation Framework and five focus areas gave insights on both the supply and demand enablers of the water ecosystem; the 8R Water Philosophy and circular economy guides the behaviour of end-users; the 5Ss guide the outcomes necessary conditions for transforming the water sector into a dynamic and sustainable water sector; and the 10-10 *My*STIE Framework guides the technologies and applications needed to transform the water sector into a knowledge-intensive sector.

To be a vibrant and dynamic economic sector, the water sector needs to not only meet the basic needs of the people, but also the needs of other sectors of the economy. Given that Malaysia is an open economy, for the water sector to make a stronger economic contribution, the water industry must take an international outlook. This will enable the sector to not only spur knowledge- and technology-transfer, but also stimulate international trade and foreign direct investment into the water sector and other economic sectors that are dependent on water.

The proposed Integrated Ecosystem Approach also provides a systematic way of developing the water sector by highlighting a sequence of development (of the enablers) initiatives that need to be put in place for the remaining enablers to deepen their impact on one another and in strengthening the entire water ecosystem and value chain. This systemic and sustainable framework is not present in other water models. The current proposed framework outlines the pre-condition (role of strengthening the institutional governance) in strengthening the other enablers of the ecosystem and fostering strong endogenous relationsbetween them. The endogenous relations between enablers are critical for enhancing the multiplier impact within the water sector and across sectors that are dependent on water.

In summary, a strong water ecosystem anchored on the 8i Innovation Framework and five focus areas that leverages on the 8R Water Philosophy and 5Ss underpinned by the 10-10 *My*STIE framework has the potential to create a new trajectory for the water ecosystem, thus increasing the return on value of the water sector, as shown in Figure 3.5.

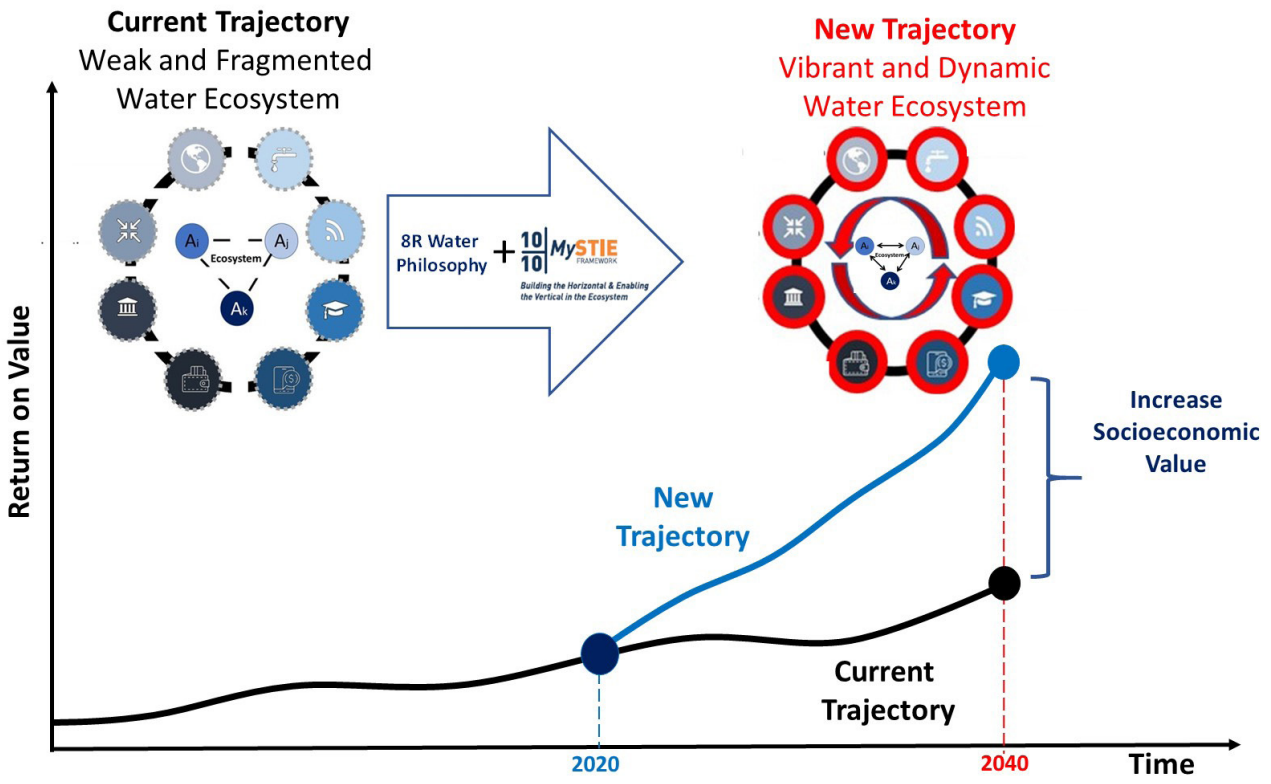


Figure 3.5. WST2040 - Transition towards a vibrant and dynamic water sector[13]

Source: Analytics by Sunway Institute for Global Strategy and Competitiveness (2021)

The new trajectory in Figure 3.5 can only be achieved if the right steps are taken. The 8i ecosystem analysis showed a seven-step systems approach in transforming the Malaysian water sector into a dynamic economic sector (i.e., a strong and sustainable water supply and demand) that will reduce NRW, increase reserve margin, and enhance economic wealth. This is summarised in Figure 3.6 and the seven sequential steps to nurture a Systemic Sustainable Water Ecosystem Transformation entails the following:

STEP 1: Strengthen the institutional governance of the water sector at all levels (federal, state, and local council levels). This includes adopting a whole-of-government and whole-of-society approach to accelerate the implementation of the IWRM framework.

STEP 2: Foster a strong collaborative partnership amongst all stakeholders in the water ecosystem, which include government agencies (federal, state, and local council), industries, community organizations, civil societies, citizen scientists and institutions of learnings.

STEP 3: Strengthen the regulatory architecture, implementation mechanisms, tracking and monitoring and ensuring a continuous improvement cycle is in place, including adherence to global best practices and outcomes reported in a transparent way on a regular basis.

STEP 4: Plan and develop of the water infrastructure by using advance technology and nature-based technology to ensure effective management of the water resources and supply chain across the country aligned to 10-10 *My*STIE framework.

STEP 5: Strengthen the talent pool and incentives for RDCI to be aligned to the technology development strategy and ensure the continuous development of talent and incentive system to deepen the infrastructure development and vice-versa.

13 Refer to Volume 9 Water as an Economic Sector Sub-Sectoral Report for full discussion of the transition. A_i, A_j, and A_k represents the different stakeholders within the water ecosystem

STEP 6: A strong water ecosystem due to implementation of STEP 1 to STEP5 will place the water ecosystem in a good position to strengthen international collaboration and partnerships that will foster two-way knowledge- and technology transfer, enabling the water sector to move up the regional and global water supply chain.

STEP 7: Continuous development of the enablers of the water ecosystem (8i-enablers) will lead to a sustainable and dynamic water sector that will reduce non-revenue water (NRW), increase reserve margin, and increase the contribution of the water sector to the Malaysian economy.

With the establishment of the first six steps, a self-generating and self-sustaining water ecosystem has a high potential to enable public -private-community partnership to be realised. At this stage, sustainable development of the water sector will increase competitiveness of other sectors of the economy that are dependent on water.

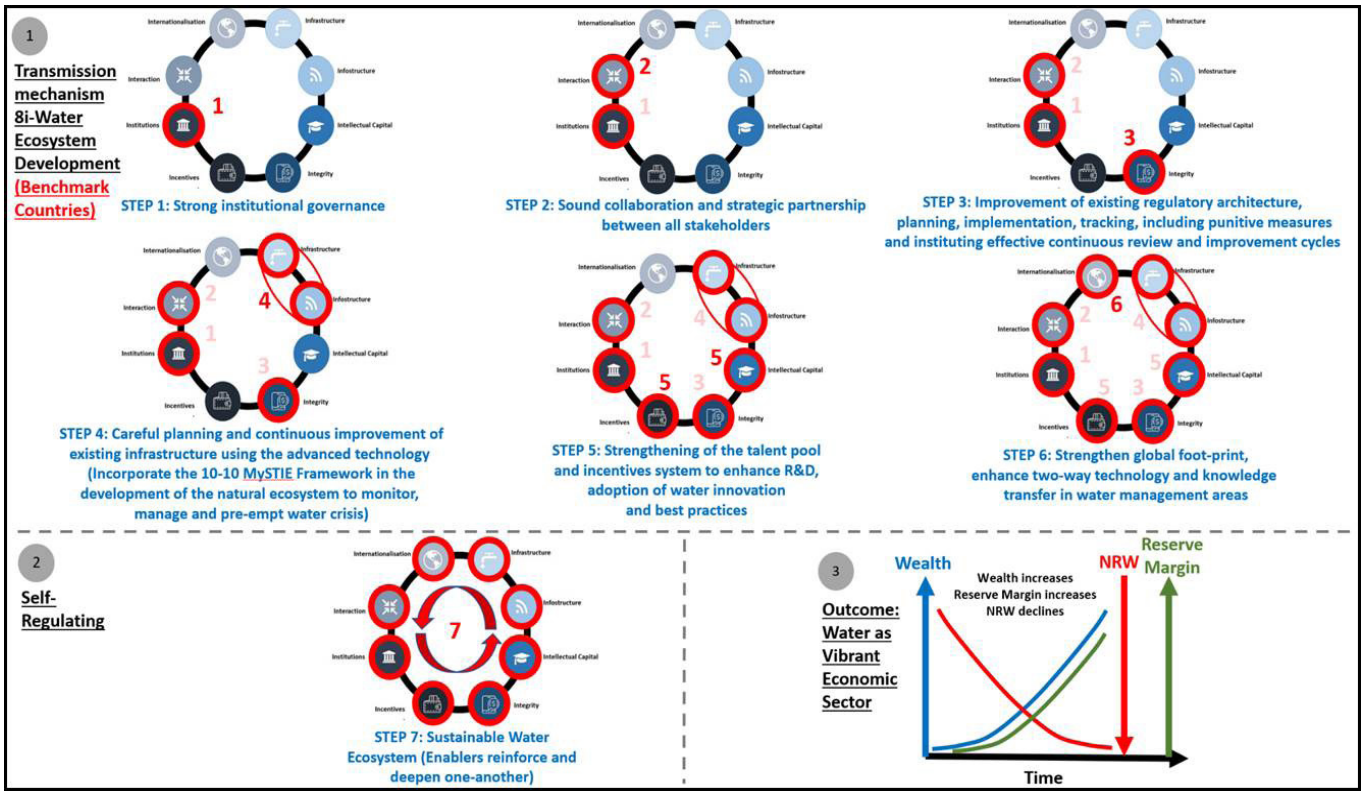


Figure 3.6. Systemic sustainable water ecosystem transformation

Source: Framework by Sunway Institute for Global Strategy and Competitiveness (2021)

Applying the seven-step systemic sustainable water ecosystem transformation approach for both the supply and demand sides together with the 8R Water Philosophy, 5Ss, and 10-10 *My*STIE as shown in Figure 3.7, the water sector could be a major contributor to the Malaysian economy, directly as an economic sector, and indirectly raising the return-on-value (ROV) of other economic sectors.

This Integrated Ecosystem Approach links the key components of a successful transformation for the water sector. Each of these aspects are needed to holistically strengthen the water sector and address any gaps within water ecosystem. Embracing the Whole-of-Government and Whole-of-Society approach in this integrated water ecosystem is critical to ensuring all the existing gaps and issues are addressed appropriately and effectively. The integrated transformation of the water sector will be an important catalyst for transforming Malaysia into a regional water hub.

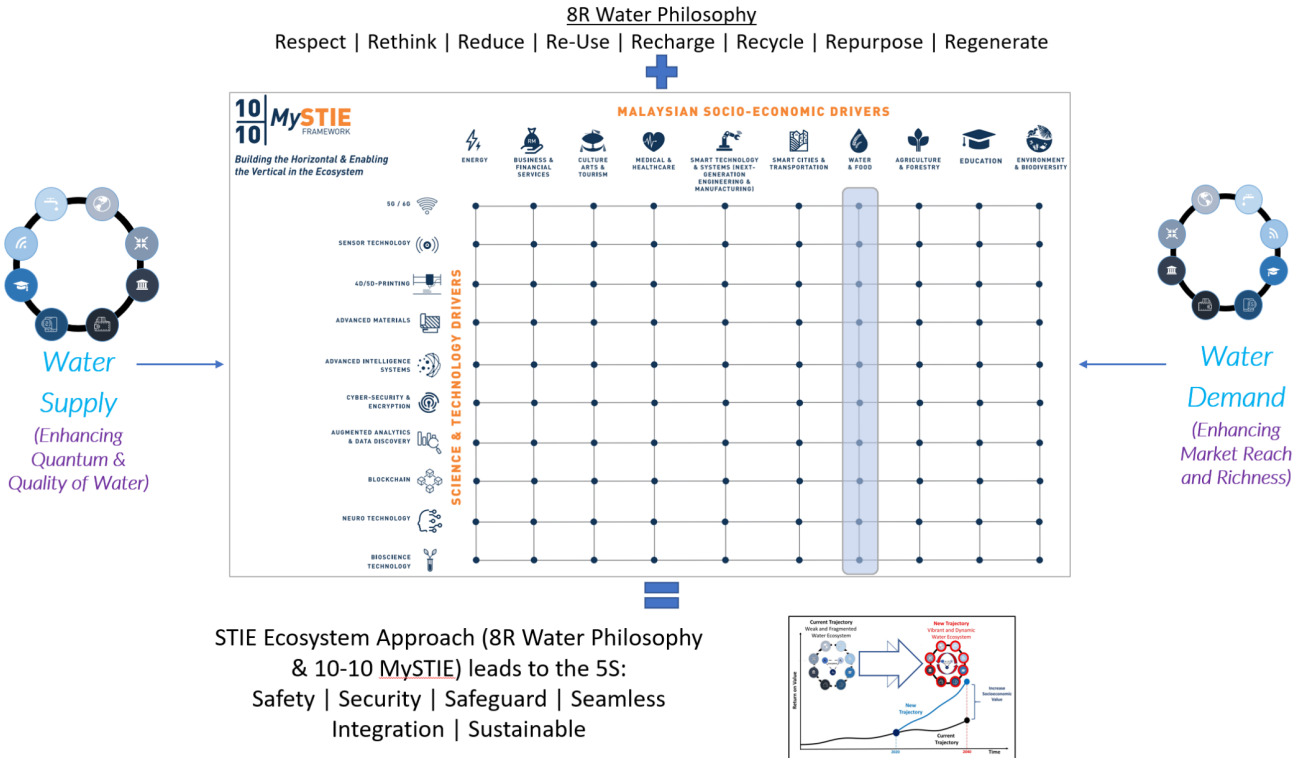


Figure 3.7. Integrated ecosystem approach to nurture a vibrant and dynamic water economic sector

Source: Analytics by Sunway Institute for Global Strategy and Competitiveness (2021)

3.3 POSITIONING THE WATER SECTOR AS A DYNAMIC NEW ECONOMIC SECTOR CAPABLE OF DRIVING THE NATION'S GDP GROWTH IN THE FUTURE

Preamble:
In fulfiling the study TOR Scope 3, that is, to study the potential of the nation's water sector through taking into account the current global market to establish the water sector as a new dynamic economic sector and capable of driving the nation's GDP growth in future, Prof. Dr. Mahendhiran Nair FASc, the Chair of the Water as an Economic Sector (WES), was requested to write on this topic. This topic has relevance to the Theme of the 14th MP of Achieving Economies of Scale.

3.3.1 Global Water Market

According to Global Water Intelligence (cited in Water Online, 2018), the global water market could grow from $770.0 billion USD in 2018 to $914.9 billion USD by 2023, with a compound annual growth rate of 3.5%. At the expected growth rate, the global water market could reach $1.6 trillion USD by 2040[14]. The growth of the global water market is mainly attributed to growing population and industrial demand, especially in developing regions such as Africa, South Asia, and South-East Asia. Water shortages and lack of access to quality water supplies are a major concern in many developing countries as well. It is estimated that global water demand would increase by around 30% between 2020 and 2050, and that by 2030, the world could face a 40% water deficit if no interventions are put in place (United Nations, 2021).

While Malaysia gets abundant rainfall, the water sources are vulnerable to increasingly erratic weather patterns. Coupled with an aged water infrastructure and under-resourced water management system, there has been an increasing trend of water supply shortages and disruptions. The problems of the country's water system have major implications on the health and well-being of citizens. These disruptions also have an adverse impact on local industries and may impact foreign investments into the country if not arrested fast. The role of the water sector in the success of local industries cannot be overstated.

14 WES analysis based on global water market CAGR from 2018 to 2023 reported by Global Water Intelligence. This analysis includes the operating and capital expenditures of water suppliers and water-dependent industries on water and wastewater treatment.

In 2010, industries globally withdrew 19% of the world's freshwater supply, with regional amounts, ranging from 2% in South-East Asia to 74% in Western Europe (AQUASTAT, 2016, cited in United Nations, 2021). As Malaysia strives to develop into a high-income nation with competitive industries, the demand for water will eventually grow significantly to resemble that of developed countries in Europe. With technology-related drivers identified as a key economic growth enabler in the 12th MP, the water sector needs to be prepared to support the development of local high-tech industries. Many high-tech industries such as data centres and semiconductor fabricators require large amounts of water for cooling purposes. In particular, the semiconductor industry requires ultrapure water for their manufacturing processes to prevent contaminants in the water from damaging the circuits. Being the 3rd largest exporter of semiconductors in the world (World Integrated Trade Solutions, 2019), Malaysia's industries and economic growth have increased exposures to water-related risks as well.

Furthermore, studies have also shown that water disruptions and shortages disproportionately affect small and medium enterprises (SMEs) in low- or middle-income countries (Damania et al., 2017). The study also estimated that informal SMEs experienced an average loss of 34.8% in sales for one water outage per month[15]. As 98.5% of Malaysia's businesses fall under the SME category, the state of the water sector's ecosystem is heavily tied to the health of the local economy and the potential of the export economy.

Therefore, better management of the country's water sources is critical to ensure the development of a vibrant water industry that becomes a major revenue earner for the nation and a key enabler for ensuring the competitiveness of other sectors of the economy where water is an important input.

3.3.2 Water Sector Ecosystems of Benchmark Countries (Advanced Water Ecosystems)

Comparison of polices against highly developed water sectors in other countries showed that a holistic multi-sectoral approach with strong stakeholder collaboration is vital for a dynamic water ecosystem. There is a stronger focus in ensuring the water ecosystem is future ready in meeting the needs of society and industries. This includes continuous infrastructure upgrades and alternative investments to fund these upgrades to prevent a systemic failure of the water supply systems due to long-term neglect. There is also a commitment to acculturate the society and industry on the 8R Water Philosophy and circular economy, as well as investing in cutting-edge research into water and water-related knowledge. The latter is critical in nurturing next-generation globally competitive local firms in the water sector that will lead market expansion to other countries. These approaches can be observed within the context of the five focus areas which equipped the benchmark countries' respective water sectors for regional and global market penetration:

People: Dedicated water education institutions, emphasis on STEM education, and sometimes citizen science programmes are common mainstays in benchmark countries. Other enablers are their strong indigenous tertiary education institutions and tech industries that help create that inflow and retention of foreign talent (i.e., students, researchers, and workforce). Additionally, some countries, such as Australia, create tailored visa programmes like its Global Talent Visa Programme that targets growth in innovation and tech economies in key areas, including resources and circular economy (Department of Home Affairs, 2021). Citizen science and community-based water monitoring are some approaches used in Australia, Canada and the UK to not only improve water literacy amongst society, but also shared water management best practices and provide cost-effective and accurate scientific data (ACSA, 2021a, 2021b; Sandford et al., 2018).

Governance: Many benchmark[16] countries approached national plans and policy design with a whole-of-government or whole-of-society approach. These countries displayed early foresight with the incorporation of environmental and sustainability targets within policies, as well as high coordination between implementing agencies. For instance, Singapore's Public Utilities Board (PUB) who is responsible for the country's water supply, was highly proactive in implementing projects and coordinating between ministries to ensure water security became an important facet of Singapore's overall growth (Jensen & Nair, 2019; Tortajada et al., 2013a; Tortajada & Joshi, 2014a). Meanwhile, Australia is a strong proponent of the whole-

15 The study uses global data. Water outage and sales loss data is not available for Malaysia specifically.

16 Benchmark countries are Japan, South Korea, Singapore, Netherlands, Australia, Canada, and selected OECD countries where appropriate.

of-society approach, having conducted some of the highest number of citizen participation programmes (e.g., citizen jury) amongst OECD countries (OECD, 2020c). This incorporation of society in policy design and decision-making allows for more holistic policy decisions that encompass the perspectives of different demographics, is contextual, and provides novel solutions that government may not have thought possible.

Strong integrity systems are present in benchmark countries to ensure accountability and transparency to gain consumer trust. Water operators (public or privatised) publish their annual reports detailing project progress, financials, and future investments that are publicly accessible. In some countries, such as in Australia and the UK, water operators publish their business plans for the next coming years outlining future investments and targets. This ensures consumer are kept abreast of how water tariffs are being invested. Similar to the polluter-pays principle, should water operators fail to meet targets or breach regulations, they are held accountable and in turn penalised for any shortfalls. Additionally, again in Australia and the UK, water operators are regulated by independent regulators (Cathryn Ross, 2017; Horne, 2020). This ensures political agendas are kept separate from judgement.

Finance: Benchmark countries have shown to use cost-reflective pricing and polluter-pays principle as a means of ensuring water operators remain financially sustainable and as a part of water demand management strategies employed. In the UK, water supply for businesses is non-monopolistic, thus incentivising suppliers to improve in terms of efficiency, price competitiveness and service quality (Government of the United Kingdom, 2017; Loveday, 2016b). In Australia, water prices are tied to license targets that may range from service quality to environmental goals (Horne, 2020). Singapore sets a water conservation tax on top of cost-reflective prices (in addition to other non-fiscal initiatives) to manage water consumption levels.

Benchmark countries show strong public investment as mechanisms for spurring research, innovation, and collaboration. Public support (in this context, financially) is important in encouraging business R&D, as the risky and uncertain nature of R&D presents a large barrier, especially for young firms and SMEs (OECD, 2021). Findings from an OECD study suggested that generous innovation-specific policies to encourage private sector innovative activity, such as R&D tax incentives, direct government support for private R&D, and increased business R&D expenditure (Westmore, 2014). However, the converse effect was found when policies were frequently reversed, indicating a stable and predictable policy environment was key for positive outcomes. In Singapore, fiscal and non-fiscal incentives help drive local and foreign direct investments into research and innovation, support local SME globalisation, and provide safety nets to encourage private sector participation in water PPPs (S. Ho, 2015; Jensen, 2017; PUB, 2018a). In the UK, research councils fund more than £120 million in public sector water research annually (Government of the United Kingdom, 2015), while in Canada and the Netherlands, fiscal incentives help drive investment and research into water technologies (Canadian Water Network, 2018; Government of the Netherlands, n.d.; Natural Sciences and Engineering Research Council of Canada, 2019; OECD, 2020b). To promote state and local government adoption of water technologies and infrastructure, Australia's federal government provides co-investment schemes (DITRDC, 2021; OECD, 2019).

Information and RDIC: Benchmark countries have shown support for open-data access, data-driven solutions and high-speed internet (i.e., broadband, 5G network). Australia and the Netherlands are among the top countries in terms of open-data access (Hisham, 2015; Open Knowledge Foundation, 2016; Speedtest, 2021a, 2021c; World Wide Web Foundation, 2017). Further, the Netherlands in particular has a strong space sector and makes data-driven solutions and digital technologies as its international water solutions (Government of the Netherlands, 2021; Kingdom of the Netherlands, 2017). South Korea incorporates technologies such as IoT, sensors and data-analytics into its water supply chain as seen in its Smart Water City projects, whereby remote leak monitoring, smart metering, and predictive maintenance are some that have been implemented to improve efficiency and transparency (Lee, 2019). Additionally, benchmark digital-based solutions are further enabled by strong investments into digital infrastructure such as strong 5G rollout and high-speed broadband coverage (Speedtest, 2021a, 2021c).

Infrastructure and Technology: Benchmark countries have a relatively low NRW (15% or less) which is aided by strong investments into improving and upgrading aging infrastructure. Additionally, some countries have made infrastructure investments that are highly contextualised, such as Singapore's NEWater plants and urban-integrated water catchment zones (e.g., Marina Barrage) and the Netherland's many massive flood barriers to increase land availability even with a third of the country lying below sea level.

Diving deeper into the policy strategies comparison with benchmark countries, Table 3.3[17] shows the differences in the state of the respective water ecosystems. Japan, Singapore, and Netherlands have developed their water sector ecosystems into one that is highly coordinated and technologically enabled. They had a clear vision and adopted a whole-of-government and whole-of-society approach right from the beginning to drive the successful transformation of their water sectors. Their strategies focused on a systems perspective and the process of continuous review and update is embedded in their institutional culture. This has resulted in their respective water sectors to be key economic drivers and enablers for their downstream and export industries.

3.3.3 Economic Impact of Dynamic Water Ecosystems in Benchmark Countries

Netherlands

The dynamic water ecosystems developed and maintained by the benchmark countries highlight the economic potential for the Malaysian water sector if the same success could be emulated. In 2019, the Dutch water sector reported an export figure of $9.6 billion USD (Dutch Water Sector, 2020). This is on top of the $19.2 billion USD value add amount for their environmental goods and services sector as shown in Table 3.3. Of the $9.6 billion USD exports from their water sector, the exports of water technologies specifically contributed $4.4 billion USD (Dutch Water Sector, 2020), around 45% of the total water exports. As demand for better water management and higher amounts of fresh water and re-use of wastewater increases, the Dutch water sector expects almost 8% growth of their international water activities in the near future, with water technologies dominating the types of water export.

The Dutch government and water sector has also developed a Netherlands Water Partnership (NWP) designed to support water cooperation and development in the Asian region. ASEAN countries such as Singapore, Malaysia, and Thailand were also identified as further opportunities for their regional development plans (NWP, n.d.). Their plans include "improving drinking water quality with state-of-the-art technologies, sustainable water use in agriculture, waste-reduction in regional rivers and oceans, and building resilience with nature-based solutions". Given that these plans are in-line with the recommendations of Water Sector Transformation 2040, a successful transformation will open up new regional markets and opportunities for Malaysia that has been previously dominated by foreign players.

17 Only selected benchmark countries (3) are shown in Table 3.3. For the full list of benchmark countries comparison, refer to Table 6 in Volume 9: Water as an Economic Sector Sub-Sector Report.

Table 3.3.Targeting the five focus areas of the water ecosystem – Policy strategies comparison between Malaysia and selected benchmark countries

Country	People	Governance	Finance	Information and RDIC	Infrastructure and Technology	Economic Impact
Malaysia	• Weak knowledge sharing culture. • TVET enhancement roles divided among institutions but poor coordination has created silos (Beschel et al., 2018). • Lack of awareness on the 8R water philosophy • Lack of next generation talent in specialized areas with inter- and multi-disciplinary skills set to foster strong nexus between the water sector and other sectors.	• Weak implementation of IWRM due to lack of a strong "Champion with Clout" and low usage of digital governance systems. • Poor cohesion in government policy and weak, patchy and territorial water governance (Lee, 2005). • Institutions operate in silos due to poor coordination. Lack of effective stakeholder involvement in water resource management. • Use of traditional water management systems that is inadequate in addressing water resources in multiple jurisdictions/ states and ensuring seamless flow of information for strategic decision making.	• Low investment in R&D for water industry. • Tariff rates have not been reviewed regularly incorporating the current costing structures • The current tariff rates are inadequate to cover operational and capital expenditure to meet the increasing needs of society and industry(SPAN, 2017). • Water service provision primarily government funded. Low private sector and FDIs into the water sector.	• Low ICT literacy. • Low adoption of advanced ICT systems in the water industry (Ali, 2019). • Low impact research resulting from high quantity but low impact publications and low technology transfer rate (World Bank, 2020).	• Water infrastructure does not utilize advance technology and cost-effective nature-based technology. • Lack of basic water infrastructure in several rural and island communities. • High NRW due to aging infrastructure and primary use of mild steel (29.1%), asbestos-cement (27.1%) and polyethylene pipes (19.0%) (Jones et al., 2021; MWA, 2018; Rishyakaran, 2016).	• Gaps and weaknesses in the enablers in the ecosystem (in the 5 focus areas) has resulted in disruptions in the quantum and quality of the water supply. This has had a significant impact on the water and other economic sectors and quality of life. • Inadequate investment in the five enablers to stimulate strong demand side water management (water conservation effort and higher value-added use of water). • Strong government participation leading to 'crowd-out' private sector participation and local innovation in the water sector. • Limited global reach and mostly operating at the low end of the global value chain.

Country	People	Governance	Finance	Information and RDIC	Infrastructure and Technology	Economic Impact
Japan	• Significant investment in next generation talent for the industry.	• Adopts a "Whole-of-Government" and "Whole-of-Society" approach (EPD, 2007). • Incorporated IWRM and strong digital governance system (MLIT, n.d.). • Strong internationalisation strategy, dispatching water experts through official development assistance (ODA) (MOFA, 2014) and overseas capacity building (Forbes, 2020). • Government-driven structured multi-stakeholder partnership to encourage MNC leadership in R&D (Government of Japan, n.d.; JST, n.d.; Tomas, 2021).	• Tiered tariff system at competitive rates (JICA, 2017). • Balanced mix of GOVERD, BERD and HERD (OECD, 2021), with BERD emphasis on experimental research.	• Smart water management system enabled by high-speed internet, satellite systems, and 5G deployment (5G Observatory, 2020; Clark, 2012; Galvin, 2017). • Competitive national universities (The Japan Times, 2021). • MNCs in areas of ICT, electronics and energy among others developing water technologies (e.g., NTT, Hitachi, Fujitsu, Sony) (Fujitsu, 2012; Hitachi, 2021; NTT Communications, 2016; Sony, 2020).	• Intelligent water management system and fully upgraded pipes bringing NRW to 10% (Macharia et al., 2021) namely, Current State Extends (CSE.	• Japanese companies' market value of water-related fields (i.e., supply, sewage, desalination) at USD2.6 billion (Matsutani, 2018). Collective market value of drinking water systems, drinking water treatment, and sewage treatment at USD12.9 billion (United Nations, 2016).
Singapore	• People-private-public approach in public education and community relations (IWA, n.d.). • Water education formalised at all levels education and online professional skills training platforms. • Policies emphasising STEM education and continuous investments in research and innovation (Y. P. Ho et al., 2009; Koh, 2006; Quah, 2018)	• Highly coordinated self-regulated proactive public water agency with extensive portfolio allowing it to tackle water security with a **'whole-system'** approach (Jensen & Nair, 2019). • IWRM through holistic cross-sectoral policy framework development and **high-level coordination between agencies** (e.g., land, housing, health) and integration of water security goals in broader range of policies (Tortajada et al., 2013). • Collaboration with foreign firms and universities to establish research centres and accelerator programmes within Singapore (PUB, 2018a). • Government-driven public-private partnerships.	• **Full-cost recovery block tariff** system (PUB, 2017)with **polluter-pays principle** (PUB, 2018b, 2018c). • Fiscal and non-fiscal incentives and support to drive local and foreign direct investment in research and innovation, as well as support local SMEs' globalisation efforts (PUB, 2018a). • Fiscal and non-fiscal **safety nets** to encourage private participation in water PPPs (S. Ho, 2015; Jensen, 2017).	• Digitalisation of water resources management and strong public investment in emerging digital technologies (PUB, 2020). • Top universities regionally and globally with water expertise (Dhalla, 2017; Times Higher Education, 2021).	• Continuous upstream and downstream improvements to digitalising water management and infrastructure for disaster management and alternative water sources (i.e., **Four National Taps**) (PUB, 2016). • 5G deployment and nationwide access to high-speed broadband network.	• Water industry employing 14,400 and generating SGD2.5 billion in annual value-add (PUB, 2018a). There are over 200 water-related companies and 25 research centres (PUB, 2018a).

Country	People	Governance	Finance	Information and RDIC	Infrastructure and Technology	Economic Impact
Netherlands	• Expansion of water research and capabilities building by renowned universities and leading water education and research institutions (IHE Delft, n.d.; KWR Water Research Institute, 2021; Studyportals Masters, 2021b, 2021a).	• Highly coordinated water governance system with decentralised water agencies whose boundaries are determined by catchment and basins (Havekes et al., 2017; Vollebergh & Dijk, 2017). • IWRM through contemporary legislation and proactive governance, enforcement and implementation to ensure transparency and overcome corruption (IRC, 2016; Mostert, 2009; Studyportals Masters, 2021a). • Global water hub offering international development projects, ODA, and multidisciplinary water expertise (i.e., Amsterdam Utility Agreement and Netherlands Water Partnership) (Amsterdam International Water Web, 2021; Kingdom of the Netherlands, 2017; NWP, n.d.).	• **Two-part tariff** system and **user-pays principle** enablers of financially independent water authorities (European Environment Agency, 2013; Havekes et al., 2017; Vollebergh & Dijk, 2017). • Fiscal incentives strong driver of investment into innovative products (Government of the Netherlands, n.d.-a; OECD, 2020a).	• Government push for open data and leader in providing open access geo-data (Hisham, 2015; Overheid.nl, 2021). • Strong indigenous firms in space, geo-data, and environmental technologies (Government of the Netherlands, 2021). • Commercialisation of smart water solutions through collaborations between water authorities, space and geo-data agencies (Kingdom of the Netherlands, 2017).	• Large-scale and long-term investments into comprehensive water infrastructure and digitalisation (e.g., **Delta Works** programme for flood mitigation and land reclamation) helped achieve an **NRW of 5%** (Havekes et al., 2017; Hisham, 2015; Kingdom of the Netherlands, 2017; Macharia et al.,2021 • High speed internet and 5G deployment (Government of the Netherlands, n.d.-b).	• Water tax revenue amounting to EUR2.7 billion (Havekes et al., 2017). Water supply and waste management worth EUR3 billion (18%) value add in the EUR16.7 billion environmental goods and services sector (CBS, 2015).

Singapore

Similarly for Singapore, they see themselves as the "Silicon Valley of water research". With an aim of developing and exporting water solutions, particularly membrane, desalination, and sensor technologies, Singapore in 2015 managed seven international projects worth $737 million USD, up from $250 million USD in 2004 (Singapore Economic Development Board, 2017). One example is Nano Sun, a Singapore-based water technology company. Nano Sun's next generation membranes have been used in multi-national semiconductor companies and also municipal wastewater treatment plants in China (Singapore Public Utilities Board, 2018).

Japan

Japan has also been a top contributor globally in the field of water. According to their Overseas Development Strategy of Water Industry (cited in The Japan Times, 2018), Japan has developed smart water infrastructure in other countries directly via exports of technologies and indirectly via yen-based loans. They have also provided knowledge and expertise through legal structures for water and intellectual capital development in other parts of the world. Japan's Export Strategy for Infrastructure Systems (Ministry of Economy, Trade and Industry, 2018) is expected to receive a value of up to $263 billion USD from overseas infrastructure projects in 2020, of which the overseas water development strategy is expected to feature significantly.

One notable recent development is the signing of a memorandum of understanding between India's International Centre for Clean Water and Japanese firm DG Takano in 2020 to bring clean water technologies and technical know-how to India (The Economic Times, 2020). India's waterborne diseases costs their economy an estimated $600 million USD per year and this partnership with Japan aims to alleviate some of that economic burden.

Hitachi Aqua-Tech Engineering Ptd. Ltd. (HAQT) located in Singapore is another key example of the global market reach of Japan's water technology companies. HAQT's innovations in desalination and membrane technologies for reserve osmosis has turned Singapore from one of the most water-stressed countries in the world to one that has a diversified and sustainable water supply. Going beyond supplying water for household and industrial use, HAQT also installed the world's tallest indoor waterfall feature in Jewel, in Singapore Changi Airport (Hitachi, 2019). The water feature has become a prominent tourist attraction and showcases the cross-cutting potential of water technologies with other economic sectors as highlighted in the 10-10 *My*STIE Framework in Section 3.2.5.

3.3.4 Potential Economic Impact of Water Sector Transformation 2040 Malaysia

The regional and global water market presents many opportunities as water scarcity and demand for cleaner water rises. Developed countries with dynamic water ecosystems have leveraged their expertise and technologies to gain market entry into developing regions and countries that struggle with their water management. Through WST2040, Malaysia can turn into one of the regional and global players as well, capitalising on Malaysia's geographical and resource advantage.

As the water sector transforms and matures, there will be key export opportunities available that are built upon the sound foundation of a dynamic water ecosystem. Water technologies in particular, as seen in the Dutch water sector example in Section 3.3.3, will be a key driver of such export opportunities. As illustrated in Section 3.2.5, aligning the development of water technologies with the 10-10 *My*STIE Framework is crucial to ensure that water solutions are targeted towards the right developmental goals in the region.

3.3.4.1 Indigenous Technologies

In addition to the technologies outlined in Section 3.2.5, there are existing water technologies developed locally that could be the blueprint for a technology development pathway that has global market potential. Professor Dr Ahmad Fauzi Ismail (Merdeka Award, n.d.) from Universiti Teknologi Malaysia developed the world's first high pressure and high CO_2 concentration hollow fibre membrane for carbon removal from natural gas stream is a prime example of how indigenous technologies can be guided and commercialised successfully. The membrane developed by Prof Fauzi is locally designed and produced, and has been sold to petrochemical industries, notably Petronas. Another example would be Professor Mohamed Kheireddine Aroua (The Star, 2020) from Sunway University Research Centre for Carbon Dioxide Capture and Utilisation.

He developed a solar-powered ultrafiltration system that has been tailored to provide access to clean water for remote communities and flood affected areas.

These local successes highlight the pockets of excellence that exists within water researchers and technopreneurs in Malaysia. Having a dynamic water ecosystem could accelerate the RDIC process that will help identify more local and regional opportunities for applications of other similar technologies in a scalable manner. The global nanofiltration membrane market is estimated to be **US$445.1 million** in 2019 while the overall renewable water market is estimated to be over **US$263 billion** in 2020 (cited in Water Online, 2021). By linking up indigenous water technologies with regional and global markets, there is significant potential economic impact for Malaysia's water sector and water-related technology sectors.

3.3.4.2 Malaysian-based Companies with International Operations

There are also other local successes where Malaysia-based companies have successful international operations in water sectors and industries. Ranhill Holdings Berhad has expanded its water and wastewater treatment services overseas, with 10 treatment facilities in Thailand and 12 in China (EU Gateway, 2020). Salcon Berhad also has water and wastewater operations in Hong Kong, Indonesia, Sri Lanka, Thailand, and Vietnam (EU Gateway, 2020).

One notable example is YTL's acquisition and operation of Wessex Water in the United Kingdom. Under YTL, Wessex Water has operated without public funding and has continuously invested to maintain the quality of their water services (YTL Power International, 2020). They adopted advanced technologies to increase operational efficiencies, upgraded key water infrastructure, and engaged with local communities to advocate for the 8R Water Philosophy and the circular economy. YTL's investments and operational excellence has seen them gain a customer satisfaction rating of 83% and is the only water company in the United Kingdom to win the Queen's award three times for excellence in innovation and sustainable development (YTL Power International, 2020). Its strategic investments have also raised their asset value from RM15.1 billion to an expected RM20.7 billion in 2025, while simultaneously increasing YTL's profit before tax by 74% (YTL Power International, 2020). These examples show the potential for increased private sector participation in Malaysia's water sector given the right incentives and accountability ecosystem.

However, the current state of Malaysia's water sector ecosystem does not have a strong environment for such private companies to thrive in. The successes highlight that the right intervention and transformation of the water sector ecosystem outlined in Section 3.2 is required. In the Wessex Water example, the United Kingdom government played a pivotal role in providing the right ecosystem for the company to succeed. The privatisation of the water industry paved the way for strong private sector participation with appropriate incentives and water tariff mechanisms. This allowed a more competitive water market to be established and allowed water operators to achieve near 100% cost recovery. The privatisation process was built on the foundation of strong initial public investments to develop the backbone smart water infrastructure necessary for private operators to succeed.

3.3.5 Value Creation for Malaysian Water Sector

In comparison, additional economic analyses also highlighted that the current spill over multipliers of the Malaysia water sector are relatively low, pointing to a lower potential of the current state of the water sector in having a positive impact on economic growth, household income as well as employment creation. Benchmark countries like Japan, Singapore, and Netherlands are able to leverage dynamic water ecosystems and strong supply chains between their water, agriculture, and industrial sectors. The high-quality water supply from their water sector can lead into agricultural outputs that are converted to higher value-added products via sales to other sectors such as food and beverage and manufacturing. Therefore, to enhance the water sector's economic multiplier to other sectors, the focus should be on strengthening the linkages between the economic sectors to streamline supply chains and efficient matching of inter-sectoral supply and demand of products and services for domestic and export uses.

As a dynamic economic sector, the Malaysian water sector will be capable of increasing its quality and output to fulfil additional demand. Under the baseline scenario the incremental household income and employments contributed by the water sector in 2040 is estimated to be **RM1.5 billion** and **55.4 thousand**

new jobs respectively. Should the Malaysian water sector ecosystem be able to emulate that of Japan's, an addition of **RM0.5 billion** of household income as well as **18,320** new job opportunities is expected to be generated throughout the economy in 2040.

In 2019, the water sector had a value-add of **RM 4.5B**, which represents a 0.32% contribution to Malaysia's national GDP. If the systemic issues above can be addressed by accelerating the growth of a skilled labour force, the right investments, and the digital transformation of the water sector (transformation of the 8i-ecosystem enablers), it is possible for the sector to achieve a much higher value-add amount to the economy. The potential of the water sector can be seen in Figure 3.8, where implementing the appropriate reforms to the water sector and water ecosystem to resemble that of Japan can lead to a value-add of **RM13.3B** by 2040, contributing 0.46% to the national GDP. Over the course of 20 years from 2021 to 2040, this simulated transformation trajectory for the water sector would have contributed a total of **RM172.6B** to the economy.

However, if Malaysia can sell its water sector services and technologies, it is possible that the contribution to the GDP can be further value-added. The reforms outlined in Section 3.2's Integrated Ecosystem Approach include transforming the Malaysian water ecosystem to be knowledge-intensive and technology-driven. A developed water ecosystem will ensure sustainable supply (both quantum and quality) of water to meet the needs of society and key economic sectors of the economy. A sound water ecosystem will then ensure appropriate strategies are in place that will ensure effective management of the demand of water by society.

3.3.6 Conclusion

This section highlights that Malaysia has the building blocks to position the water sector to be a dynamic economic sector capable of driving the nation's GDP growth in the future and building a strong regional water hub. At the present moment, the ecosystem is unable to capture the full return on value from the water resources of the country. This study reinforces that the water sector can be a major contributor to the Malaysian economy and be a regional player in attracting higher value-added demand for the country. This can be achieved by attracting foreign direct investments into the water sector and increasing the inflow of high-end foreign multi-national companies that require sustainable and high-quality water supply for industries.

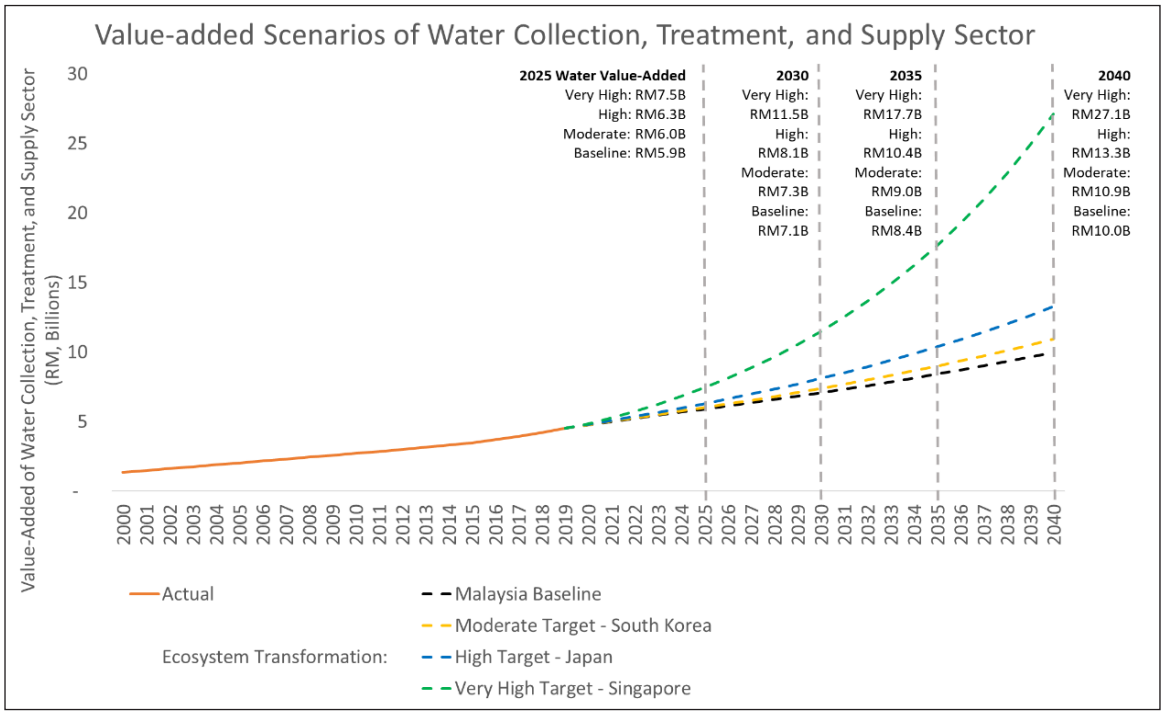


Figure 3.8. Economic potential of the water sector

Source: Department of Statistics, Malaysia. Analytics by Sunway Institute for Global Strategy and Competitiveness (2021).
Note: Economic data for the water collection, treatment, and supply sector was only available for 2010, 2015, 2017, and 2019. Missing data between years were interpolated and back casted.

This vision can only be realised if the water sector took an integrated ecosystem approach for its transformation to become an STI-driven sector underpinned by the 8i innovation framework, 8R Water Philosophy and circular economy framework, 5Ss, and 10-10 *My*STIE Framework.

3.4 STUDY ON THE NATIONAL AGENDA FOR THE WATER SECTOR TRANSFORMATION 2040 (WST 2040) AND DEVELOPMENT OF A ROADMAP

Section 1.1 to Section 1.4 of Chapter 1 of this report has elaborated on the above-mentioned EPU-commissioned study awarded to ASM as its strategic partner. Details regarding the background to the study, its objectives, and terms of reference can be found in the above-referred sections of Chapter 1.

3.4.1 Water Sector Transformation 2040 Vision and Transformation Principles

The WST 2040 initiative by EPU aims beyond the implementation of the National IWRM agenda and meeting SDG targets by 2030. It aspires to transform Malaysia's water sector from an economic enabler into a dynamic economic sector, positioning itself as a regional hub by 2040, and tapping from the huge global and regional market size of the water industry. This aspiration is contained in the address delivered on 9th December 2019 entitled "Water Sector Transformation – 12th Malaysia Plan 2021 to 2025, by Encik Azhar Noraini, then Deputy KSU of the Ministry of Economic Affairs, Malaysia (MEA, 2019)**.** In his address he also described the WST2040 initiative as a national agenda and way forward to be undertaken in four phases over 20 years, beginning with the 12th MP - 2025) and ending with the 15th MP (2036 – 2040). The 12th MP also represents the first half of the nation's Shared Prosperity Vision 2030. The 2040 Vision of the Water Sector Transformation Agenda is reflected in Box 3.4**.**

Box 3.4: 2040 Vision of the water sector transformation

1. Water security so that every Malaysian has access to reliable, sufficient, clean and quality water supply and sanitation systems at affordable costs.
2. Water Security for sustainable food production and the environment.
3. Viable and economic alternative water sources are always available.
4. Precision water supply and demand is practiced at all levels for better efficiency and sustainability.
5. The water sector becomes a vibrant economic sector with a fully competent workforce, contributing to the national GDP.
6. Every Malaysian is protected from the risk of water-related disasters and the impacts are well mitigated.

In addition, the overall objective of the WST2040 Transformation Agenda is to:

i) Manage the nation's richness in its water resources for the wealth of the nation and sharing the prosperity this wealth provides.
ii) Recognise, reorganize and make more visible as a significant contributor to national growth economically, socially and environmentally; and
iii) Transform the national water sector from one that empowers the economy to an economy that is dynamic and able to contribute more significantly to the country's Gross Domestic Product by 2040.

National commitment to IWRM Framework would continue to be the foundation for the water sector transformation agenda while also complying to 10 cross-cutting Transformation Principles, figuratively encapsulated in Figure 3.9 and as enumerated below: (i) Governance (ii) Water Resources (iii) Planning and Development (iv) Technology Adoption (v) Water Services (vi) Water Ownership (vi) Data Management (vii) Wealth Creation (ix) Risk Governance, and (x) Research, Development, Innovation and Commercialisation (RDIC).

The above-mentioned 10 Transformation Principles when applied to the current context of the Malaysian water sector are as described below:

i) Governance

It is essential that the governance systems and arrangements between the Federal and Regional/State Governments pertaining to the water sector as stipulated under the Federal Constitution be harmonised. A start in harmonisation had already been made way back in 1998, with the establishment of the Majlis Sumber Air Negara (MSAN), renamed in 2019 as Majlis Air Negara (MAN), which is a national apex body on Water Resources and Water Services Management. The Council is chaired by the PM with Members being drawn from the Regional/State Menteri Besar/Chief Ministers and relevant Ministries. It was established on similar lines as other natural resources, such as the National Land Council, National Forestry Council, and National Minerals Council.

At the Regional/State level, in line with the MSAN 08 directive, the Regions/States were directed to establish Majlis Sumber Air Negeri (MSANg) with the exceptions being Selangor (LUAS), Sabah (SWRC) and Kedah (LSANK), whereby these institutions instituted earlier as body corporates by the respective State Governments were already in existence.

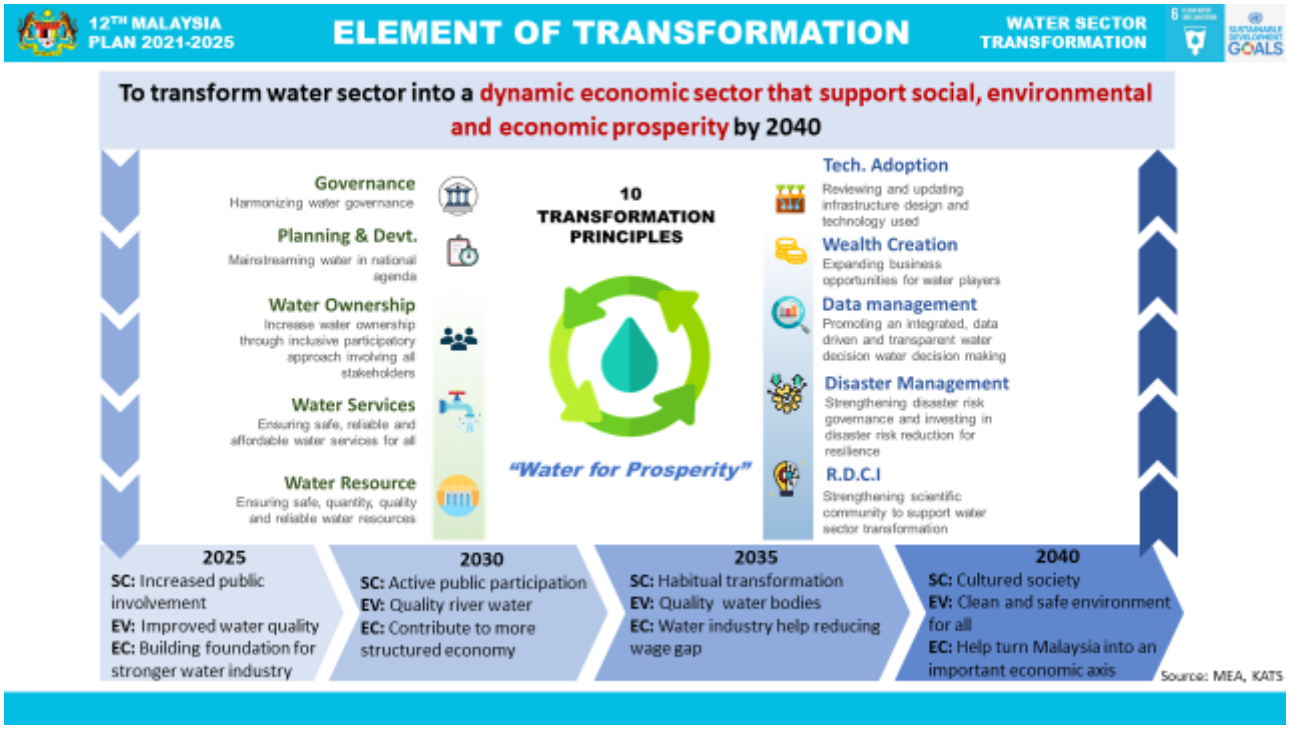


Figure 3.9. The 10 Transformation Principles

Source: MEA (2019)

The launching of the National Water Resources Policy in March 2012 was yet another landmark event to ensure uniformity in the management of water resources by respective State Administrations. An accompanying contemporary Water Act (RUU SA) to replace the outdated Water Act of 1920 was drafted in 2016 and awaits adoption by States and subsequent legislation as State Enactments.

Recent institutional changes saw the merger of water resources management and water supply services at the Federal Administration level with the formation of the Ministry of Environment and Water (KASA) though the integration of surface water and groundwater resource institutions has yet to take place.

ii) Water Resources

Towards ensuring safe, sufficient, clean, and reliable water resources, the formal adoption of IWRM as its central paradigm since the turn of this century forms the basis in ensuring that the country's water resources are sustainably managed while water supply services are efficiently and equitably provided to all users, be it domestic, municipal, industrial, agricultural or to meet environmental needs.

iii) Planning and Development

This principle ensures that water is mainstreamed in the national agenda, especially when planning and development policies are considered at the Federal, Regional and State levels.

iv) Technology Adoption

This principle ensures the need for the review and update of infrastructure design and use of latest technological advances, especially in development plans executed over the sequential five-year Malaysia Plans largely funded from public sector finance. Knowledge of current technologies, including those supported by IR 4.0, would be cost-effective while ensuring minimum risks to lives and properties. The need to replace outdated infrastructure to support current and future demand, coupled with the application of non-structural measures and adoption of nature-based solutions, wherever feasible, would need to be actively pursued.

v) Water Services

Water Services are provided to meet the demands expressed in Malaysia's Water Vision formulated in the year 2000 reproduced below:

"Malaysia will conserve and manage its water resources to ensure adequate and safe water for all (including the environment)".

The key objectives of the Malaysian Water Vision are:

- Water for people – all communities will have access to safe, adequate and affordable water supply, hygiene and sanitation.
- Water for food, agriculture, and rural development – provisions of sufficient water to ensure national food security and promote rural development.
- Water for economic development – provisions for sufficient water to spur and sustain economic growth within the context of a knowledge-based economy and e-commerce.
- Water for the environment – protection of the water environment to preserve water resources (both surface and groundwater resources) and the natural flow regimes, biodiversity, and cultural heritage as well as the mitigation of water related hazards; and
- Water for Energy – this has been added in to reflect the current trends on the water-energy-food nexus, looking at it in terms of both policy and process, as water is inextricably linked to agriculture, food production and where there is an urgent need for continuous improvements in water and energy efficiencies to ensure sustainable economic growth.

vi) Water Ownership

Increased water "ownership" and greater "buy in" requires an inclusive participatory management approach involving all stakeholders. The WST 2040 initiative has recognised PEOPLE as the main driver of the transformation; hence, a robust Advocacy, Awareness, Capacity Building and Public Participatory Platforms (AACB) programme is crucial to ensure the success of the initiative. The three components of the AACB programme are defined below to add more clarity of purpose:

- ***Awareness raising*** – inculcate greater understanding regarding the shared value of water, while also enhancing the ability to raise concerns on water issues that impact communities both within and outside their social circles.
- ***Advocacy*** – exercise the mandate to pursue in support of a cause, idea, initiative or policy.
- ***Capacity Building*** - Planned development of knowledge base, output rate, management skills, and other capabilities of a public, private and community stakeholder organisation through acquisition, incentives, technology drive, and training based on needs assessment.

vii) Data Management

This principle is targeted to promote an integrated data-driven and transparent decision-making system. It entails the development and establishment of a dedicated central Integrated Water Sector Data Centre which is also seen as one of the key game changers in the transformation.

viii) Wealth Creation

The water sector being hitherto over-reliant on public sector funding needs to explore alternative water financing to sustainably fund the whole-value chain of the water sector sustainably. Wealth creation simply calls for the creation and expansion of business opportunities for the water industry players. It includes taking a re-look at the water ecosystem in the country, re-examining current gaps and proposing strategies and policies to strengthen them, thereby raising the productivity and efficiency of the sector.

ix) Risk Governance

Disasters cause social, environmental, and economic losses to the nation, with loss counted in terms of lives lost as well as damage to properties. Therefore this principle aims at strengthening disaster risk governance as well as investing in disaster risk reduction for reliance.

x) Research, Development, Innovation and Commercialisation (RDIC)

Strengthening the scientific community's RDIC to support water sector transformation is indeed a much-needed prerequisite to stay updated, if not ahead, in providing the latest in technology driven water infrastructure and extended to management practices. The ASM Advisory Report of 2014 entitled "Setting a National Agenda for Integrated Water Research" has comprehensively addressed this subject with recommendations including strategies to be pursued.

3.4.2 The Four Phases of Water Sector Transformation (WST) 2040

The National Agenda for WST2040 aspires to transform the national water sector from one that empowers the economy to an economy that is dynamic and able to contribute more significantly to the country's Gross Domestic Product. This dynamic role as a new economic sector will directly enhance the growth of employment opportunities in the water sector and indirectly drive the development of the nation's science, technology and innovation.

The WST2040 study, to be implemented over 20 years, will be undertaken in four Phases, beginning in 2021 (Figure 3.10), focusing on the following strategic directions:

a. Phase 1 (2021 – 2025): Accelerating implementation of Integrated Water Resources Management (IWRM)
b. Phase 2 (2026 – 2030): Uplifting indigenous technology to be at par with international standards
c. Phase 3 (2031 – 2035): Achieving economies of scale
d. Phase 4 (2036 – 2040): Becoming the regional water industry hub

The year 2030 marking the end of Phase 2 and the 13th MP is another significant milestone being the target year for the National Shared Prosperity Vision (SPV) and the Global Sustainable Development Goals (SDG) as shown in Figure 3.10 below,

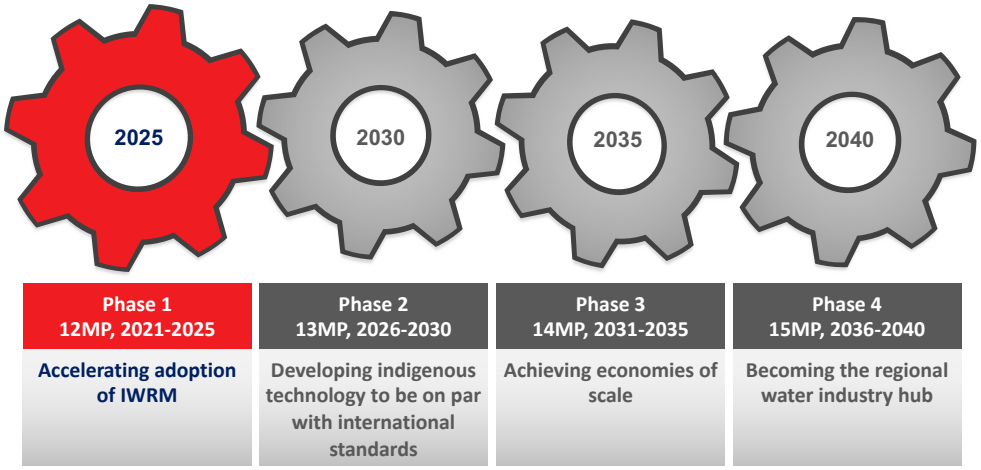


Figure 3.10. The Four Phases of the National Agenda on Water Sector Transformation 2040

Source: EPU, 2021)

Phase 1 WST 2040 will begin in the 12th MP with the focus on developing the foundation to enable the transformation process to begin, that is, through accelerating implementation of Integrated Water Resources Management (IWRM). Special emphasis to IWRM will be supported by five focus areas, as shown in Figure 3.11, namely:

i) People (Empowering People)
ii) Governance (Strengthening Governance at all levels)
iiii) Information and RDCI (Enhancing capability in Data-driven Decision-Making)
vi) Finance (Ensuring Sustainable Financing)
v) Infrastructure and Technology (Developing Sustainable Infrastructure with Cost Effective Technology.

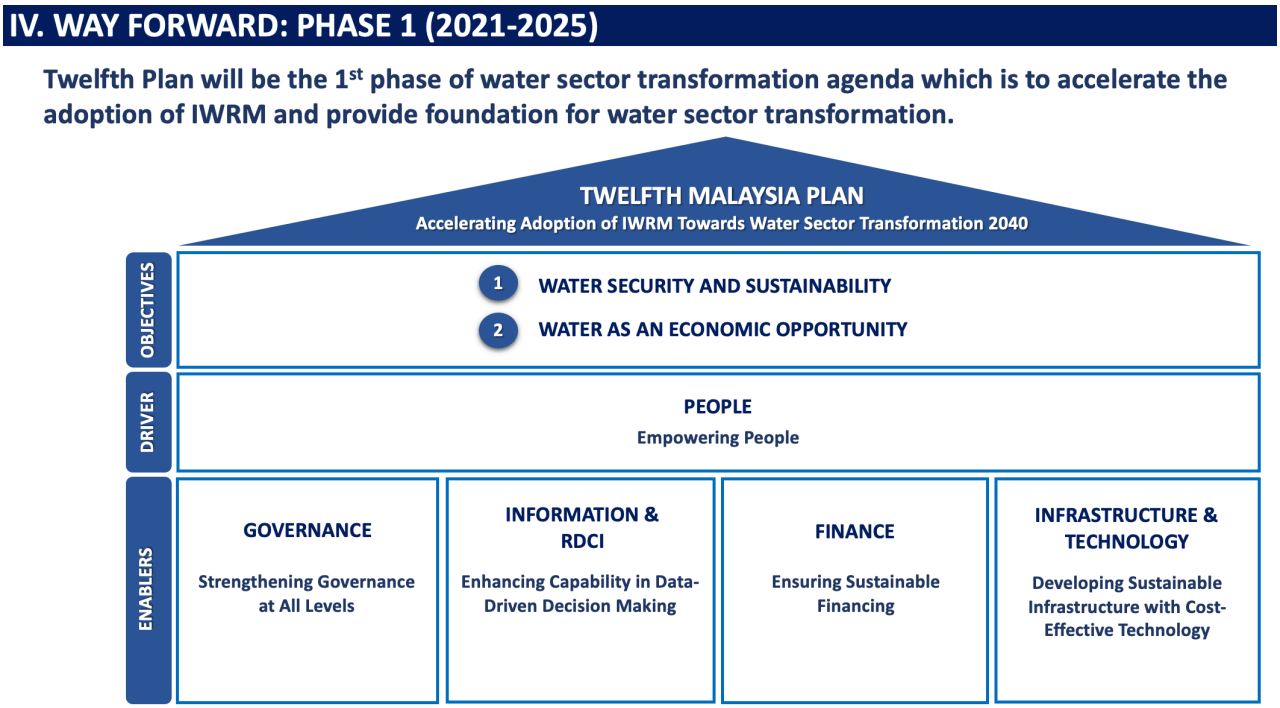


Figure 3.11. The national agenda on the water sector transformation 2040 (Phase 1: five focus areas)

Source: EPU, 2021

Figure 3.10 above also illustrates the "staged" approach adopted over four Malaysia Plans to achieve the WST target by year 2040. The staged approach as depicted does not mean there will be clean breaks from one Malaysia Plan to another in terms of the key focus directions and related strategies, namely (i) Accelerating Adoption of IWRM under the 12th MP (ii) Uplifting Indigenous Technologies to be at par with international standards under the 13th MP, (iii) Achieving Economics of Scale under the 14th MP, and (iv) Becoming a Regional Water Hub by the end of the 15th MP.

3.4.2.1 Phase 1, 12th MP (2021 to 2025):

The implementation of Phase 1 under the 12th MP would have its focus on the Phase 1 key focus direction of Accelerating Adoption of IWRM, while parallel efforts and actions would also simultaneously begin during the 12th MP on the key focus directions for the subsequent three phases. This transformation process over the 12th MP is best illustrated in Figure 3.12-1 below. While the dominant larger "cogwheel" coloured red represents the key focus direction for the 12th MP, the 3 other cogwheels representing the key focus directions of the 13th MP, 14th MP and 15th MP would also begin their process of engagement under the 12th MP to form an interlocked system moving together at varying pace heading towards the targeted WST by 2040.

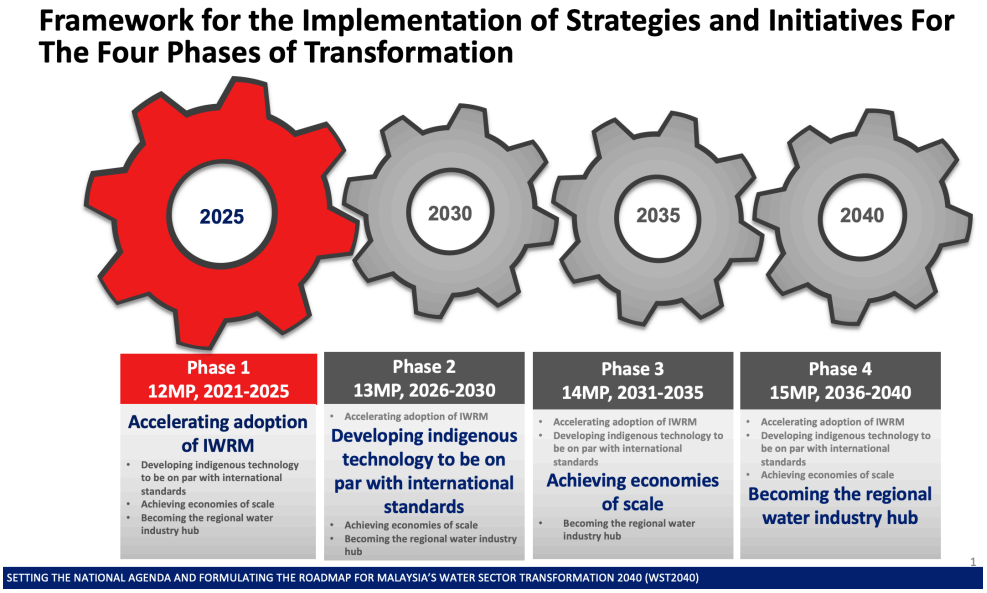


Figure 3.12-1. Phased seamless approach to WST2040 implementation (Phase 1) – 12th MP

3.4.2.2 Phase 2, Phase 3 and Phase 4 (13th MP 14th MP and 15th MP):

Similarly for the remaining three phases of the Water Sector Transformation Process, the dominant key focus direction would shift to its next designated position in the interlocked system as depicted by the position of the larger red coloured cogwheel in Figure 3.12-2, Figure 3.12-3 and Figure 3.12-4 hereunder. Therefore, the entire water sector Transformation journey to 2040 is a seamless process of continuous engagement spread over four phases beginning with the 12th MP and ending with the 15th MP.

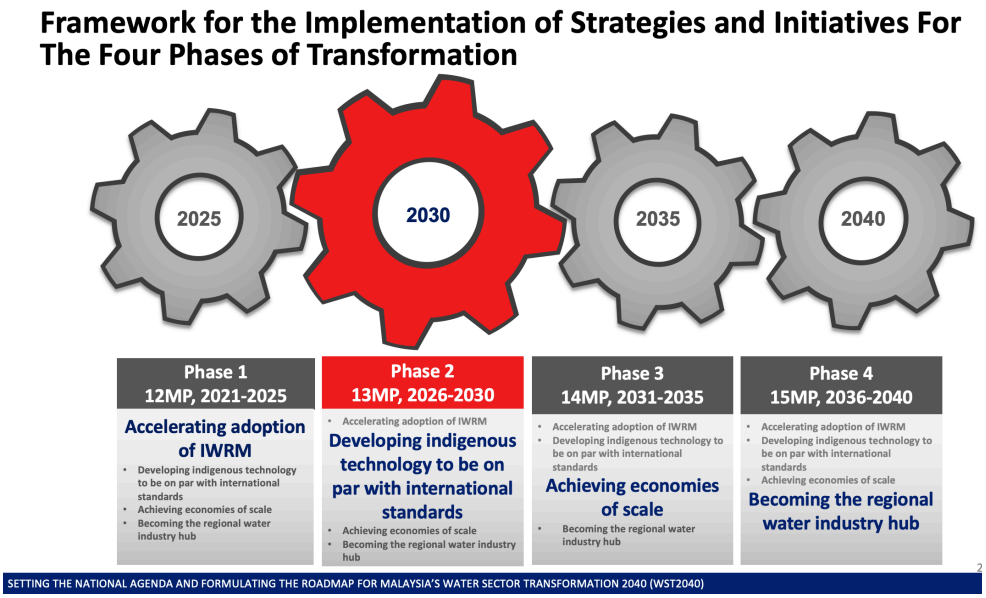


Figure 3.12-2. Phased seamless approach to WST2040 implementation (Phase 2) – 13th MP

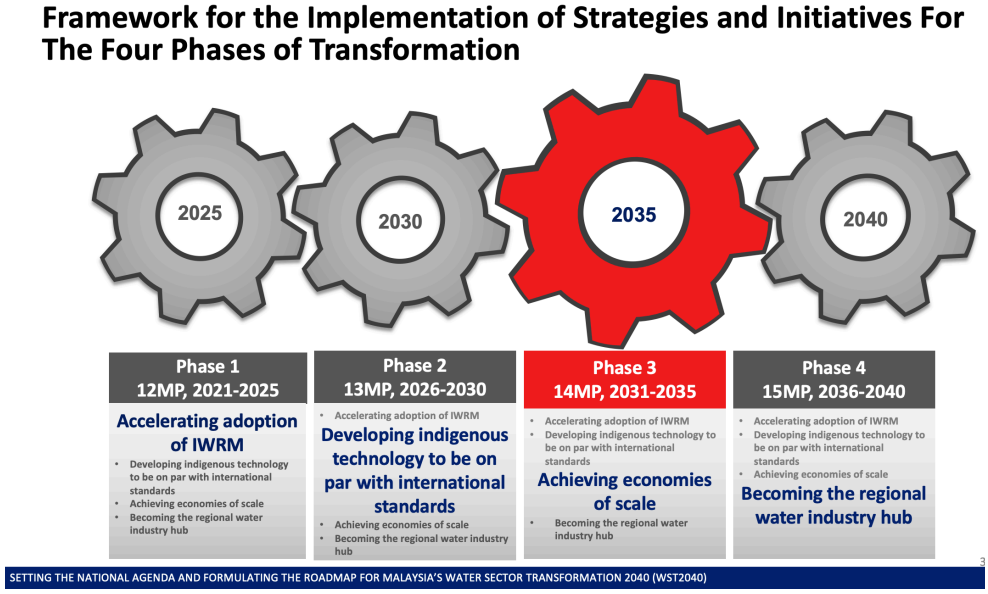


Figure 3.12-3. Phased seamless approach to WST2040 implementation (Phase 3) – 14th MP

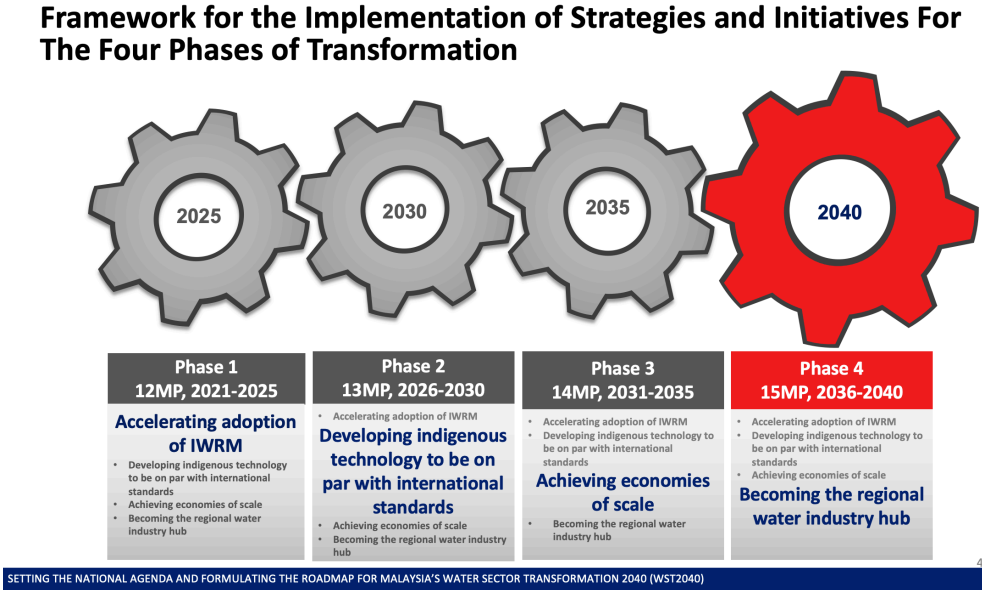


Figure 3.12-4. Phased seamless approach to WST2040 implementation (Phase 4) – 15th MP

3.4.2.3 Five-Step Review Process:

A 5-step Review Process is proposed for each of the four phases of the WST 2040 roadmap, comprising **Coordination, Implementation, Monitoring, Reporting** and **Evaluation** as illustrated in Figure 3.12-5 below. The review process would come under the purview of the National WST Task Force reporting to the **National WST2040 Management Committee** proposed in Section 3.2.5.3 of this chapter to oversee the successful implementation of the Transformation of the Water Sector over 4 phases until the year 2040. Similarly, for the Monitoring and Evaluation function, the Study has proposed an independent body to undertake this task as reported in Section 3.2.5.4.

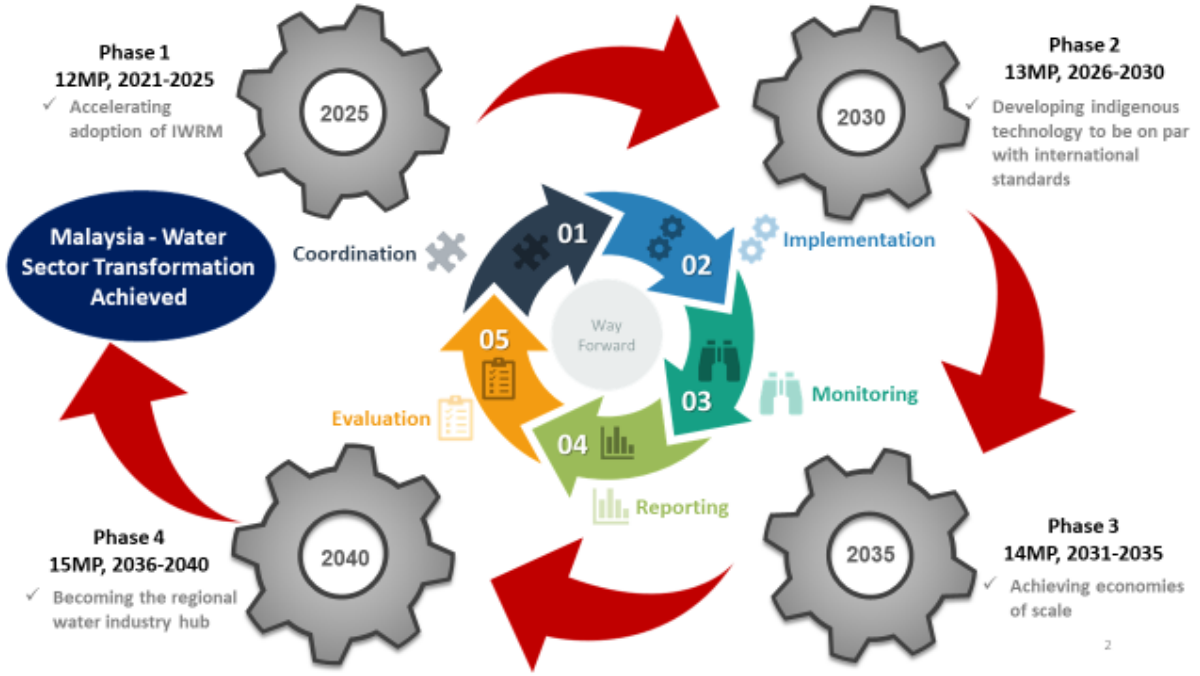


Figure 3.12-5. Five-step review process

3.4.2.4 12th Malaysia Plan (2021 to 2025) and its impact on WST2040 Study:

As reported in Section 1.5 of Chapter 1, during the implementation of the WST2040 study and when the Study had already reached the stage of submission of the Draft Final Report, the 12th MP was officially launched in Parliament on 27September 2021. Extracts from the 12th MP document of relevance to the WST2040 agenda are described below.

The Plan, with the objective of 'A prosperous, inclusive, sustainable Malaysia', is in line with the SPV 2030 and SDG 2030 targets. The focus over the next four years (until 2025) will be on three key themes, namely, **(i)** ***resetting the economy,*** **(ii)** ***strengthening security, well-being, and inclusivity*** as well as **(iii)** ***advancing sustainability.***

Theme three focuses on advancing sustainability through advancing green growth as well as enhancing energy sustainability and **transforming the water sector**. The next five years will see a nationwide shift to more sustainable economic practices and lifestyles that value natural endowments and environmental health. This shift will address the issues of climate change, unsustainable consumption and production practices, loss of biodiversity, lack of coherence in the implementation of policies and inefficient water resources management. In the12th MP, green growth will be augmented to achieve sustainability and resilience. In this regard, the need to share responsibility through adopting the whole-of-government whole-of-society approach in moving towards a low-carbon nation will be emphasised, while more equal benefit sharing from the utilisation of natural resources will be promoted.

Energy and water will be managed holistically and sustainably, considering the supply and demand of these resources. The energy sector will address the energy trilemma, while the water sector will focus on **ensuring water security** for all. Two game changers will be implemented under Theme 3, namely embracing the **Circular Economy and accelerating adoption of the Integrated Water Resources Management (IWRM)**. Transitioning to the Circular Economy will yield significant efficiency gains and cost-effectiveness as well as reduce pressure on the environment. It will also deliver a more innovative and competitive economy as well as create new opportunities for green growth. **Accelerating the adoption of the IWRM will be the starting point in transforming the water sector.** The effective execution of policies and strategies under Theme 3 will contribute to sustainable and resilient growth as well as the achievement of the 2030 Agenda (EPU, 2021).

In the document, the chapters of relevance to the water sector are Chapter 8 (Advancing Green Growth for Sustainability and Resilience) (Box 3.5) and Chapter 9 (Transforming the Water Sector) (Box 3.6).

Box 3.5: Clean, Green and Resilient Development Agenda through the Whole-of-Nation Approach

The clean, green and resilient development agenda through the whole-of-nation approach, whichis socially inclusive and sustainable will be the way forward for green growth. Clean in the sense that it minimises environmental impact, green in that it is efficient in the use of natural resources and resilient in accounting for natural hazards.

The whole-of-nation approach is a holistic means to hold all stakeholders accountable in implementing the clean, green and resilient development agenda. Such an approach will intensify collaborative efforts and ensure complementarity of actions taken by stakeholders in addressing environment-related issues. In this respect, the public and private sectors, civil society organisations (CSOs) and individuals will share responsibility in ensuring environmental sustainability and achieving the common goals of the 2030 Agenda. In addition, the financial services sector will play a key role in channelling capital to accelerate the adoption of sustainable business practices.

The 2030 Agenda reflects the common understanding that a healthy environment is integral to the full enjoyment of basic human rights, including the rights to life. Directly acknowledging the linkages between the environment and socioeconomic development present new and interwoven opportunities to meet the SDGs. Implementation of the clean, green and resilient development agenda will contribute towards planetary health, a green economy that is competitive and innovative as well as the achievement of Goals (2, 6, 7, 11, 12, 13, 14 and 15)

Clean
Socioeconomic development that is low-carbon, less polluting and resource-efficient will lead to a green economy, create new opportunities for growth and shift people's behaviour towards sustainable consumption and production practices.

Green
Conservation and protection of the natural capital will improve the health of ecosystems, enhance livelihood and ensure food security.

Resilient
Ability to adapt and prepare for the impact of climate change and disasters will reduce risks and vulnerabilities as well as protect development gains
From
Current Collaboration Approach
To
Whole-of-Nation Approach

Source: EPU – 12th MP document

Box 3.6: WST2040

Managing water resources as natural capital for higher levels of economic growth, environmental quality and social development is an important aspect of green growth. The water sector will be restructured to enable it to be a significant contributor to national growth and wealth creation through a 20-year transformation agenda. The WST2040 will be developed to set the strategic direction towards positioning the sector as a dynamic growth engine, while ensuring water security for all. By 2040, it is envisaged that Malaysia will become the regional water industry hub. The transformation will be carried out through four phases under Malaysia Plans with specific focus in every phase, as described in Figure 1.

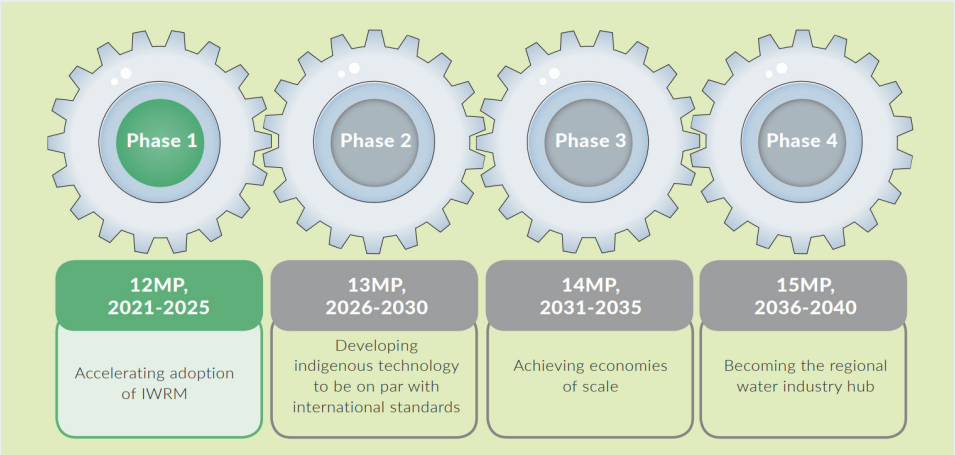


Figure 1: Four phases of WST2040

A roadmap will be developed to outline strategies, initiatives and programmes for each phase to ensure the success of the transformation. In Phase 1 (2021-2025), the adoption of IWRM will be accelerated. This is the most critical phase that will lay the foundation for the transformation.

A dedicated task force comprising members from the public and private sectors will be established under the National Water Council. The task force will guide, coordinate, monitor and report progress as well as review, realign and provide recommendations for the successful implementation of the WST2040 agenda.

(*Source*: EPU – 12th MP document)

The strategies and initiatives relevant to the water sector in the 12th MP Chapter 8 and Chapter 9 are as listed in Table 3.4 and Table 3.5 below:

Table 3.4. Water sector related strategies and initiatives in Chapter 8, 12th MP

No.	Strategy	Initiative
A2	Accelerating Transition to the Circular Economy	Creating an Enabling Ecosystem for the Circular Economy
		Improving Design and Processes of Products and Services
		Implementing Extended Producer Responsibility
		Strengthening Waste Management
A3	Sharing responsibility in pollution control	Prioritising Environmental Health
		Implementing Environmentally Sound Management of Chemical and Hazardous Substances
A4	Increasing Resilience against Climate Change and Disasters	Implementing Evidence-Based and Risk-Informed Actions
		Adopting Integrated Approaches for Climate Adaptation and Disaster Risk Reduction
		Enhancing Early Warning Systems and Disaster Response
		Enhancing Disaster Preparedness and Recovery)
B1	Conserving Natural Ecosystems	Enhancing Conservation Measures for Terrestrial and Inland Water Areas
		Enhancing Conservation Measures for Coastal and Marine Areas
		Mainstreaming Natural Ecosystem Science and Approaches into Development Planning
B4	Enhancing Conservation of Water Resources	Strengthening Water Resource Governance
		Addressing Water Pollution
C1	Strengthening Environmental Governance	Improving Policy and Legislation
		Strengthening Institutional Framework and Human Capital
		Strengthening Local Authorities
C2	Scaling-up Green Financing and Investments	Enhancing Domestic Green Financing and Investments
		Leveraging Bilateral and Multilateral Financing
		Enhancing Environmental Economic Instruments
		Promoting Disaster Risk Financing
C3	Instilling Sense of Ownership and Shared Responsibility	Increasing Awareness to Steer Behavioural Change
		Promoting Inclusive Stakeholder Collaboration

(*Source*: Chapter 8: Advancing Green Growth for Sustainability and Resilience; EPU – 12th MP document)

Table 3.5. Water sector related strategies and initiatives in Chapter 9, 12th MP

No.	Strategy	Initiative
B1	Empowering People	Establishing Public Consultation Platform
		Implementing Comprehensive Awareness, Advocacy and Capacity-Building Programmes
		Expanding Community-Driven Conservation Programmes
B2	Strengthening Governance at All Levels	Strengthening Water Resources Management
		Mitigating Water Pollution
		Institutionalising the Water-Energy-Food Nexus Approach
B3	Enhancing Capability in Data-Driven Decision-Making	Strengthening Water Data and Research Centre
		Enhancing Capacity of Water Industry Players and the Scientific Community
B4	Ensuring Sustainable Financing	Strengthening Financial Sustainability of Water Services Providers
		Promoting Innovative Financing
B5	Developing Sustainable Infrastructure with Cost-Effective Technology	Adopting Alternative System for Water Services in the Rural Areas and Islands
		Reducing Non-Revenue Water
		Optimising Water Resources through Cost-Effective Infrastructure
		Emphasising Nature-Based Approach
		Implementing Circular Economy in Water Sector
		Scaling Up Efficient Use of Water

(*Source*: Chapter 9: Transforming the Water Sector; EPU – 12th MP document)

3.4.2.5 Comparative Review

Comparing the Four Phase Transformation 2040 agenda depicted in Figure 3.10 above with that shown in Box 3.6 of the 12th MP document, it is obvious that the two are similar, if not identical. The Strategic directions for each phase are also the same. The five focus area framework adopted for Phase 1 and reflected in Figure 3.12-1 above and the five Strategies B1 to B5 appearing in Chapter 9 of the 12th MP document, there is again a similar perfect match between the two except by way of terminology used, i.e ."Focus Area" vis a vis "Strategy". For all intents and purposes, the launch of the 12th MP is indeed timely to assert the government's endorsement of the 4 phase WST2040 agenda and its planned implementation as intended in the Study objectives. Notwithstanding, the Study Team has studied the 12th MP document in greater detail and where there are inconsistencies they have since been duly rationalised to ensure congruence.

3.4.3 Summary Briefs, Summary Findings and Recommendations of the 8 Sub-sectoral Studies

As described in Section 3.4.2 above, in appointing ASM as its strategic partner to undertake the WST2040 study, EPU had taken into consideration the earlier ASM NIWRMP Study's 2-Volume Reports' findings (ASM, 2016) and supporting IWRM-related thematic standalone Advisory Reports. EPU recognised that the ASM Studies were important and would serve as complementary references to Ministries/Agencies nation-wide when implementing the national Water Sector Transformation 2040 (WST 2040) agenda. To further reiterate the study scope, the WST2040 study addresses eight additional sub-sectors identified as being strategic in advancing the WST2040 agenda, some of which regarded as game changers. The eight sub-sector studies are as follows:(i) Advocacy, Awareness, Capacity Building and Public Participatory Platforms (**AACB**) (ii) Integrated Water Sector Data and RDIC Centre (**IWSDC**) (iii) IR 4.0 in the various Water Sub-sectors (**IR4.0WS**) (iv) Water-Food-Energy-Nexus (**WFE Nexus**) (v) Virtual Water and Water Footprint (**VW&WF**) (vi) Climate Change Impact and Adaptation (**CCIA**) (vii) Alternative Water Financing (**AWF**) and (viii) Water as an Economic Sector (**WES**).

Chapter 1 has described in detail the management structure instituted by ASM to undertake the 20-month WST2040 study. Briefly, to manage the eight sub-sectoral Studies, a Project Management Committee (PMC) was established by the ASM council, which is overseen by a Technical Committee chaired by an ASM Council member and a Steering Committee chaired by the Deputy Director of EPU. Internal oversight for the study by ASM as the strategic partner was provided by STIPAC. Apart from the Chair, the members of the PMC are the Task Force Leaders of the above mentioned 8 sub-sectoral studies who are all Fellows of ASM. In addition, there are four other nominated Subject Matter Specialists and a Chief Writer who are members of the PMC as well as an Advisor to the PMC Chair appointed by the ASM Council.

The completed study reports of the eight sub-sector studies undertaken by the respective Task Forces are submitted as stand-alone reports as follows:

1. Volume 2 - Advocacy, Awareness, Capacity Building and Public Participatory Platforms (**AACB**)
2. Volume 3 - Integrated Water Sector Data and RDIC Centre (**IWSDC**)
3. Volume 4 - IR 4.0 in the various Water Sub-sectors (**IR4.0WS**)
4. Volume 5 - Water-Food-Energy-Nexus (**WFE Nexus**)
5. Volume 6 - Virtual Water and Water Footprint (**VW&WF**)
6. Volume 7 - Climate Change Impact and Adaptation (**CCIA**)
7. Volume 8 - Alternative Water Financing (**AWF**), and
8. Volume 9 - Water as an Economic Sector (**WES**)

3.4.3.1 Summary Briefs of the Eight Sub-sectoral Studies

Summary briefs of each of the above eight standalone reports have been included in this main report with the roadmaps inserted in the respective standalone Final Reports (Appendix 3.1). Each Summary brief addresses the following aspects:

- Background/Introduction of each sub-sectoral study
- Objectives of sub-sectoral studies
- Findings based on each Scope of the TORs by each of the sub-sectoral study as required
  - current policies reviewed and analysed (please include Ministry currently responsible and year of Policy launch, Proposals for Improvement of Policy (ies)
  - comparative strategy analysis/business models with other nations)
  - potential of the nation's water sector industry taking into consideration current global markets towards making the water sector a dynamic new economic sector capable of driving the nation's GDP growth in the future
  - Consultations with stakeholders and experts with the aim of finalising the proposed strategies and initiatives of the nation's water sector transformation (including providing lists of stakeholders/ experts engaged with and dates)

- A list of Immediately Implementable Projects for 12th MP
- Transformation items, Targets and KPIs for the four MPs

A total of 601 Targets and 601 KPIs were identified by the eight sub-sectors over the four MPs (Table 3.6).

Table 3.6. Number of targets and KPIs over four MPs

Sub-Sectors	12MP		13MP		14MP		15MP	
	Targets	KPIs	Targets	KPIs	Targets	KPIs	Targets	KPIs
AACB	18	18	14	14	13	13	13	13
IWSDC	19	19	11	11	8	8	8	8
IR4.0WS	9	9	9	9	9	9	9	9
WFE NEXUS	26	26	15	15	25	25	47	47
VW & WF	13	22	3	2	4	4	2	5
CCIA	63	63	54	54	48	48	49	49
AWF	15	15	15	15	15	15	15	15
WES	13	13	13	13	13	13	13	13
TOTAL	**176**	**174**	**134**	**133**	**135**	**135**	**156**	**159**

3.4.3.2 Summary Findings and Recommendations of the 8 Sub-sectoral Studies from the PMC's Subject Matter Experts

The Project Management Committee's (PMC) four Subject Matter Experts, Academician Datuk Fateh Chand, Dato' Dr. Abdul Rahim Nik, Dr. Low Kwai Sim and Dr. Kalithasan Kailasam, as well as the PMC Chairperson, Dr. Ir. Salmah Zakaria, were requested to read and summarise the 8 Sub-Sector Draft Final Reports' findings and recommendations and submit their write-ups based on the five focus areas of People (Dr. Kalithasan Kailasam), Governance (Academician Datuk Fateh Chand), Information and RDIC (Dato' Dr. Abd. Abdul Rahim Nik), Infrastructure and Technology (Dr. Low Kwai Sim), and Finance (Dr. Ir. Salmah Zakaria). Their synthesised summary of the findings and recommendations organised around the five focus areas is as follows:

1. Findings

i) People

PEOPLE appears as major component in almost all the eight sub-sectors defined as the driver to accelerate actions in tackling the issues and to be solution for the agenda proposed under the WST2040. It is also noted that PEOPLE are seen as the victim of circumstances due to ignorance and lack in the level of awareness, knowledge, skill and personal connection to water and its value. When there is no value placed for water, the impact leads to wastage and pollution which impose significant impact on human livelihood. Awareness and skill need to be feed upon to the PEOPLE, especially on the importance of water resources, the need for protection, the water security and water supply mechanism in whole as well as the key roles that PEOPLE can play on IWRM.

AACB highlights the need for PEOPLE to be seen as the driver as PEOPLE are the source (cause of the issue) and also the solution. Lack of awareness and guidance to advocate on issues related to water resources backfires the public. PEOPLE can be the army of network and taskforce to address the proposed initiatives/ transformation with awareness and training as well as guidance. Start at mass and tackle the source of the issues with empowerment and awareness. PEOPLE stand for public; seen as the driver, where the ignorance turned to be their strength into IWRM. PEOPLE to be acknowledged to significantly contribute to the water sector through the followings: (i) Accelerating implementation of IWRM. (ii) Transforming the water sector from an Economic Enabler towards becoming a dynamic growth via the national agenda on WST 2040.

AACB also highlighted that to be part of the Water Advocacy - awareness, knowledge and skill are required to lead action driven PEOPLE. Communities also can advocate for water sector – i.e. via the public participatory platform (PPP) and Training Modules (based on Quadruple Helix Model). There are four main stakeholders with common and differentiated roles and responsibilities to be put into practice under the model. The stakeholders should be made aware of their roles, potential contributions and how to overcome

some of the challenges in implementing IWRM.
With capacity building, network platform, trainings and continuous engagement using the **AACB**, PEOPLE can play significant role to address and mitigate corresponding issues as well as contribute to the policy developed in long run. For the agencies, their officers need to be educated and trained before approaching the communities. Train the Trainers and Top to Bottom Approach is significant for outreach and engagement via the governmental agencies. As for civil society and community engagement, Citizen Science Model is seen growing exponentially in urban setup in Malaysia and can be replicated to other areas or community background for wider engagement. This is a proved and well acceptable concept worldwide.

VW & WF are notably wider in scope and narrowed to be focused on three key strategies: development of a WF training module for water manager competency programme, conduct capacity building for WF competency and promotion of WF as a priority research area. The objective is to empower PEOPLE (the driving force) focused on IWRM (connecting PEOPLE) and to have impact on the socio-economic outcome. This is vital to ensure that the virtual water usage is also properly understood and managed sustainably as part of water and water resources management.

IWSDC focused on empowering PEOPLE through better access to information through proposed legal amendments, promotion of open science concept, establishment of public participation platform, as well as enhancing training and capacity building program in data, technology, and water management related skills. IWSDC also highlights the focus and expand the talent pool through participation of PEOPLE through establishment of open science and crowdsourcing. This will enhance access to good and trusted data for meaningful participation in IWRM and provide platform for people to participate in water sector decision – making process.

IR 4.0 highlights on the integration of advanced internet-based control systems that allow PEOPLE (that has access to technology) accelerating innovation and adoption of 4IR technologies to focused group of PEOPLE.

WFE Nexus objective and outcome being narrowed to only municipal linked – case study and baseline data, where PEOPLE defined as human capital requirements to enhance nexus security and capabilities, the target and outcome is narrowed and specific to those with access to the tech, respective target groups which are able to work on it.

CCIA, AWF and WES highlight PEOPLE as the victim, impacted badly when the water sector is affected, by highlighting the importance of resilience among PEOPLE. PEOPLE need to be empowered not only on how to live together but also on how to safeguard themselves from disasters related to inefficient water management. PEOPLE also need to be empowered on the importance of nature- based solution which in long run benefits the PEOPLE and reduces the impact to PEOPLE. Furthermore, outreach and awareness on how the corporates, financial business and industries can support and sustain water management as part of their water stewardship/balancing also highlighted and address.

ii) Governance

Water shortages and inadequate access to quality water supplies are a major concern. While Malaysia gets abundant rainfall, the water sources are vulnerable to increasingly erratic weather patterns. Coupled with an aged water infrastructure and under-resourced water management systems, there has been an increasing trend of water supply shortages and disruptions. These problems of the country's water system have major implications on the health and well-being of citizens and the development of local industries. Hence, better management of the country's water sources is critical to ensure **security, sustainability** and the development of a **vibrant water industry** that becomes a major revenue earner for the nation and a key enabler for ensuring the competitiveness of other sectors of the economy where water is an important input.

In the transformation of the water sector, five focus areas were identified of which **Governance** is one and it plays a key role in the management of the water sector. Based on **ASM's 8i water ecosystem framework,** governance covers **institutional quality, interaction, integrity systems and internationalisation.** Water

resource management in Malaysia has been sectoral and fragmented for decades. Although several programmes and training have been developed at government, community, academia, and business/ industry levels to create awareness on the importance of water management, there is still a general lack of understanding on water management especially with respect to **IWRM**. No **awareness, advocacy and capacity building** mechanism and tools for water management are embedded in some of the policies. There are a large number of stakeholders that need water resources for the sustainable management of their activities. These activities cover water for: domestic supply, manufacturing, agriculture for food and plantation crops, management of natural resources, transportation, recreation, and the environment.

Different Ministries/Agencies have formulated policies, acts and enactments which have resulted in the current fragmented state of Governance at the Federal, State and Local Council levels. Thus, there is an urgent need to make progress in streamlining the individual sectoral policies. The streamlining will help each department to achieve their goals and they can identify any gaps and overlaps in implementation and enforcement. Water, food and energy sectors are highly interconnected and require integrated solutions which have been lacking, probably due to a lack of incentives for a nexus approach. While there are many players in the water sector, there is a lack of a **"Champion with Clout**" which has led to a lack of coordination and harmony in policy direction, planning and execution. Politics often tends to get in the way to optimally managing the sector to be a vibrant economic sector. Further, due to the different stages of development of the institutions (federal, state, local council, industry, and community organisations), the level and quality of cooperation, collaboration and knowledge sharing among the stakeholders are patchy and fragmented. In some instances, there exists overlapping roles.

The levels of use of **digital governance systems** in the water sector amongst the institutions are relatively low. Without sound digital governance system and the under-utilisation of **IR 4.0**, managing the complex relations between the multiple agencies and stakeholders remains a challenge. Lack of proper regulation and planning of data collection and dissemination result in **low levels of information sharing** amongst institutions in the water sector. These **gaps in the water governance system,** including **risk management** lead to challenges in managing and monitoring water basins, especially enforcement of pollution control of the water sources, and thus affecting security and sustainability for the maintenance of human health, water-related economy, environmental health, and today's lifestyle.

Weak governance systems also impact the adherence to global best practices a challenge. This results in industry operating at the lower end of the global innovation and supply chain. This affects international linkages with global centres of excellence and players from the global water markets. As such, the level of knowledge and technology transfers between local and foreign players is low. This negatively impacts the level of FDIs into the water sector and the export market for high value-added products and services remains low. This has relegated the water sector to be a primarily domestic focused industry. It has not been a major export earner for the country.

Several policies, relevant legislation, and strategies to fully transform the sector into a dynamic competitive economic sector are not in place (e.g., competitive tariff/pricing policies, water trading rules, water footprint and virtual water, risk management, nexus system for water, food and energy, data sharing and other competitive market mechanisms) to attract private or foreign investments into the water sector. Due to fragmented governance system in the supply chain, the full potential of the water as a vibrant economic sector has not been realized.

To enable the transition from the conventional linear economy to the **circular economy** to create a more sustainable and responsible businesses and investments, an enabling framework needs to be developed as guidance for the economic sectors to shift to the circular economy where the entire value chain of products and services as well as the stakeholders involved will be mapped (12th MP document).

iii) Information and RDIC

- Reliable information and data are crucial enablers in the Water Sector Transformation agenda, especially in data-driven decision-making process. However, sharing of and accessibility to pertinent data from the government domain are not easy and cumbersome, largely due to restrictive laws, such as the Official Secret Action (OSA), the Ministerial Functions Act, 1965 and partly due to an archaic retrieval and storage system. This is so due to collection and managing of water-related data by various government agencies[18] are generally designed to serve respective departmental purposes, including for monitoring, regulating, or forecasting, which has led to unnecessary duplication in data collected. In this connection, initiatives created by the government to share data, such as the Public Sector Open Data (DTSA) by MAMPU and MyGDI by the National Geospatial Data under KeTSA, have seen a limited success due to the above stifling laws as well as the sectoral nature of governing institutions.

- In addition, the lack of the legal framework related to an open data ecosystem and the national data sharing policy that supports free flow and sharing of information which are keys to spurring innovation and economic growth. Moreover, to accelerate the implementation of IWRM, an integrated and comprehensive information sharing framework is essential to ensure an efficient flow reliable and trusted data from government agencies to all stakeholders.

- RDIC activities in water sector face many challenges and can be generally characterised as fragmented, weak linkages and coordination, and a lack of national focus. Research activities in the past were largely ad hoc and a lack clear direction, although pertinent issues and challenges in water sector have been identified and appraised. Similarly, research funding for water sector has been meagre and insufficient in comparison with other sectors. Nevertheless, huge potential could be derived from RDIC in water sector by harnessing the advanced science and cutting-edge technology, and innovation through a collaborative and coordinated multi-disciplinary research based on national needs and priorities.

- While the digital transformation/ecosystem in the water sector is still in infancy stage, it is becoming increasingly important feature in ensuring greater efficiency and enhancing greater network in the sector. Therefore, there is an urgent need for a review of the digital ecosystem to support the intensification of digital technology in all segments of water ecosystem value chain - the primary, secondary and service sectors, which invariably requires major investments to raise the quality of service and economic outcomes. These include the use of 5G/6G, advanced intelligence systems, cyber-security & encryption technology and augmented analytics & data discovery to ensure that the sector has the enabling technology to monitor, manage and obtain valuable market intelligence to create economic value for the sector.

- The water footprint (WF) is a relatively new area of study in Malaysia that ultimately requires a sufficient and reliable data set and yet has a significant potential in future. To support the WF implementation in Malaysia, relevant studies need to be carried out for priority sectors, including palm oil production, rubber glove manufacturing, semi-conductor manufacturing, in view of the scarcity of pertinent WF data. In addition, NAWABS's role in implementing WF at the river basin scale is crucial in order to strengthen and widen the existing efforts. This can be implemented by conducting WF analysis within the boundary of the selected river basins and the establishment of a model river basin for full implementation of the WF concept.

- There is an urgent need to improve understanding of the climate change and health nexus in order to prevent water borne diseases, particularly during dry spells and water related disasters. The target group should include local communities, small and medium industries, school children, and tertiary students among others. Programmes that focus on a river basin approach or local scale approach should be promoted in addressing the multi-faceted impacts of climate change such as disaster-related health management and the training the trainers (ToT).

18 DID, METMalaysia, JBA, DOE, JMG and MOH, etc

iv) Infrastructure and Technology

Water security was delivered as a national key priority area (NKEA) that cuts through all sectors of the economy and livelihood (ASM, 2015). In it, a broad spectrum of thoughts on water transformation was cemented a year later in the ASM 2016 Report on `*Transforming the Water Sector: National Integrated Water Resources Management Plan, strategies and Road Map*, that now forms the foundation to the present study, commissioned to ASM by the Malaysian Government through the EPU.

The transformation process itself has come a long way since 2001 in the 8th MP with an inkling start to a resolute effort to go towards an IWRM approach in the country. By 2021 (20 years later), we see the fruitful results of this effort that culminated in the 12th MP, which has specific policy statements on water transformation, water security, water sector governance and management in its chapters.

The importance of the eight sub-sectors in the study is underlined by the country's continuum to implement the water transformation process to the year 2040 via four Malaysian Plans, from 12th MP to 15th MP (another 20 years). This represents a concerted effort to have at least one whole generation of the young growing up to adulthood, imbued with the knowledge and appreciation on all aspects of water, and how to use it wisely and prudently. This new generation will become the real champions and leaders of our water resources management in future. They may be able to make good what we could not do effectively at present we as grabbled with the daily insurmountable challenges within the water sector, ranging from fragmentation in governance, low financing, inadequate infrastructure and information, and community inertia, wherein the five focus areas hope to distil in the eight sub-sectors for implementation in the 20 years ahead.

Specific to the transformation process itself, it was noted that all eight sub-sectors indicated a need for capacity building through formal and informal training to provide knowledge and develop skills in all sectors of water management. More importantly, all groups wanted a concrete platform with infrastructure to deliver training to a wide spectrum of water needs, which are not just modules, booklets or having activities once a while. To be meaningful and effective, the main platform for water transformation is to empower the communities through the education system. With process change in education, through various tools, such as the syllabus and curriculum in schools and institutes of higher learning, it will be able to transform at least one generation with the universal knowledge and acceptance on the importance of water. The 12th MP will be a good start to transform the water sector, so that by 2040 (20 years later), we will have a whole new generation savvy in the water sector and its management in the country.

Infrastructure is divided into three components: physical, non-physical, and adaptive infrastructure. Technology cuts through all the three components as alluded to in all the eight sub-sectors.

(a) Physical infrastructure: As a prelude to the definition of physical infrastructure used here: it refers to the physical water entities and water assets, which although have improved in recent years, still are inadequate, with many aging and rundown assets. As the draft Final Study Report (ASM, 2021) aptly said, there is also a low resilience to support its potential growth with proper maintenance and long-term planning to replace all the ageing physical infrastructural assets. Cost and manpower are often cited for the delays in replacements or maintenance. With 45 policies, 73 state enactments and 75 federal acts, and many masterplans all related to water, there is as yet no concrete commonality devoted to this aspect of work, which is often relegated to one Ministry (looking after water resources and water supplies) that also has other work to do.

The water transformation process requires physical and technology to be successful. **IR 4.0WS** has called for the setting up of a physical Integrated Water Sector Data Centre **(IWSDC)** and a digital infrastructure; while **AACB** wanted platforms in institutions to deliver capacity building and training. Other sub-sectors prefer in-house training, without mentioning physical assets per se. Overall, there is as yet to have some consensus to institutionalise and internalise water as a commodity that has to be carefully looked after, monitored, and managed holistically, adequately, and sustainably for all uses, as called for by **WES & AWF**.

Notwithstanding the above, all the sub-sectors seemed to agree on having platform(s) for the water sector, while sub-sector **IR 4.0WS** has recommended that it is a best place to house the big data therein.

(b) Non-physical infrastructure: The second dimension is the non-physical infrastructure desirous by all the eight sub-sectors, for technologies ranging from simple to very sophisticated ones for operations in the water transformation process. While these are just as important to forge ahead in technology to be on par with other developed countries, the study may be caught up so strongly in proposing the best and latest technology that they negate the need to think of how the new technology can help contribute to the overall transformation process as envisioned in the **IR 4.0WS, WFE Nexus, VW&WF, AWF** and **WES** studies.

The transformation process is like a matrix system, whereby programmes and software technology change so fast that the physical infrastructure may not be able to play catchup. Such is the dilemma on relying on software and best technology. Every update means a whole gamut of training and capacity building to go along with the change process. This aspect has not been thought through in the sub-sectors. In fact, the most important part of the non-physical infrastructure is the human resources to mount the new technologies in the years to come. The preparation of human resources in non-infrastructure is thus just as important to complement all the technology.

(c) Adaptive infrastructure: The third dimension is related to the fallacy to always think that water is scarce. There is no shortage of water for the country as a whole, as it is located within the humid tropics, whereby rainfall received is generally high throughout the year. However, there are very noticeable rainfall variabilities within the country because of the global and regional synoptic conditions and moderated by local topography creating heavier rainfall in some places and lower in other areas. The country receives on average 2,400mm of rainfall, plus and minus between places. Water is therefore variable within and between river basins and regions in the country, depending on the amount of rainfall received and time of the year. Therefore, the management of water and water resources is extremely important to optimise the rainfall received, and to make good use of surface flows and groundwater.

CCIA has given a new dimension to the infrastructure section where it calls for an adaptation to the global phenomenon of climate change, which although imperceptible, is becoming obvious in low lying areas. The types of adaptive infrastructure required will and should shed more light on new ways to look at development of the future in specific affected low-lying areas. The study should therefore include some of the ways to implement and to prepare the affected communities (this is also related to studies on people and financing sections) to adapt to the phenomenon. This should include but not limited to, preparing the countries' planners, architects, engineers, and contractors on adaptive infrastructure with workable technologies to protect the affected communities and areas. In the past, many local indigenous knowledge of adapting to floods is to build houses on stilts. This can still be done. With new technology, it can be done even more effectively.

v) Finance

Of the eight sub-sectors studied, four, i.e. IWSDC, IR4.0WS, WFE Nexus and VW&WF, are essentially new sub-sectors with no dedicated agency responsible. Previous funds for the development of information/ data and IT, related to IWSDC and IR4.0WS were channelled direct to the relevant agencies, e.g. DID and DOE, through their various identified projects. No indication for WFE Nexus and VW&WF funds from the public sector. Funds for AACB and CCIA are also channelled through related agencies dealing with the challenges, such as DID and NADMA. AWF identified challenges of funding water projects, largely through public sector and the subsequent development of PAAB (Pengurusan Aset Air Berhad) as the primary financing vehicle for the water services industry. WES explores the overall transformation of the Water Sector as a dynamic economic sector together with the necessary integration of financial instruments as the WST unfold through the four phases, to ensure a whole eco-system focus, through 8i's. Below are the summary of findings on finance from the eight sub-sector reports of AACB, IWSDC, IR4.0WS, WFE Nexus, VW&WF, CCIA, AWF and WES.

AACB (Advocacy, Awareness, Capacity Building and Public Participatory Platforms)

In the current fragmented water sector, funds and financial help are sector-based. The current funding for AACB and Public Participatory Platforms are from government (federal and state), private business & industry through corporate social responsibility (CSR) programmes, NGOs/ CBOs through crowdfunding and other kinds of sponsorship too. Currently there are insufficient critical sustainable flow of funds to AACB, to "Accelerate the Adoption of IWRM" This is target for the 1st Phase of 12th Malaysia Plan, and

consequently will be part of the overall preparation for the whole Water Sector Transformation by 2040.

IWSDC

IWSDC analysed the Fees Act 1951, to understand the current limited data and information sharing among agencies, critical for the management of Malaysia's huge "Water Wealth". These analysis are required to identify options for future investment to enable WST2040.

IR 4.0 (Industrial Revolution 4.0 in the Water Sector)

Development of IR4.0 oriented solutions, requires high investment levels. The funding constraints for implementation of infrastructures and info-structures, prevent the water sector from necessary quantum leap, towards achieving long term sustainability. Equipment has also been left in poor conditions due to poor of maintenance.

WFE Nexus (Water-Food-Energy Nexus)

There are two major challenges in WFE Nexus in Malaysia. Firstly is that the fiscal and non-fiscal incentives do not encourage efficient water use in agriculture, energy or domestic use. Water wastage is a particularly significant issue in paddy cultivation, and paddy development authorities have cited difficulties in altering resource conservation behaviour, amongst farmers. Secondly, is the lack of incentives to encourage distributed RE (renewable energy) adoption to reduce water and food sector's energy cost. Such incentives would also stimulate GHG emissions reductions and contribute to the achievement of climate change ambitions.

VW&WF (Virtual Water and Water Footprint)

Water Footprint is perceived to have limited incentives to be gained. The current limited WF research and development, may led to researchers not gaining financial assistance or incentives that could further boost WF implementation. The lack of reward and regulations on water recycling and reuse technologies make it more difficult for those involved to value the importance of WF. There need to be consideration for provision of financial rewards in the form of tax incentives and to review water tariffs for the industries, as well as imposing penalty/ties to support water demand management.

CCIA (Climate Change Impact and Adaptation)

CCIA highlighted that disaster risk financing enables the availability of funds to meet the incurred losses and to ensure that the funds reaches the recipient within the time required and that this role of risk financing and social protection needs to be further explored. Also, financing should focus on prevention, early warning, keeping community infrastructure safe as well as expanding disaster risk financing, relief and reconstruction to reduce future risk.

AWF (Alternative Water Financing)

Most of the financing for the water sector comes from public funds, especially in the non-revenue-based industry, such as agriculture and flood mitigation projects. There is a lack of incentives for consumers to purchase water-efficient products such as rainwater harvesting systems to reduce overall water demand. The water sector falls under sustainable and green sectors in some national and international financing instruments, such as in Sustainable and Responsible Investment *Sukuk* (SRI *Sukuk*). The government provides incentives in the form of a grant to encourage the issuance of SRI *Sukuk*. However, the projects must have a guaranteed revenue stream to pay back the investors.

AWF then analysed PAAB which is striving to provide sustainable funding to fulfill its responsibility under the restructuring agreement, especially in repaying its loan to the MOF and offering least burdened terms with mostly unsustainable water operators. Unlike in a typical project financing deal, water operators are not required to put front equity. Most of the interest incurred during construction was capitalised as part of the development cost of a long-term lease.

PAAB's business model assists water operators in improving their services by upgrading the facilities and relieving them from the financial burden in CAPEX development. Achieving this objective provides a conducive environment for tariff revision. Operating in a capital-intensive environment requires rigorous financial planning and cash flow management to become sustainable in the long run. PAAB borrowing cost fluctuates, depending on the market and credit factor. Market risk has more to do with interest rate

fluctuation, evidence in the Malaysian Government Securities (MGS) yield, whereas credit risks are related to the borrower's creditworthiness. Sometimes perception of risk increases due to other factors which may attract additional costs or premiums to borrowers. Credit enhancement such as government guarantee, plays an essential role in reducing borrowing costs. During an earlier stage of operation in 2010, the GG Sukuk issued by PAAB attracted premium charged over MGS in the range of 18 –25 years basis points. Investors were competing fiercely for the allocation as PAAB was a new borrower in the market.

PAAB had established its name in the market as the issuer primarily for the water industry. However, with a significant volume of *Sukuk* outstanding, the market started to have difficulty attracting investors, partly because some have reached their exposure limit. It is also related to the maturing of GG *Sukuk*, refinanced by AAA-rated investors who usually do not assign limits on government-guaranteed investments. Competitions also come from other government investment corporations (GIC) and projects raising funds by using GG. A considerable supply of guarantees coming to the market has affected the scarcity status resulted in some increase in the credit premium. In the wake of interest rate run-up recently, PAAB *Sukuk* was priced poorly at 75 basis points above the MGS, a staggering 25 basis points higher than what it used to pay as the investors become more defensive on rate hike fear.

Market-based financing is beginning to show its limitation to provide good support to the industry and will no longer be sustainable if the cost of borrowing is determined by the perception that risks and price recovery is dictated by investors. In some cases, inadequate responses from investors could result in Sukuk issuance being under subscribed. Worse if the refinancing exercise fails to attract sufficient interests, leading to financial defaults. Other financing sources such as bank loans require a strong cash flow profile, security arrangement, and covenants. The tenure of the loans is typically shorter, lesser quantum, requiring equity injection and subject to annual review. Some challenges mentioned earlier underscore the need to explore alternative sources of financing to improve access to funds at a fair cost.

WES (Water as an Economic Sector)

Although Malaysia has abundant rainfall, spatial and temporal distribution differences as well as climate change, creates water resources vulnerability. Aging water infrastructure and inadequate integrated and holistic water management, has resulted in increasing trend of water supply shortages and disruptions. The problems of the country's water system will have major implications on the health and well-being of citizens and the disruptions will have adverse impact on local industries and may impact foreign investments into the country. Better management of the country's water sources is critical to ensure the development of a vibrant water industry which can become a major revenue earner for the nation and a key enabler for ensuring the competitiveness of other sectors of the economy where water is an important input. Past policies within the water sector have broad goals but without a clear framework, hard targets and timelines. Comparison of polices against highly developed water sectors in other countries indicate that a holistic multi-sectoral approach with strong stakeholder collaboration is vital for a dynamic water ecosystem.

Incentives or lack thereof, determines the commitment level of the players in the water sectors particularly the water operators and industry players, in the development and management of water resources. Two main disincentives facing the players in the Malaysian water sector are the suboptimal water tariff rates and thelack of funding for water-related R&D. Tariff is an important economic tool in regulating the behaviour of producers and consumers. Consumers are not motivated to use water efficiently given the low cost of water. On the supply side, due to the suboptimal water tariff rates, most water service providers in Malaysia are having difficulties even to recover their cost of operation. Infrastructure investments in water and wastewater projects are known to be highly capital intensive. Due to the low water tariff rates which in turn leads to a low rate of return of investment, investors do not find the water sector to be an attractive investment avenue. As a result, capital spending to upgrade or maintain water and wastewater treatment infrastructure in the country is inadequate.

In the R&D funding, there is minimal research grant dedicated to water research despite the high socio-economic benefits that can be gained from contemporary research in water, such as water footprint and WFE nexus. Funding from government and private sectors for water projects are either fragmented or event-based. These have resulted in lack of long-term research strategy and investment to nurture local

scientific and technological developments. Moreover, there is also lack of reward and recognition program for sustainable practices such as the implementation of water recycling and reuse technology and the use of water-efficient products that could potentially reduce overall water demand.

A preliminary assessment has shown that there are systemic issues within the enablers of the water ecosystem, including the lack of incentives and ability to foster R&D as well the non-competitive and insufficient water tariff. A wayforward to align R&D funding for water-related research to the 10-10 *My*STIE Framework need to be established. So also the need to develop a multi-tiered water tariff model, critical for attracting private and foreign investments.

2. Recommendations

i) People

One of the national targets of WST is to ensure increasing effective participation of all stakeholders in planning, decision-making, implementation, monitoring and evaluation through education, public awareness raising, advocacy and capacity building. For the 12th MP, EPU had identified Empowering People in Transforming the water sector as one of the main strategies to accelerating implementation of IWRM as well to transforming the water sector from an economic enabler towards becoming a dynamic growth engine for the Water Sector Transformation 2040. Go along with the tag-line *"tak tahu/kenal, maka tak cinta"*, it is therefore essential to empower the PEOPLE and make it one of the key recommendations by all task forces. Main recommendations/way forward:

AACB - Ignorance countered and strengthened with knowledge needs ownership and action. This will be significant to address the loop of IWRM. There are two forms of approaches, i.e. PEOPLE in form of stakeholders (quadruple helix; government, business, academia, community) – focusing through the (i) Stakeholder Cap (Top to bottom) and (ii) PEOPLE (peer or peer/bottom to top) Cap. Both are played by the public (PEOPLE) – all level of economic strata. Actions proposed to include SMART Approach - Public Participatory Platform (PPP) and Environmental Education - Training Modules (based on Quadruple Helix Model) to ensure decision makers address water issue as national issues and given equal importance to other national security issues.

VW&WF – Nation is lacking expertise on WF and the limitation on the research, data availability as well as exposure will be a hinder to establish the expected outcome within the timeframe. Therefore, developing WF training module focused for water manager competency programme, conducting capacity building for WF competency and most importantly promoting WF as a priority research area with a clear socio-economic outcome is required. Besides, development and dissemination of VW&WF awareness programme and knowledge for public, school and universities, and industries should be carried out to induce lifestyle changes. Engagement and outreach to be carried out through social media (Facebook, YouTube, Instagram, Twitter), other mass media or via workshop and webinar on WF awareness. The suggested activities such as roadshow will create awareness amongst the water users in achieving reduction WF per capita to get buy-in from agencies and state governments. Exposure and eye-catching exposure and visibility is required to gain the attention of the PEOPLE.

IWSDC - The IWSDC will be staffed with dedicated personnel as well as equipped with systematic training and capacity building programme, in areas related to IWSDC's strategic reports such as water accounting and WFE Nexus, as well as in big data analytics, artificial intelligence, and blockchain. This will catalyse the development of new talents, opportunities, jobs, professions, knowledge in digital economy and space technology. This talent development will also assist in integrating the flow of the RDIC sequence for the development of internationally recognised indigenous technologies. Besides, the IWSDC will also help expand the talent pool through participation of people through establishment of open science and crowdsourcing. This will enhance access to good and trusted data for meaningful participation in IWRM.

IR 4.0 – suggesting the following as the way forward:
Intensify Strategic partnerships through quality collaboration between various level, co-creation and knowledge sharing amongst stakeholders. It should address the lacking awareness, knowledge and engagement amongst public as well to support the preparation of data matrix to provide scenario-based solutions focusing on Must Have, Should Have and Nice-to-Have options by stakeholders.

Strengthening talent stock within the operational agencies for water digitization technology and management, fundamentals of IR 4.0 such as cloud technology, IoT, big data, AI, etc., cybersecurity crisis handling, business insights generation and operational improvement from data analysis. There is a need to invest in multi-disciplinary talent as well the reskilling of talents required to accommodate experts and skills required for IR4.0 implementation.

Emulate innovation culture by utility operators, IT staff, technologists, engineers and particularly, water and wastewater operators for identifying new technologies and embracing digital innovation based on the existing digital approach in Malaysia, i.e. NAWABS, PRABN, DIPAN and BDA.

WFE - Wide-Ranging Capacity Building and CEPA on the WFEN

- To address the lack of data science, or indeed data collection or access capabilities within and across the WFE sectors to further the studies or research on the matter.
- Undertaking expertise and skills mapping related to the WFEN. This involves the identification of new areas of expertise required to cater for future direction of management for water resources for water, food, technology and energy security.
- Establishing a WFEN training programme for relevant government agencies.
- Establish a platform for CEPA and engagement on WFEN implementation nationwide.
- Equipped with expertise on both technical and policy as well as R&D for WFE Modelling for Malaysia

CCIA

- **Enhancing public awareness of IWRM and IRBM and their linkages**: The importance of both IWRM and IRBM to address disaster risks and climate change impacts have to be transmitted to all stakeholders especially communities. Accessibility of the data and information in time of/related to drought or flood is crucial for survival among the communities. Skills, knowledge, and updated platform to access information is an advantage/ resilience against flood and hazards, will lead to action from their end. This preparedness to face the disaster will reduce the impact.
- **Improving understanding of the climate change and health nexus:** New strategies that emphasise people-friendly approaches within specific river-basins by integrating official flood, drought, biodiversity impact, or disaster-related health management programme with traditional and local systems should be considered.
- **Interchange or cooperation among agencies and PEOPLE –** Transdisciplinary technical skill sets are required in various agencies focusing on near term disaster risks and long-term climate risks. Such skill sets include cultivating long-term partnerships, engagement and mobilisation of local champions, particularly community leaders and youths through volunteer programmes.

AWF - Improve public awareness on the value of water to save water usage by reducing national average water usage from 205 litres per capita per day (LCD) in 2020 to 180 LCD in 2025, 160LCD in 2030, 158LCD in 2035 and 155LCD in 2040. Besides, it is expected to increase willingness to pay for water services and the adoption of water-efficient products and rainwater harvesting systems. It is also vital to highlight the linkages between water consumption and wastewater disposal into the environment. Public awareness on water conservation and consumption is vital to reduce water wastage amongst consumers (PEOPLE) and to pay for the services; the current water tariff is still the lowest amongst other countries. This has created the assumption that water is freely available in abundance. Initiatives to increase the awareness of water resources should also include PPP and industry – pay back or water balancing initiatives to return the water used for manufacturing and production back to nature through conservation efforts. Agencies also to implement action plans or mitigations to highlight issues related to flood, drought and impact of climate change on water availability and security.

WES

- Establish a strong water research and training institutes to nurture the next-generation talent for the water industry. These training institutes must inculcate the 8R water philosophy, which include: Respect Water; Rethink the Value of Water; Reduce Wastage; Re-Use Water; Recharge Ground Water (Rain

Harvesting); Recycle Waste-Water, Repurpose Water for Higher Value Use; and Regeneration of Water.

- Transform the water training institutes in Malaysia to emulate that of Japan, Korea and Singapore (refer to the case studies) to nurture the next-generation talent and technology for the water industry in Malaysia and other developing countries in the region.
- Need expertise with sound understanding of the value of water to society aligned to the 8R water philosophy; the types of technologies required to improve efficiency in the management and delivery of water supply to all stakeholders; undertake risk assessment to address climate change, natural and man-made disasters to the water supply; and, develop innovative regulations, standards, incentive systems, financial and business models to derive better return on value and investment (ROV and ROIs) from the water resources in the country.
- To establish strong platform or specific government agency with manpower and think-tank to sell the ideas and get buy in from various stakeholders and to get the message out to public for implementation.

ii) Governance

The **National Water Resources Policy (2012)** is currently being reviewed to amalgamate water resources and water services and hence it is timely to consider the incorporation of policy recommendations which have been identified by the eight sub sectors under the WST2040 study. The policy recommendations delve on matters pertaining to virtual water and water footprint, data sharing and data centre, IR 4.0, the water-food-energy nexus, groundwater management, disaster risk reduction, competitive tariff/pricing policies, and water trading rules and regulations. In addition, there is the concurrent need for states who have yet to enact contemporary laws for the management of water resources based on **IWRM principles and practices**, to expedite the review and replacement of outdated enactments, some dating back to 1920. The LUAS model is worthy of study by the states and tweak it to suit their respective environment.

'**Freedom of Information Policy'** and the subsequent '**Freedom of Information Law'** will place Malaysia at par with international standards and practices. Such a law is essential for data collection and data sharing in the country. The **IWSDC** has been recommended to be set up and once established it is to be developed as **one-stop centre** for all water-related data and it will serve as an integrated, single point platform for data sharing to allow interested parties to harness available data rapidly and effectively. This will certainly provide the opportunity for all stakeholders to unlock the full potential of the multitude of data. IWSDC can also serve as a **hub for RDIC**. This centre will also produce an independent, **annual water accounting report** which will become an essential water governance quantifying tool in this country. Further, amendments to the Statistics Act 1965 be made so that water data is clearly established as a '**must-share data'** under the Statistics Act. It is also recommended that a **WF certification scheme**, in collaboration with the Department of Standards, be introduced for water managers. A further recommendation is the establishment of a **one-stop centre for WF** to disseminate knowledge on VW and WF and to get a stronger buy-in from state agencies and it can double-up as an institutional level platform for industries. It is recommended that Malaysia join an **international open data alliance** such as **Open Government Partnership** or **Open Data Charter**. It is also proposed to form alliances with major international players and consequently assume a leading role in the global WF initiative for international trade agreements and to study the global economic opportunities, drivers, and impacts of WF and VW.

Another area which needs to be strengthened is **AACB** and the recommendations include strategic alliances with renowned regional and international water research and training centres to enhance leadership skills and capacity in water management; introduction of AACB training modules to enhance stakeholders' leadership roles and facilitate enforcement of policies and laws for better water governance; using available centres for training in every state; enhancing leadership of government officers, especially at local and district levels in moving and realising the IWRM via quadruple helix mode; and provide local government with knowledge and appropriate tools on IWRM and DRR to minimise impact on river basins. The establishment of IWRM Information Centres will be a welcome move. It is also the intention to gain political support for WST via the involvement of parliamentarians of Malaysia through their All-Party Parliamentary Group Malaysia (APPGM).

In line with stepping up the use of **digital governance**, recommendations have been put forth to aggressively implement **IR 4.0 technologies** for real time data not only in the management of water resources and services but also to trouble shoot water disruptions due to pollution and water transmission breakdowns. Use of digital governance systems will go a long way to help address complexities of multiple stakeholder

management. In addition, SOP for crisis management is required.
The water sector being highly fragmented, recommendations are in place to reorganise the institutional mandates and structure for the water sector to address **WFEN**.

Steps should also be taken to make **JPS Malaysia the National Water Resources Department** with expanded roles and mandates over cross-sectoral water resources issues.

For better coordination of water and sewerage infrastructure works, KASA is working on an amalgamation of its technical departments, JPS, JPP and BBA, into a single technical department. This amalgamation will not only allow for better optimization of resources, but will also help in project management, implementation and monitoring in a more effective manner. However, the process will take time as KASA is required to undertake necessary consultations at the Federal and State levels with regards to the role of JPS.

Options should be reviewed for the development of a separate entity to manage Irrigation and Agriculture Drainage with emphasis on **Agriculture Water Management Services** under MAFI.

A recommendation has also been made for the PM's Department to undertake foresight studies on ensuring long-term sustainability of strategic resources of which water is one of them, more so now that the updated National Security Policy 2021-2025, launched by the PM in July 2021, places "Water Security" at the top of the 7th core value addressing "sustainable development". Another important area is the creation of **RBOs** by State Governments to ensure the quality – and effectively sustainability – of water resources at the river-basin level. This will facilitate land use planning and strengthen pollution control. Other recommendations include development of informational policy instruments, including a **WFEN Technical Guide & Manual** and develop a '**Water Stress Index' (WSI)** to identify nexus hotspots in relation to food and energy sectors.

Climate Change has been creating a havoc worldwide, either causing storms and floods or fires and drought. This scenario is unlikely to change soon in view of global warming and countries will just have to adapt. The key recommendations are:

- Linking **disaster risk reduction and climate change adaptation** at the river basin level. The "starting point adaptation" approach could be implemented commencing with measures to strengthen disaster risk governance, upgrade disaster related decision-making systems, build capacity, promote strategic investment in climate proofing infrastructure and assets, enhance groundwater supply and promote nature-based solutions including protection of groundwater, amongst others.
- **National Water Council** should set up a **standing committee on groundwater** led by the **KeTSA** to oversee integrated management of groundwater resources.
- A **National Committee** has been proposed to connect all water-related government agencies to promote collaboration and reduce the overlapping responsibilities. This could be supplemented with a strong inter-ministerial and multi-stakeholder platform for addressing disaster risk reduction, which comprises all relevant sectors, such as planning and finance, education, health, agriculture, food security, environment, emergency response, relevant private sector, scientific and other civil society representation. The Malaysian DRR Platform (**myDRR**), which is currently under the aegis of **NADMA** could be further strengthened and expanded for this purpose.
- Establish a **regional platform** and strengthen linkages on disaster risks, climate change and IWRM, whereby Malaysia could leverage on the linkages at the regional level to promote good practices and technology and become a **regional hub in ASEAN.**

In managing water resources, adequate finance is crucial which currently comes mainly from the Federal Government. It is recommended to strengthen the existing laws to create a **conducive environment for private investment**. **KASA** has targeted the **development of appropriate policies and laws,** including **amending the existing Water Services Industry Act (Act 655) and Regulations** to strengthen SPAN's function and role in pollution control and implement the new government policy on **water reclamation and treated effluents**. In addition, the **Environmental Quality Act (Act 127)** will be amended for better environmental protection within the 12th MP. Other recommendations include setting up of **River Basin Organisations** to integrate all the available resources from different agencies to deal with localised challenges faced by each river basin and in the case of shared rivers KASA has plans to establish **interstate River Authority (iSRA)** to strengthen the cooperation between the Federal and State Government agencies and between the Federal

government agencies in water resources management. A binding Integrated River Basin Management Policy to supplement the National Water Resources Policy would ensure uniformity in the management of river basins across all states in the country. KASA is also proposing to set up a **Federal Water Department** and plans are being made to establish a **Water Bank** to finance water projects. Concepts of polluter pay, beneficiary pay, licensing fees, cess charges, incidental incomes, environmental taxes, levies, and royalties favouring better management of an integrated water sector are reviewed. In addition, KASA will re-examine the role of **Majlis Air Negara's (MAN)** and other institutional arrangements to enhance the federal-state cooperation in water resources.

With the establishment of integrated water management institutional framework, it will foster strong collaboration between government agencies (at the federal, state and local council levels), industry and community organisations to work in partnership to better manage and harness the economic value of the national water resources. This will require a **"Whole-of-Government & Whole-of-Society"** approach and will need a **"Champion with Clout".**

The "**Synergistic Governance Models"** should put in place strategies and policies to foster strong collaboration and partnership between government, research institutions, industry, and community organisations to create the multiplier effects in the water industry. These include ensuring the policies are business-friendly and conducive to attract foreign investment. The governance system should also enable sharing of data and best practices by all stakeholders. Others include fostering cooperation amongst key players to strengthen food-water-energy nexus and the multiple players in other sectors of the economy to develop the virtual water markets. These include establishing a common platform (**one-stop platform)** for enhancing engagement, sharing of information and best practices amongst all players in the water sector.

A **blueprint for the circular economy** related to solid waste, plastics, scheduled waste and agricommodities will also be introduced to deliver better system-wide economic and environmental outcomes (12th MP document).

There is a need to establish **'Community Champions'** in various localities who can play catalytic roles to foster strong cooperation with key agencies and authorities to ensure effective management of the upstream and downstream water ecosystem of the country. This can be facilitated by putting in place architecture for River Basin Organisation to manage the water ecosystem. Appropriate incentives for the federal, state, local councils and industry will encourage all parties to work together to ensure more effective management of the water basin, all of which will benefit the *'rakyat'* and ensure the competitiveness and sustainability of the economic sectors that are dependent on water.

To ensure the complex relations between all stakeholders are managed effectively across the multiple jurisdictions, there is a need to intensify the governance systems by using the best technologies identified under the **10-10 *My*STIE** Framework and **STIE foresighting** framework to capture multiple spillovers across the different economic sectors. These include taking a more **holistic approach** in setting the direction for the water ecosystem and **an integrated approach** for policy formulation and implementation to develop the enablers of the water ecosystem (**8i-enablers or the five focus drivers**).

The **way forward** is therefore to establish an **integrated water management institutional framework** that embraces a **"whole-of-government & whole-of-society"** approach, incorporating the ***8R Water Philosophy*** in every facet of policy development and implementation: **Respect water; Rethink value of water; Reduce wastage; Re-use used water; Recharge ground water (rain harvesting); Recycle wastewater; Repurpose water for higher value use; and Regeneration of water. Water should always be treated as a national security issue.**

iii) Information and RDIC

- It is recommended that an IWSDC[19] be established to serve as one-stop centre for all water-related data and to function as an integrated, single point platform for data sharing, to allow interested parties to harness available data rapidly and effectively. Such an open access to immense water data (available across the departments and agencies) will certainly provide the opportunity for all stakeholders to unlock the full potential of the multitude of data. To operationalise this concept, the IWSDC plans to establish linkages with current databases, such as the *Sistem Maklumat Sumber Air* (SMSA) by DID, *Data Industri Perkhidmatan Air Negara – Spatial Mapping Interaktif* (DIPAN-SMI) by KASA and MyGDI by the National Geospatial Centre. Hence, IWSDC will be able to provide an integrated database which will cover the full spectrum of water sector as well as other related data, including land use, demographics and socioeconomics.
- IWSDC can also serve as a hub for Research, Development, Innovation and Commercialisation (RDIC) and eventually become a water research collaboration platform for interaction between public and private sector to collaborate and innovate in niche areas of R&D, especially to employ data in inventing solutions and commercialising technological innovations for water management. In addition, with the creation of proposed the National Integrated Data Bank under IWSDC, it will become the key driver to accelerate the implementation of IWRM and facilitate an effective real-time decision making of stakeholders at the operation levels.
- To accelerate the implementation of IWRM throughout Malaysia, it is recommended that the IWRM Information Centre or Hub be established, with the purpose of disseminating information and creating awareness on water resources management to targeted stakeholders by adopting specific communications channels and specialised modules. The Hub will provide three primary services, namely education and training, knowledge dissemination and public participatory platform. The platform also allows civil organisations and local communities to propose new projects and garner interest among potential partners.
- It is recommended that a national policy on IR 4.0 for water sector be developed to facilitate a technologically enable system of water delivery and hence to provide the public the convenience of accessing pertinent services within reach of their fingertips. It is also recommended that IR4.0 technologies be used to identify water-food-energy nexus flashpoints within catchments or river basins, particularly by the use of big data analytics, IoT-connected devices, remote sensing, and artificial intelligence. Remote Sensing/GIS platform can act as a field verification mechanism for a continuous monitoring of catchment health. Establishing an information system, including remote sensing and GIS tools to support precision farming, are also recommended. These technologies can also be used to measure real-time irrigation and drainage performance across granary schemes, and thus allowing for the maximisation of process efficiencies.
- It is recommended that climate services for early warning of multi-hazards be expanded using existing and new approaches, in order to support science-based decision-making at the river-basin level. This is to supplement information from downscaled climate change models, specifically on rainfall that should be used judiciously due to amplified uncertainties. These approaches should involve multidisciplinary experts and practitioners, coupled with local knowledge to inform adaptation plans and policies.
- Greater alignment of R&D collaborations undertaken in institutions of higher learnings/research institutes with the water industries will go a long way to help bridge the chasm between academic research and translational outcomes that benefit the water sector. Improving the level of R&D funding by relevant ministries is a great step in the right direction to address funding gap. Institutions of higher learning should be encouraged to work collaboratively with industry players to develop local technology and meet the needs of the industry. These include technologies to monitor water quality and water supply, and potential risks of climate change and other natural disasters based on water basins.
- In support of the institutionalising of the WFE nexus approach, it is recommended that a Decision Support System (DSS) be established which consists of, among others, hydrological databases that allow monitoring of key indicators of resource use, security and sustainability within selected river basins.

19 The 12MP Document uses the term 'Integrated Centre for Water Data and RDIC'. However, to maintain a consistency in this write-up, IWSDC is used throughout.

iv) Infrastructure and Technology

A summary of the sub-sectoral recommendations and way forward is given in the table below:

Sub-Sector	Current Findings	Sub-sector recommendations	Way Forward
AACB (Advocacy, Awareness, Capacity Building and Public Participatory Platforms	• Limited number of water training centres. • Platform for public participation	• Set up Pusat Informasi Sungai for capacity building • Set up Pusat Informasi Sungei • Strategic alliances with renowned regional and international water research and training centres. • Develop and manage a comprehensive data sharing framework.	• Increase Training Centres in each state. • Strengthen AACB through use of Public Participatory Platforms. • Use existing institutions for capacity building.
	Capacity building during pandemic COVID-19 situations.	Capacity building during abnormal situations, such as: COVID-19.	
	Training programmes based on IWRM modules.	Provide relevant IWRM training programmes.	• Enhance PPPs and AACB through digital learning space. • Activate environmental volunteerism e.g.: Rakan Alam Sekitar, Friends of Rivers etc • Provide training modules in four different areas: government, academia, business & industry, community.
IR4.0WS	• Lack of data standards and tools to assist decision making • Fragmented info-structure (databases) in water sector.	To be a single-point reference centre to provide reliable and consistently high-quality water data and information in the water sector.	• Set up IWSDC • (Integrated Water Sector Data Centre) for big data. • Improve data and information accessibility by accelerating the Open Science Initiative. • Prepare a strategic framework towards realization of IR4.0, Big Data Analytics and RDIC for the water sub-sectors.
	• Lack of single formal platform for public participation. • Gaps in water management spectrum.	• Accelerate IWRM by integrating water and land data • Empower public participation • Affirmatively support the National Digitalisation Blueprint	IWSDC to produce the Annual Strategic Reports on water accounting, water auditing and water productivity to fill in gaps in the water management spectrum.
WFE Nexus (Water-Food-Energy Nexus)	**Nexus Interaction** Water-Energy: Opportunities to shift to less water-intensive energy generation technologies Energy-Water: Opportunities to shift to more energy efficient/less energy-intensive technologies Water-Food: Opportunities through modernisation of farming Water-Food-Energy: Opportunities to produce food and energy simultaneously with lower water intensity than other forms of energy generation	• Multi-stakeholder facilitation and platform • Strategic planning • Governance and enabling environment • Experimental nexus infrastructure • Integrated ecosystem • Strategic resource.	Have a pilot project in place as a show case of the WFE nexus.

Sub-Sector	Current Findings	Sub-sector recommendations	Way Forward
VW&WF (Virtual Water and Water Footprint)	• The existing policies do not explicitly mention VW & WF • Identified the economic sectors to be the focal points of the VW & WF inventory study.	• To suggest the inclusion of VW & WF in the coming Dasar Air Negara • Establish VW & WF inventory for selected case studies • To include the ESG initiatives.	Include VW & WF analysis into government policy, with reference to the international policy on VW & WF.
CCIA (Climate Change Impact and Adaptation)	1. Water related hazards will have a cascading effect on food security and agriculture, coastal areas, forests and biodiversity, public health and the built environment.		Improving linkages between disaster risk reduction and climate change adaptation to IWRM at the river basin level
	2. Stakeholders and community engagement is hindered by lack of open-source data.	Building resilience is hindered by the lack of open-source data	• A one-stop open data hub on hazards and risks of extreme climate. • To liaise with the IR 4.0WS
	3. Global climate change models should be used judiciously for decision-making at the river basin or local scales to avoid maladaptation.	Climate change models in the country should be used judiciously for decision-making	Expanding climate services for early warning of multi-hazards and strengthening adaptive capacity of operational agencies
	4. Groundwater use is expected to increase to support water supply requirements in rural and water-stressed areas.	Invest in groundwater use.	Delineate and operationalise water supply from climate resilient aquifers.
	5. Local communities are vulnerable to climatic and health risks.	Improve surveillance on climate and health of communities.	Aligning the global recovery from COVID-19 to respond to climate change
AWF (Alternative Water Financing)	• Lack of investment to increase treatment capacity • Income is lower than the cost • High level of non-revenue water (NRW) • Frequent water supply disruption	• Improve the water standards to reflect the quality of water services to consumers • Need for a fair tariff system to overhaul the water sector.	• Accelerating IWRM implementation • Water Technology Innovation • Achieving Economies of Scale • Becoming the Regional Water Hub
WES (Water as an Economic Sector)	1. Lack of awareness and capability to meet global best practices & standards and climate changes issues	• Adopt IWRM anchored on 8R-Water Philosophy & STI framework: • Respect water. • Rethink the value of water. • Reduce wastage. • Re-use used water. • Recharge groundwater. • Recycle wastewater. • Repurpose water for higher value use; and • Regenerate water	• Implement water financing mechanisms to develop the water sector. • Strengthen the Wakaf Air system to finance rural water supply and sewerage system. • Set-up a Water Industry Fund for water resource use and conservation. • Study the feasibility to establish a national water company
	2. Do not use advanced Technology – lack a SMART Water Grid system.		
	3. Do not have a good system to monitor and manage demand for water. Low use of digital technology and IR4.0 Technology.		
	4. Lack of awareness of 8R water philosophy		

v) Finance

The eight sub-sectors are a mix of existing and new areas of interests. Each generally agreed, on the need for integration of focus, either within the five specific focus areas, irrespective of the specific subsectors, or the holistic whole country ecosystem approaches, in line with Strategy B5 of Chapter 9 of the 12th MP, which include nature-based approach and implementing circular economy in the water sector. Many of each of their specific recommendations are also relevant to the other subsectors, for example the proposed restructuring of current incentives to discourage inefficiency. The introduction of new economic instruments will help promote sustainable resource management for the future. These include, but not limited to, payments for ecosystem services, the enforcement of polluter-pays principle and a uniform pricing model for water resources. These proposed recommendations will help to strengthen the financing capacity and/or just simply allocation of budget for new areas of interests.

AACB recommends:

- Adequate funds for non-structural capacity building towards IWRM, comprehensive AACB programme at the PPPs, finance for the pool of water experts to advocate IWRM and training future water leaders by using the facilities at the National Training Centres.
- Incentives and award for green watershed restoration and nature-based solutions. MIDA (Malaysian Investment Development Authority) is recommended to introduce a new category in green incentives that is related to water management project, aiming to encourage more stakeholders to adopt and implement water management project in their premises and operations, for example, water reuse and reclamation for non-portable purposes. Concurrently Ministry of Finance (MOF) and Inland Revenue Board of Malaysia (LHDN) is also recommended to also give tax incentives to business and industry that managed, protect and upgrade the condition of the nearest water body (company tax exemption given to business and industry entities) for their involvement and contribution in conserving water resources.

- Green incentives, in recognition and certification for SMEs and other general attendees attending IWRM related training programme before water servicing licensing and relicensing.
- Ensure balanced fiscal allocation between federal and state/local government with provision of continuous and adequate federal funding for vital rehabilitation and restoration of river basin management. Provide related training programme to enhance the leadership roles of civil servants for sustainable water resources management and water-based recreation and tourism activities, included but not limited to, rehabilitation and restoration of river basin management, green economic approaches for IWRM such as 'payment for ecosystem services', application of 'polluter pays' principle, and uniform pricing model for water resources.

IWSDC recommends measures to incentivise the free sharing of data and information that is already being continuously collected, and subsequently unlock their values. This will help to provide complete dataset and information for managing the nation water-wealth for the development of better options for investment decisions and strategies, through publication of data and information in annual strategic reports.
IR 4.0WS recommends fiscal and non-fiscal incentives, encourages Research and Development (R&D), adoption of new technologies, innovation, commercialisation of local technology, and market expansion, including globalisation of local technology. Incentive compatible schemes is recommended to be put in place to foster public-private partnership to develop new innovations and applications in IR 4.0 for the industry. Improve incentive schemes (tax and subsidies) is also recommended for SMEs in the industry to adopt IR 4.0.

In challenging the inefficient water use in Malaysia and the minimal incentives, **WFE Nexus** recommends a radical overhaul of the incentives structure, whereby water must be valued appropriately to discourage its inefficient use. Economic instruments, promoting sustainable resource use, such as payments for ecosystem services, the enforcement of polluter-pays principle and a uniform pricing model for water resources should be considered.

The lack of rewards and regulations on water recycling and reuse technologies will make it more difficult to value the importance of WF (Water Footprint). The **VW&WF** recommends that the WF element be included under the ESG (Environmental Sustainable Governance) initiative and placed under Bursa Malaysia. Again, financial rewards in the form of tax incentives, review on water tariffs and penalties to support water

demand management have been recommended. In strengthening the financial capability to support water sector transformation, three KPIs outlined. First, the financial rewards and tax incentives programmes be implemented by 2027. Second, mainstreaming WF in businesses to be conducted and the water provision in ESG be incorporated by 2027 and third, participation of public listed companies in the new provision of ESG by 20% in 2040.

While facing potential disaster risks from ongoing climate changes, the communities were also concurrently vulnerable to the COVID19 pandemic. Climate resilient and environment-friendly alternative sources of financing need to be explored. Investment should be channelled for strengthening of adaptive capacity to build resilience at all levels. Aligning the global recovery from COVID-19 and response to climate change offers a triple win: improving public health, creating a sustainable economy and building resilience. An option to be considered is to expand the national health financing system through alternative pathways such as establishing a national social health insurance mechanism and improving technical capacity to implement and operate health financing. Funds for disaster risk financing and social protection needs to be further explored and to include insurances against natural perils such as floods, to expedite economic and social recovery after each disaster occurrences. Mainstreaming disaster risk management in public investment will benefit the economy by increasing the resilience of capital stock, keeping public debt dynamics manageable, and maintaining adequate fiscal space to cope with disasters. Financing should focus on prevention, early warning, keeping community infrastructure safe as well as expanding disaster risk financing, relief and reconstruction to reduce future risk.

Groundwater use is expected to increase by the next decade to support water supply requirements in rural and water stressed areas. The cost of shifting supplies from groundwater to surface water for groundwater-dependent communities is high, particularly with increasing pollution of rivers. Investing in climate resilient groundwater resources is critical for economic growth. The cost of water disruption to economic activities compared to the cost of investing in groundwater to supplement surface water, to prevent interruption of services has to be examined in detail. This will include the costs involved in handling emerging climate change threats to groundwater, specifically in areas where this is the primary source of water supply must be estimated. In this context, investments should be channelled to delineate groundwater resources and aquifers that maintain their recharge capacity under extreme climate conditions. An inventory of groundwater-dependent communities in Malaysia has to be developed to enable a comprehensive economic evaluation. Fiscal and non-fiscal benefits to encourage groundwater development and maintenance of aquifer systems also need to be identified, with initial funding sourced from the Federal Government.

In general, the water sector lacks incentive tools for mass group participation to attract interests from policymakers, regulators, consultants, contractors, manufacturers, operators, consumers and the general public. **AWF** recommends for greater private participation in the water sector through policy changes. One is to provide incentives in purchasing water-efficient products and rainwater harvesting systems through easier market accessibility. The other is through extending the licensing period of the public water supply system and wastewater treatment system from 3 years to up to 20 years. A think tank group could be set up to formulate the various incentive schemes and programs to make this water sector much more participative, including collating and merging incentives from other subsector groups such as to propel the paradigm shift forward.

Below are specific proposals from **AWF**:

1. **Implement a transparent and fair Tariff Setting Mechanism (TSM) to improve financial sustainability in the water sector.** A systematic tariff revision process creates a chain effect in water usage reduction, reserve margin improvement, leading to decrease production, and more cash for the operator to invest back into enhancing the water supply system. It is the crux of a conducive environment to attract private investment into the sector. The proposed TSM takes into account the interest and right to water of the B40 group, safeguarding each family's lifeline consumption for 80% of users, using up to 20 cubic metres of water a month. In contrast, wasteful users should be fairly charged with higher tariff rates.

2. **Maximise the value of existing assets for water security investments** by improving the operational efficiency and effectiveness of existing infrastructure and for service providers to delay investment needs. A prerequisite to further investment in water security and for better operation and maintenance

of infrastructure, demand management, and engagement with stakeholders in enhancing the assets are the following targets:

i) Increase the number of water operators that achieved OPEX recovery from four in 2020 to seven in 2025 and 10 in 2030. From 2030 onwards, KASA expected the operators to move towards full cost recovery. The ministry targeted eight water operators to maintain 100% OPEX recovery, four water operators to achieve 25% full cost recovery in 2035; four operators to attain 35% full cost recovery, three water operators achieve 25% full cost recovery, and five operators reach 10% full cost recovery.

ii) Improve the OPEX recovery of sewerage service providers from 83% in 2020 to 90% in 2025 and 100% in 2030. KASA also targeted IWK to attain 25% full cost recovery in 2035 and 35% in 2040.

iii) These targets have to be supported by the sustainable tariff setting regime to help water operators cover OPEX, CAPEX and make decent profits to continue serving the customers. Without that, investment in the water sector will be severely jeopardised and will fail to cope with increasing demand from domestic and non-domestic sectors.

3. **Implement financing mechanisms for water infrastructures development** to increase the alternative financing from 10% in 2025 to 40% in 2040, increasing 10% in every Malaysia Plan, through:
   i) An improved private finance initiative (PFI) with a build-own-transfer (BOT)/concession model under SPAN's regulation for large-scale water supply and wastewater projects to be realised in the 12th MP.
   ii) Public-private partnership models, namely performance-based contract (PBC) for non-revenue water (NRW) reduction projects, land swap model and hybrid annuity model (HAM) for wastewater projects to be realised in the 12th MP.
   iii) Green Climate Fund for adaptation projects to be utilised in the 12th MP.
   iv) An innovative Cash Waqf Sukuk model for large water projects, to be realised in 14th MP.
   v) A water bank to be established as an enabling institution for water projects, to be realised in the 15th MP.

4. **Strengthen Wakaf Air to finance rural water supply and sewerage projects** to complement the scope of KPLB by improving public participation and implementation cadences to implement at least 20 projects per year, amounting to RM 1 million investments. The Wakaf Air, launched in December 2020, is targeted to increase its fund size by RM1 million a year so that by the end of the 12th MP, Wakaf Air has about RM8 -10 million. As of 23 Sept 2021, seven projects were implemented, benefiting at least 2,880 water users in six states.
5. **Upscale the financing through improved risk-return frameworks** to allow the public and private actors (including water users) to earn returns proportional to the risks they take.
6. **Set up of the Water Industry Fund (WIF) for water resources conservation**. The fund's establishment is provided for in Section 171(1) of the Water Services Industry Act (Act 655) is to be set up, controlled, and managed by SPAN. The proposed WIF prescribes that the fund's contributors include consumers from residential, commercial and industrial areas and institutions with private water and sewerage systems. It is suggested that the quantum of the levy is between 1% –1.6 % on water bills per month. It requires an amendment to Act 655, as the current law states that the fund contributor is licensees or persons authorised under the law and based on the prescribed rates.
7. **Select investment pathways that maximise water security returns over time**. This requires rigorous triple bottom line analysis on projects' sequences (or portfolios) and carefully considers the effect of pursuing a specific project in foreclosing or enabling future investment options. It also needs an analysis of the performance of the system over time under different scenarios.
8. **Explore the feasibility of establishing a national water company** to achieve operational efficiency and economies of scale, emulating the Tenaga Nasional Berhad in the power sector. It could begin with the consolidation of water companies at the regional level, such as Northern (Pulau Pinang, Kedah and Perlis), Southern (Johor, Negeri Sembilan and Melaka), East Coast (Pahang, Kelantan and Terengganu) and West Coast (Selangor, Kuala Lumpur, Putrajaya and Perak). Each water operator has equity participation in the company, based on criteria agreed by all parties. It is anticipated that this move can smoothen the formation of the RBOs as each water operator has mutual interest in the shared river basins.

9. **Establish a raw water price mechanism for water resources conservation.** The price is based on the water quality of the resources. Higher quality water (Class I) is pricier than water with Class III and below. It aims to encourage the State Government to preserve and conserve water resources to obtain higher revenue from raw water extraction. The target is to set a pricing mechanism for inter-state river basins in 2025 and international rivers in 2030.

From the **WES** analysis, for sustainable operation of water service providers and quality water services, water tariffs must be adjusted to cover both operating and capital expenditures. The Tariff Setting Mechanism (TSM) will lead to tariff rates increase and give an immediate boost to the water operator's revenue. It will also send a positive signal to the market that the water sector is on the path to full-cost recovery, and investment opportunities are emerging in the industry. Other proposed financial instruments are similar to those proposed by many of the 8 sub-sectors such as recommendations of AACB and AWF on the adoption of green economic approaches and nature-based solutions and recommendations for lower interest rate, tax deductions of green certification etc. Vis-a-vis the Water Industry Fund, it can be used to fund critical projects such as rehabilitation and restoration of river basin management, water resources assessment, groundwater development and management as well as training water experts and future leaders to advocate IWRM. The adoption of sustainable use of water in green building and halal certifications will go a long way to modify corporate and consumer behaviour towards more responsible use of the nation's water resources.

3.4.4 The Way Forward

The Government had targeted the year 2040 for the transformation of the Malaysian water sector. The recent launch of the 12th MP has further reaffirmed this target when the country would have attained the position to:

- Manage the nation's richness in its water resources for the wealth of the nation and sharing the prosperity this wealth provides.
- Recognise, reorganise, and made more visible as a significant contributor to national growth economically, socially, and environmentally; and
- Transform the national water sector from one that empowers the economy to an economy that is dynamic and able to contribute more significantly to the country's Gross Domestic Product by 2040. (MEA, 2019)

The journey towards achieving the aspired 2040 target has been frameworked in three roadmaps, described below, with the dominant roadmap produced as a result of the WST2040 study. Nonetheless, it is important to take note of the proposed strategies, initiatives, projects, and where available, the proposed budgets given in the updated NIWRMP roadmap (Appendix 2.1) as they, together with the WST2040 strategies, look at the totality of the IWRM Agenda to be implemented nationwide.

3.4.4.1 Roadmaps from previous and current studies and criteria for integration and merger

As highlighted earlier, for the construction of a dominant road map, information and data were extracted and compiled from the eight road maps of sub-sectoral studies', developed through consultations with relevant central agencies, ministries, state administrations and implementing departments and agencies. For the purposes of the WST 2040 study, the study team prepared three roadmaps as follows:

a. Continuous strategies/initiatives/programmes/projects carried over from the 11th MP which were compiled and organised into a road map formatted fulfilling the requirements stated earlier. This RMK 11th MP component road map is attached as Appendix 3.3**.**
b. Strategies/initiatives/programmes/projects included as a roadmap under the ASM NIWRMP (2016) report targeted then to end in year 2030 (complying to SDG 2030) and organised following the IWRM General Framework. The strategies/initiatives/programmes/projects contained therein have since been updated, validated, and supplemented by the study team at consultation sessions and through communication with respective ministries/states/departments/agencies. All the information and data have also been reorganised to conform to the five focus area framework adopted by the study. The reorganised updated NIWRMP component roadmap is attached as Appendix 2.1 with the conclusions and recommendations appearing as Appendix 2.2 to Chapter 2 of this Report. [**Note**: This roadmap also comes with a list of proposed **Investments in Water Infrastructure** largely compiled and published by ASM under the NKPA (2014) report, which has since been updated and supplemented by relevant ministries/states/agencies who responded to requests made by the Study Team at recent consultations and through direct communication].
c. Under the current WST 2040 study addressing an additional eight sub-sectors, the respective task forces have completed their studies and reported their findings and recommendations, inclusive of a roadmap containing strategies for implementation over four five-year phases ending in 2040. The study team has since consolidated them into a single WST 2040 component roadmap attached as Appendix 3.4.
d. The launch of the 12th MP on 27 September 2021 has dedicated two chapters, namely Chapter 8 and Chapter 9, to the energy and water sectors with a special focus pertaining to the government's commitment to the WST 2040 agenda and for which several strategies have been incorporated in the 12th MP document. The Study Team has extracted these strategies from the document's Chapter 8 and Chapter 9 and now appear as Table 3.4 and Table 3.5, respectively.

3.4.4.2 The Composite WST2040 Roadmap

The roadmap, which comprises the main deliverable prescribed by the Study Terms of Reference, has been developed through a harmonisation process that involved the amalgamation, consolidation, realignment and removal of duplication, and reprioritisation to meet the objectives and targets set for the Transformation of the Water Sector by 2040. The WST2040 roadmap on EXCEL format is attached as Appendix 3.4, which has a sorting function capable for inter-active usage.

3.4.4.3 Management Structure overseeing Coordination and Implementation

A five-step Review Process (Figure 3.12-5) has been proposed for each of the four phases of the WST 2040 roadmap, comprising **Coordination, Implementation, Monitoring, Reporting** and **Evaluation**. The review process would come under the purview of the National WST2040 task force reporting to the **National WST2040 Management Committee** (proposed in Section 3.2.5.3) to oversee the successful implementation of the Transformation of the Water Sector over four phases until 2040.

The main function of the proposed **National WST2040 Management Committee[22] (NMC)** (Figure 3.13) will be to assist the Majlis Air Negara (MAN) in the accelerated implementation of IWRM nation-wide as well as the implementation of WST2040 projects over the four phases to 2040. The NMC is proposed to be chaired by the Chief Secretary to the Government (KSN) to oversee the coordinated implementation of the IWRM agenda nationwide with six sub-committees to assist the KSN in the oversight function with each sub-Committee looking after the following matters: Technical, IRBM, Governance, Information and RDIC (IR4.0 and ISWDC), Human Capital Development (People) and Investment and Finance. It is further proposed that the Sec Gen KASA be the Deputy Chair.

The roles of the Six Sub-Committees are as follows:

1. Technical (Infrastructure, project implementation & monitoring)
Monitoring implementation of the proposed strategies and roadmap, updating with new proposals, as and when necessary.

2. IRBM (Creating awareness on river basin perspectives)
IRBM leading towards Integrated Natural Resources Management (INRM) over the longer term; a holistic perspective taking into consideration the symbiotic relations between land and water. Also, to address related IRBM sub-sets such as ICM, ILBM, IASM, IUWM, ICZM, ISM, IFM and IDM[23]. KASA/KETSA/MAFI/KPKT are major ministries dealing with water and land development. While MAFI focuses on agriculture development, KPKT focuses on local authorities and urban management. JPBD, an agency within KPKT, prepares and regularly update the National Physical Plan.

3. Governance (Policies and Legislations)
Analysing, national and global relevant policies and legislations, for inclusion into the national agendas. These include relevant recommendations within the IWRM pillars of "Enabling Environment", "Institutional Framework" and "Management Instruments". Undertaking the IWRM Implementation score card in line with UNEP SDG requirements.

4. Information & RDIC (including IR 4.0 & IWSDC)
Developing and research into the development of an "Integrated National Water Data and Research Centre"

5. Human Capital Development (People)
Identifying, planning and developing needed training for required talent development, to support WST2040

6. Investments and Finance
Ensuring cross-integration financial investments and appropriate tariff mechanisms to water services across multiple sectors, including land and water, to ensure optimising of investments in all development initiatives.

In the 12th MP document, it was stated that "A dedicated task force comprising members from the public and private sectors will be established under the National Water Council. The task force will guide, coordinate, monitor and report progress as well as review, realign and provide recommendations for the successful implementation of the WST 2040 agenda". However, the study team has counter-proposed that the Task Force be modelled after the ETP-monitoring PEMANDU to monitor on behalf of the operational WST2040 National Management Committee (NMC), reporting to the NMC and serving as its Secretariat. The 12th MP document had also proposed the Task Force membership be drawn from the public and private sectors. The study team has counter-proposed that selected members of the private sector serve as members in the NMC's Advisory Panel with other members drawn from ASM, selected Academia and experts from selected international organisations.

In addition, the Study team proposes that the National Water Sector Transformation Task Force serving the NMC be headed by a Senior Executive who is well-versed in IWRM matters. It will be ideal if this same secretariat, again for continuity purposes, also serves the **Majlis Air Negara**.

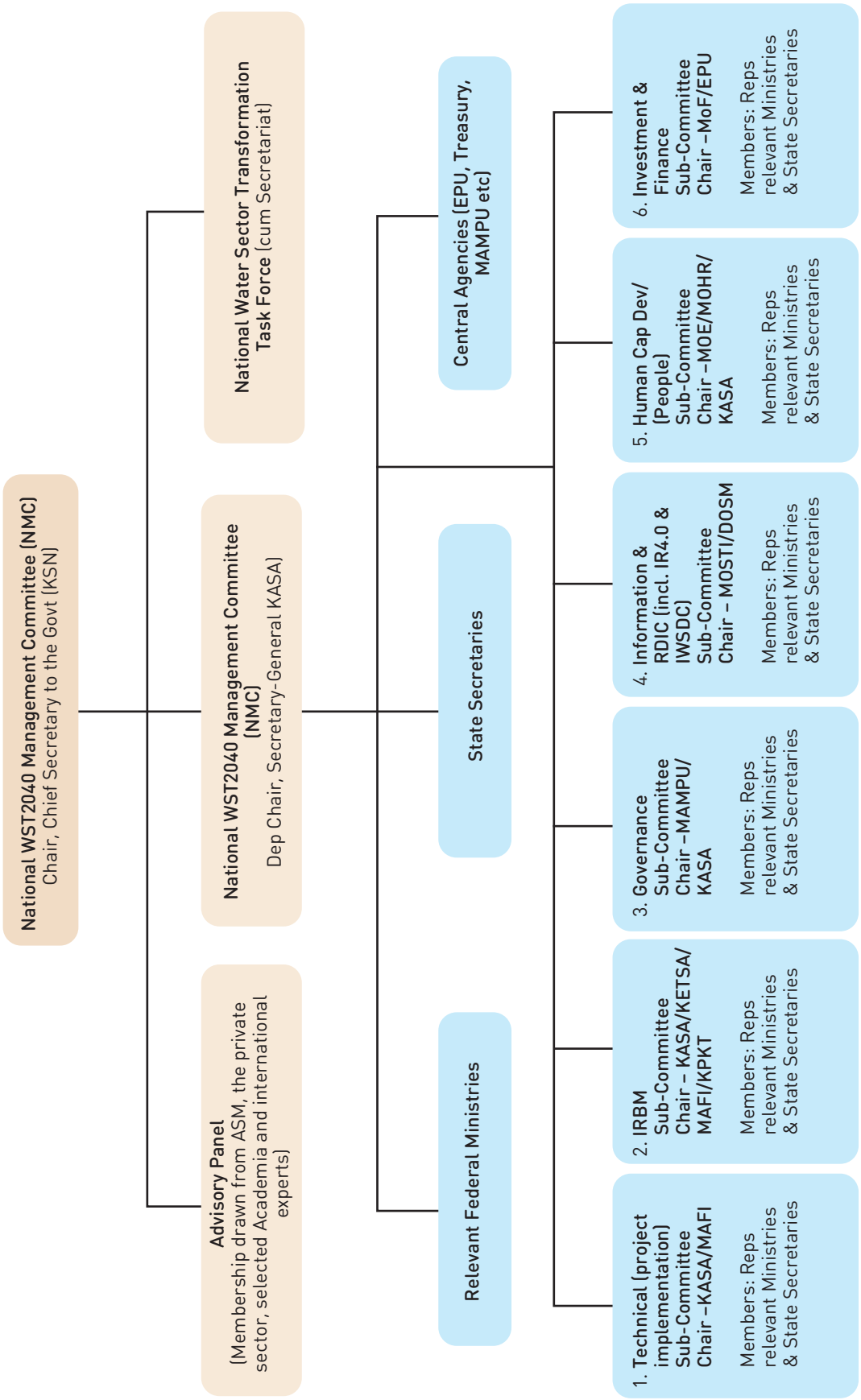


Figure 3.13. Proposed National WST2040 Management Committee

The above counter-proposal is submitted for the consideration by the Government.

3.4.4.4 Monitoring/evaluation annual review/report card

Further to the Five-Step Review Process reported in the earlier **Section 3.4** of the report and illustrated in Figure 3.12-5 and re-produced below, the Study Team recommends that an **independent Monitoring and Evaluation body**, modelled after PEMANDU which monitored the ETP Projects, be established during the implementation phase to undertake on a continuing basis, periodic and annual reviews of progress made in implementing the WST2040 roadmap. An appropriate monitoring system would be designed by the proposed M&E body to fit the purpose of undertaking regular management/performance audit of the WST 2040 programme throughout the four phases. Apart from preparing periodic management audit reports, it would prepare an annual score card highlighting the achievements and shortfalls together with recommendations on corrective measures to be taken to ensure that the progress stays on course in achieving the set targets over the four phase implementation time frames ending in 2040. It is envisaged that the management audit reports, and the annual score card will be submitted to the proposed WST2040 National Management Committee mentioned in **Section 3.4.4.3** above and, on a need basis, be also brought to the attention of the Majlis Air Negara, chaired by the PM.

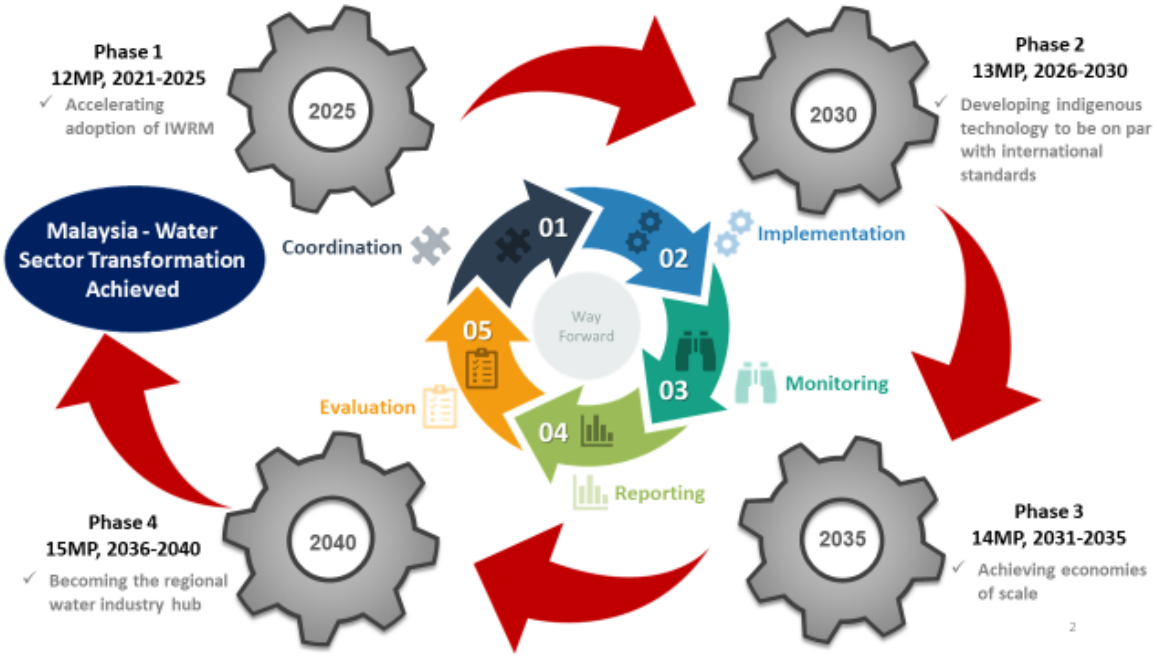


Figure 3.12-5. Five-step review process

3.5 STATEMENT FOR CLOSURE

The eight sub-sectors, undertaken as game changer studies, have identified, and proposed a set of **106 Immediately Implementable Projects** for 12th MP as well as proposed Strategies, Initiatives and Programmes for consideration by the relevant Ministries for implementation during the 12th MP, 13th MP, 14th MP and 15th MP. In addition, the study had proposed a total of **87 Strategies** in the WST2040 roadmap (each with the proposed Targets and KPIs set) over the four phases until 2040 (details given in the respective sub-sector reports). These eight sub-sectors strategies, initiatives and programmes have been used to populate the WST2040 roadmap developed after consultations with ministries and agencies nationwide. However, a number of ministries/agencies were not able to provide the necessary details beyond 12th MP. It is therefore proposed for EPU to conduct appropriate consultations at the appropriate times with ministries and agencies to obtain the necessary data. The implementation of the proposed strategies (as shown in the WST2040 roadmap) by the ministries under the four Malaysia Plans and monitored by the **National Water Sector Transformation Task Force**[20], will ensure that the four themes of the four Malaysia Plans are fully realised.

A vibrant water sector will be an integral part of the nation's Shared Prosperity Vision 2030 and Sustainable Development Goals 2030 in achieving social well-being, environmental sustainability, and economic prosperity, leaving no one behind while ensuring everyone has access to clean water. The water sector will also be regarded as a source for growth of the national economy by exploring the full potential of income generating value-added products and services that can be derived from the sector. It is expected that, through implementation of the findings of the WST2040 study, the water sector will be established as a regional water hub by 2040.

It is emphasised that if viewing the government and its agencies as the sole implementers of the proposed strategies, then it will be difficult to achieve what has been planned by the Transformation Agenda. It takes the full participation of everyone, including industries, institutions of higher learning, NGOs and the ordinary people (essentially the whole-of-nation approach) to collaborate fully through smart partnerships all the way down to river basin level to achieve the national aspirations by 2040 as a people-driven initiative, more so for the generations of Malaysians to come through ensuring sustainable and clean water is always available. More so, despite the seemingly inevitable climate change impacts, the Transformation will ensure that economic generation will continue placing Malaysia in a high position as a regional economic and water hub.

20 This Task Force is proposed to be a dedicated Secretariat to concurrently serve the Majlis Air Negara and the WST2040 Management Committee (**Figure 3.13**).

APPENDIX 3.1

Sub-Sectoral Summary Briefs

1.0 Advocacy, Awareness, Capacity Building and Public Participatory Platforms (AACB)

1.1 Introduction of AACB Sub-Sectoral Study

In the WST 2040, AACB Sub-Sector is undertaking the mission of awareness-raising, advocacy and capacity building matters related to water resources management which is 'Business Unusual. AACB sub-sector has established four clusters, namely Government Cluster, Business Cluster, Community Cluster, and Academia Cluster to develop the products and fulfil the requirements of the 12th MP, 13th MP, 14th MP and 15th MP to cover the water sector transformation issues for the next 20 years (2021 – 2040).

1.2 Objectives of Sub-Sectoral Study

The objective of this AACB sub-sector is to review and recommend products of the AACB programme for nationwide implementation, targeted at all water-related institutional and community stakeholders at Federal, State and local levels to grasp the issues regarding Water Security and Water as an Economic Opportunity.

i) To recommend a management plan to the government for better enforcement of IWRM policies.
ii) To benchmark businesses and industries current water management practices towards sustainability and to act responsibly in managing their water resources throughout the value chain.
iii) To instil a sense of ownership amongst them towards their rivers and engaging in effective participation towards ensuring sustainable management of their river basin.
iv) To incorporate academic knowledge to support sustainable water resource management.

1.3 Scope of the Sub-Sectoral Study according to the Terms of Reference

The AACB sub-sector scope of the study is:

1. Review and analyse current policies with a view of improvement for the meaningful implementation of IWRM towards WST2040.
2. Undertake comparative strategy analysis/business models with other nations.
3. Study and consider the current global markets towards making the water sector a dynamic new economic sector capable of driving the nation's GDP growth in the future. Therefore, AACB sub-sector will focus on the following matters:
   a. Public Participatory Platform (PPP)
   b. Training Modules (based on Quadra Helix Model)
4. Prepare a transformation strategy and initiative implementation framework for each of the four phases, including the Implementation Agencies, Estimated Budgets and Main Target Achievements Based on the Analysis Undertaken and Expert Reviews with the progress of the study.
5. Undertake consultations with stakeholders and experts to finalise the proposed strategies and initiatives of the nation's Water Sector Transformation.
6. Prepare a complete roadmap for the National Agenda on the Water Sector Transformation 2040 for the various information of ministries and agencies and guidance for the implementation of programmes and activities towards achieving the targeted Transformation objectives.

1.3.1 TOR Scope 1 (Review and Analyse Current Policies with a view to Improvement)

The AACB sub-sector has analysed 26 National policies and action plan with regards to advocacy, awareness raising, capacity building and public participatory platform as Table 3.1.1.1 below:

Table 3.1.1.1. National policies reviewed

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
1	National Resources Water Policy 2012		-			Enhancing the sense of ownership. It is suggested that new policy to address this issue by ensuring new development to include the name of the river and the river basin in their advertisement. Instead of just highlighting that new home-owners will enjoy the lake view or the river view, they can include the fact that "new owners will enjoy living near a scenic Sungai Lui, a sub-basin of Langat River." Such requirement can be imposed by the local government when granting planning permission to the developer under Section 21A (1A) of the Town and Country Planning Act 1972. At the moment, the law only requires the developer to include an analysis of the social implications of the development. As a matter of fact, the development will have a direct and indirect impact on the river or the river basin. It is thus natural for the public to understand the rivers and the river basin where they are going to live in and appreciate the nature and status of the river nearby. There are many IWRM experts and talents in Malaysia from academia, government, NGOs, and the community. They are very useful and important assets in ensuring the acceleration of the implementation of IWRM in Malaysia. Some of them get specialised education in core streams at the university. Meanwhile, some of them are mobilisers and practitioners in their residential areas. And some of them become an expert because of training and experience from their careers. They are agents of knowledge transfer to the community and very valuable advocator in the community. This expert needs to be identified to assist as an advocate for the implementation of IWRM. Robust AACB and tailor made must be established to accelerate the IWRM understanding at all levels Institutionalization of public participatory platform (PPP) for the effective decision-making processes of IWRM.	NRE	KASA
						Empowering people and developing capacity building via the Quadruple Helix (Government, Business & Industry, Academia, Community) with IWRM and IRBM knowledge by using several communication strategies. Capacity building and continuous improvement of stakeholders can be strengthened via enhancing communication skills, river care knowledge, environmental subjects. Soft skills training on public outreach will enhance the awareness and capacity of all stakeholders. Moreover, enhancing the River basin understanding of the government officials will be effective via developing awareness that is in line with IWRM, IRBM, ICZM, etc. Enhancing and promoting river address, developing a simple brochure, video, etc. will also enhance the awareness of the civil servants on IWRM. One of the game changers or tipping points for AACB sub-sector in making the WST a reality and to be matched by political will via the involvement of parliamentarians of Malaysia via their All-Party Parliamentary Group Malaysia (APPGM).		
2	National Integrated Water Resources Management Strategic Plan					AACB training module to enhance stakeholders' leadership roles and facilitate enforcement of policies and laws for better water governance. AACB training module aspires to enhance stakeholders' leadership roles to facilitate the enforcement of policies and laws for better water governance, including to minimise future disaster from man-made and natural sources	NRE	KASA

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
3	National Policy on the Environment 2002					• KASA to expedite the enactment of DAN that promote the IWRM. • Strengthening AACB & Public Participatory Platforms in Malaysia via AACB WST 2040 programmes based on the quadruple helix model, i.e. comprising the main four clusters of stakeholders namely the Community & NGO; Business & Industry; government; and Academia. It is suggested that relevant agencies should take special non-structural measures such as campaigns, advertisements, water fairs, trainings and such to raise the awareness and capacity building of the people to enhance their participation in the effective water resources management platform. • To activate and empower the existing environmental volunteers and community-driven programmes e.g.: Rakan Alam Sekitar, Friends of River and updated them with info/ status on IWRM in their community. Community-driven programmes in environmental conservation need to be increased to empower people to protect and conserve water resources as well as create socioeconomic activities. Various successful initiatives, including the Tagal system and FoR programmes will also be expanded. Campaigns to inculcate water-saving habits and precise water use amongst domestic users and farmers will be intensified through community platforms such as Kumpulan Pengguna Air.	KeTTHa	KASA
4	Solid Waste Management Policy (2016)					To incorporate the solid waste management practices into AACB modules and programme. • AACB training module to enhance stakeholders' leadership roles and facilitate enforcement of policies and laws for better water governance. AACB training module aspires to enhance stakeholders' leadership roles to facilitate the enforcement of policies and laws for better water governance including to minimise future disaster from man-made and natural sources.	-	KPKT

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
5	National Policy on Climate Change, 2009					Empower the government's role in climate change through: The IWRM AACB WST2040 training module for government officials is designed from the perspectives of disaster risk reduction (DRR), considering both natural and man-made water-related disasters. The DRR perspective has been included in the training module to prepare the government officials for the worst situation to tackle water-related disasters so that they can act promptly to reduce the frequency and intensity of future disasters. Empower the academia role in climate change through: Develop teacher professional development workshop module and pedagogical activities (for formal and non-formal settings) on water sustainability and climate change adaptation. Develop inquiry-based climate change pedagogical resources for formal and non-formal settings, including resources for teacher professional development. Offering courses related to water sustainability and climate change education in Program Ijazah Sarjana Muda Pendidikan (PISMP) Incorporate elements of sustainable water resources management into relevant teaching programmes in public TVET institutions and private providers Develop a water and climate literacies assessment instrument Empower the business & industry roles in climate change through: Providing holistic 'Training of Trainers' capacity building programme for the stakeholders of the Business & Industry cluster whereby the capacity building module will include awareness-raising on demand management and how business and industry could play a role in addressing risks and environmental consequences of their operations and improving water efficiency and sustainability. Empower the community role in Climate Change trough: Through the WST2040 AACB community module, it is hoped that the enabling environment can be created to accelerate community participation and water stewardship expansion in the country. Strategic partnerships between the NGOs and the community will be organised to tackle issues faced by them effectively, to increase the community's awareness and to instill a sense of ownership towards their rivers.	MOSTI	KASA

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
6	National Policy on Science, Technology and Innovation 2013-2020			-	-	• Enhance PPPs and AACB Through Digital Learning Spaces. It is recommended for Malaysia to leverage the pervasiveness of technologies to serve the greater cause of water resource management. To adopt suitably advanced medium technology to spread awareness to the IWRM stakeholders. Inclusivity in data sharing. Data is an important component for decision making. In Europe, the United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters, famously known as the Aarhus Convention, requires greater access to data for the public to make good decisions in environmental matters. There is no such provision in the ASEAN region, let alone in Malaysia. Compared to the websites of agencies in Europe, America and Australia, there are relatively lack of data on the website of agencies in Malaysia, and there are data which will be released upon certain payment. Thus, concerted efforts are needed for the government agencies to make data readily available on their website to ensure public can make good judgement for their community. It is recommended that the Official Secret Act to be amended to exclude information relevant for environmental decision making. In the case of Malayan Trade Unions Congress (MTUC) & Ors v Minister of Energy, Water and Communications & Government of Malaysia (Civil Appeal No: 01(f)-6-03/2013(W) the MTUC pursued against the Government for access to an audit report and the concessionaire agreement with Syarikat Bekalan Air Selangor Sdn Bhd (SYABAS). The court satisfied that the MTUC had a genuine interest in the document but denied access to both documents on the ground of official secret document. The decision relaxed the law on locus standi by allowing anyone who has genuine interest in clean environment to bring an action in the court but denied access to data and official documents relevant to environmental matters.	-	MOSTI
7	National Cleanliness Policy 2019					Empowering people and developing capacity building via the Quadruple Helix (Government, Business & Industry, Academia, Community) with IWRM and IRBM knowledge using several communication strategies. Capacity building and continuous improvement of stakeholders can be strengthened via enhancing communication skills, river care knowledge, environmental subjects. Soft skills training on public outreach will enhance the awareness and capacity of all stakeholders. Moreover, enhancing the river basin understanding of the government officials will be effective via developing awareness that is in line with IWRM, IRBM, ICZM, etc. Enhancing and promoting river address, developing a simple brochure, video, etc. will also enhance the awareness of the public on IWRM	-	KPKT
8	National Policy on Biological Diversity 2016-2025					Government officials become more functional – following every measure of programmes, must have Communication Environment Public Awareness (CEPA), and working for info centre, gallery on big projects, such as that collaboration with the tourism department, whereby people can have information on the projects, and also local business which have a bit of economy gain for the locals	NRE	KASA

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
9	Green Technology Master Plan Malaysia 2013-2030				-	• Incentives and award should be provided for the green watershed restoration and nature-based solutions. It is recommended for Malaysian Investment Development Authority (MIDA) to introduce a new category in Green Incentives that is related to water management project. This recommendation aims to encourage more stakeholders to adopt and implement water management project in their premises and operations, for example, water reuse and reclamation for non-portable purposes. Any investments in this area to enable business and industry to adopt these practices should be given tax incentives. Besides, Ministry of Finance (MOF) and Inland Revenue Board of Malaysia (LHDN) should also give tax incentives to business and industry that managed to protect and upgrade the condition of the nearest water body for instance the company tax exemption will be given to business and industry entities, especially to companies for their involvement and contribution in conserving water resources. • Green incentives and certification for AACB WST Training attendees. Green incentives and certification, and recognition should be given to the SMEs for attending the AACB WST Training program before water servicing licensing and relicensing for Industries and Academia.	KETTHA	KASA
10	National Agrofood Policy 2011-2020	-	-			- Embed the IWRM principles in Agriculture practices trough AACB programs- In the agricultural sector, farmers' involvement in water resource management needs to be enhanced through their participation in the operation and maintenance of irrigation infrastructure. The implementation of AACB programmes will help in decision-making for development, particularly in land use change.	MOA	MAFI
11	National Environmental Health Action Plan (NEHAP) Malaysia		-			- Comprehensive and tailor made AACB programme must be established	-	MOH
12	National Urbanisation Policy 2 (2016-2025)					Role of local government serves as an important mechanism to further the policies and to facilitate the implementation of relevant strategies and programmes of the federal and state governments especially on Disaster Risk Reduction (DRR). Incorporate IWRM in the local plan; hence, future development will minimise the impact on the river basin.	-	KPKT
13	National Policy on Rural Development (2030)				-	Enhancing the sense of ownership. As people are relying on water supply from the tap, they forget that the water comes from the river. They may or may not even know the name of the river nearby and the bigger river basin where they live. It is suggested that new policy to address this issue by ensuring new development to include the name of the river and the river basin in their advertisement. Instead of just highlighting that new home-owners will enjoy the lake view or the river view, they can include the fact that "new owners will enjoy living near a scenic Sungai Lui, a sub-basin of Langat River." Such requirement can be imposed by the local government when granting planning permission to the developer under section 21A (1A) of the Town and Country Planning Act 1972. Currently, the law only requires the developer to include an analysis of the social implications of the development. As a matter of fact, the development will have a direct and indirect impact on the river or the river basin. It is thus natural for the public to understand the rivers and the river basin where they are going to live in and appreciate the nature and status of the river nearby.	-	MRRD

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
14	Shared Prosperity Vision 2030				-	Ensure balanced fiscal federalism, and carrot and stick to local government. Continuous Federal funding is also very vital for the rehabilitation and restoration of river basin management. AACB training program will enhance the leadership roles of stakeholderst for rehabilitation and restoration of river basin management. Federal funding is the main strength to adopt the green economic approaches for IWRM in Malaysia. Therefore, adequate green funding along with training will encourage stakoholders for sustainable water resources management while applying green economic approaches such as 'payment for ecosystem services', application of 'polluter pays' principle, and uniform pricing model for water resources, and as such. Moreover, water-based recreation and tourism activities via AACB training program will also encourage local authorities to promote local level income generation while incorporating the local communities.	PMO (EPU)	PMO (EPU)
15	National Community Policy					Establish IWRM information centre such as Pusat Informasi Sungai at community or Information corner at religious institutions such as surau and churches, local authority offices, tourist info centres, schools and universities. Strengthening AACB & Public Participatory Platforms in Malaysia via AACB WST 2040 programmes based on the quadruple helix model, i.e. comprising the main four clusters of stakeholders namely the Community & NGO; business & industry; government; and academia. It is suggested that relevant agencies should take special non-structural measures such as campaigns, advertisements, water fairs, trainings and such to raise the awareness and capacity building of the people to enhance their participation in the effective water resources management platform.	-	KPKT
16	National Energy Efficiency Action Plan, 2015				-	To incorporate the IWRM AAACB program into current and future	KeTTHa	KeTSA
17	National Forestry Policy (1978; Revised 1992)					Continuous RDIC for National Integrated Data Bank. Continuous RDIC (i.e. research, development, commercialization and innovation) for National Integrated Data Bank will be the key driver to accelerate the implementation of IWRM. These RDIC will effectively facilitate the real time decision making of stakeholders, especially at the local level to promote decision-making processes quickly. In this regard, the stakeholders mapping, series of dialogue and consultations among the federal, state and local level stakeholders will also justify the use of real time data and information coming from RDIC for IWRM. To mainstream water resource management as one of the priority research areas in RDIC. It will enhance the roles of researchers and academia from higher education institutions (HEIs) in promoting sustainable water resources management.	NRE	KeTSA
18	National Transport Policy 2019-2030				-	To incorporate the IWRM AAACB program into current and future National Transport policy programme and initiatives.	-	MOT
19	Shared Prosperity Vision 2030					Establish IWRM information centre such as Pusat Informasi Sungai at community or Information corner at religious institutions such as surau and churches, local authority offices, tourist info centres, schools and universities.	Ministry of Economic Affairs	Ministry of Economic Affairs

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
20	National Consumer Policy (2002)					• Strengthening AACB & Public Participatory Platforms in Malaysia via AACB WST 2040 programmes based on the quadruple helix model, i.e. comprising the main four clusters of stakeholders namely the Community & NGO; Business & Industry; Government; and Academia. It is suggested that relevant agencies should take special non-structural measures such as campaigns, advertisements, water fairs, trainings and such to raise the awareness and capacity building of the people to enhance their participation in the effective water resources management platform. • Establish Communication strategy in advocating and educating the consumers on water related matter such as water tariff mechanism, save water education programme, save river program etc. • Empower the public participatory platform through Forum Air – established under Section 70 under WSIA act, this body is doing exactly what AACB is doing, an arm under SPAN, especially in water tariff • Denai Sungai Kebangsaan as one of public participatory platform – as of this year, we have established more than 200km of trails, focusing more in Selangor, Johor, Kelantan, Negeri Sembilan; an approach to make people more close to water source, we have compiled all in the form of publication, parts for the DSK also can be extracted out and put into AACB module. The target for next 5 years is to have 5,000km of trails (end of 12MP).	-	KPDNKK
21	Education Blueprint (2006-2010)					• Reiterate importance of rivers as water resources for human and the environment at school. The topics related to water have been incorporated into school curriculum, this includes the syllabus of preschools, primary and secondary schools. This means that the topics are related to water have already being part of the formal education. However, it is possible that students might have forgotten or still not aware that the water is actually come from the rivers. In this regard, teachers should be trained and retrained, where they should learn more case studies related to river management, and thus they can share these case studies with students when teaching water related topics in the syllabus. A strong TVET ecosystem will be a game changer that will create future-ready talent in meeting industry demand. In this regard, there is a need to incorporate elements of sustainable water resources management into relevant teaching programmes in public TVET institutions and private providers. • Enhance the roles of researchers from higher education institutions (HEIs) in promoting sustainable water resources management. Researchers at HEIs have vast experience in research, training and consultation, hence they should share their expertise with stakeholders, namely government, industry and community. For government, researchers can provide technical inputs as subject matter experts (SMEs) to government officers, as well as to represent Malaysia or assist government officials in international and regional negotiations. Besides, researchers can also become the memory keeper for the relevant ministry/agency to ensure sustainable knowledge transfer. For industry, researchers can work closely with professional bodies to provide professional training courses or become consultants/technical advisors to selected industries. As far as community is concerned, researchers can take the leadership and proactive measures to outreach to the communities. Besides, researchers can also promote the concept of citizen science to enhance community engagement in sustainable water resources management.	-	KPM

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
						• Continuous RDIC for National Integrated Data Bank. Continuous RDIC (i.e. research, development, commercialization and innovation) for National Integrated Data Bank will be the key driver to accelerate the implementation of IWRM. These RDIC will effectively facilitate the real time decision making of stakeholders especially at the local level to promote decision-making processes quickly. In this regard, the stakeholders mapping, series of dialogue and consultations among the federal, state and local level stakeholders will also justify the use of real time data and information coming from RDIC for IWRM. • To mainstream water resource management as one of the priority research areas in RDIC. It will enhance the roles of researchers and academia from higher education institutions (HEIs) in promoting sustainable water resources management.		
22	National Physical Plan 3 (2016)					• Appropriate tools that can be used by government officers and local community to monitor the river water quality. Local government should be given the appropriate tools/ applications/ software to measure/monitor the quality and quantity of the waters under their jurisdiction. The local people should also be the first person to report the water issues. • AACB training module to enhance stakeholders' leadership roles and facilitate enforcement of policies and laws for better water governance. AACB training module aspires to enhance stakeholders' leadership roles to facilitate the enforcement of policies and laws for better water governance including to minimise future disaster from man-made and natural sources. • Role of local government serves as an important mechanism to further the policies and to facilitate the implementation of relevant strategies and programmes of the federal and state governments, especially on Disaster Risk Reduction (DRR). Incorporate IWRM in the local plan, hence future development will minimise the impact on the river basin. • Enhance leadership of government officers, especially at local and district levels in moving and realising the IWRM via quadruple helix mode via practices and activities supported by good flow of scientific data and information.	-	KPKT

No.	Related Policies/ Strategic Plans Reviewed	A	A	CB	PPPs	Area for Improvement	Previous Ministry	Current Ministry
23	Malaysia Smart City Framework (2018)					• Role of local government serves as an important mechanism to further the policies and to facilitate the implementation of relevant strategies and programmes of the federal and state governments, especially on Disaster Risk Reduction (DRR). Incorporate IWRM in the local plan, hence future development will minimise the impact on the river basin. • Appropriate tools that can be used by government officers and local community to monitor the river water quality. Local government should be given the appropriate tools/ applications/ software to measure/monitor the quality and quantity of the waters under their jurisdiction. The local people should also be the first person to report the water issues.	-	KPKT
24	Environmental Sustainability 2020-2030					• Strategic alliances with renowned regional and international water research and training centres. The National Research and Capacity Building institutes to enter into strategic alliances with renowned regional and international water research and training centres. Regular participation in reputed water-related international water fora by the civil servants will enhance their leadership skills and capacity in water management. • Collaboration with government agencies and relevant stakeholders. Partnerships between agencies and joint programmes between government sectors as well as collaboration and smart partnership help build linkage to enhance knowledge and help foster connectivity between agencies to develop a common sense of ownership.	-	KASA
25	Ministry of Water, Land and Natural Resources Strategic Plan 2019 –2023					Evenothough water portfolio has been chage to KASA, IWRM related AACB program must be continours. The AACB training module to enhance stakeholders' leadership roles and facilitate enforcement of policies and laws for better water governance. AACB training module aspires to enhance stakeholders' leadership roles to facilitate the enforcement of policies and laws for better water governance including to minimise future disaster from man-made and natural sources.	KATS	KASA/ KeTSA
26	Malaysia Roadmap Towards Zero Single Use Plastics (2018-2030)					To incorporate the IWRM AAACB program into current and future Zero single use plastics programme.	KPKT	KPKT

Indicator :

Present

Not Present

Proposals for Improvement of Policy (ies)

The importance of water management was emphasised in some national policies. There are strategies, thrusts, plans on water-related awareness-raising, advocacy, capacity building and public participatory platforms. Most of the existing program emphasizes integration or collaboration of Quadruple Helix stakeholders, i.e. government, business and industrial, academia and community that includes all hierarchies.

- Inclusivity in data sharing. Data is an important component for decision-making. In Europe, the United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters, famously known as the Aarhus Convention, requires greater access to data for the public to make good decisions in environmental matters. There is no such provision in the ASEAN region, let alone in Malaysia. As compared to the websites of agencies in Europe, America and Australia, relative lack of data on the website of agencies in Malaysia, and there are data which will be released upon certain payment. Therefore, concerted efforts are needed for the government agencies to make data readily available on their website to ensure public can make good judgement for their community.

It is recommended that the Official Secret Act to be amended to exclude information relevant for environmental decision-making. In the case of Malayan Trade Unions Congress (MTUC) & Ors v Minister of Energy, Water and Communications & Government of Malaysia (Civil Appeal No: 01(f)-6-03/2013(W) the MTUC pursued against the Government for access to an audit report and the concessionaire agreement with Syarikat Bekalan Air Selangor Sdn Bhd (SYABAS). The court satisfied that the MTUC had a genuine interest in the document but denied access to both documents on the ground of official secret document. The decision relaxed the law on locus standi by allowing anyone who has genuine interest in clean environment to bring an action in the court but denied access to data and official documents relevant to environmental matters.

- Capacity building and empowerment. Now, only officers in water-related agencies are aware of the water management concept and issues in the country. Not many local government officers, who are dealing with water related problems faced by the public, understand and well-equipped with knowledge and know-how to manage, identify and prevent water related disaster. There is thus a vital need to institutionalised capacity building on water resources management among the local government officers and the public. The capacity building and the training module should consider improvement on Water Framework Directives for effective overall environmental governance. The capacity building centre can also act as a focal point for all NGOs as well as all relevant platforms of multistakeholder sectors to share their knowledge and concerns on water issues faced by the public. It may also act as the data centre on water related matters for all stakeholders.

- Enhancing the sense of ownership. As people are relying on water supplies from the tap, then forget that the water comes from the river. They may or may not even know the name of the river nearby and the bigger river basin where they live. It is suggested that new policy to address this issue by ensuring new development to include the name of the river and the river basin in their advertisement. Instead of just highlighting those new homeowners will enjoy the lake view or the river view, they can include the fact that "new owners will enjoy living near a scenic Sungai Lui, a sub-basin of Langat River."

Such a requirement can be imposed by the local government when granting planning permission to the developer under Section 21A (1A) of the Town and Country Planning Act 1972. Now, the law only requires the developer to include an analysis of the social implications of the development. As a matter of fact, the development will have a direct and indirect impact on the river or the river basin. It is thus natural for the public to understand the rivers and the river basin where they are going to live in and appreciate the nature and status of the river nearby.

- Embedded the IWRM principles in Agriculture practices trough AACB programmes- In the agricultural sector, farmers' involvement in water resource management needs to be enhanced through their participation in the operation and maintenance of irrigation infrastructure. The implementation of AACB programs will help in decision-making for development, particularly in land use change.

Public Participatory Platform (PPPs)

Align with 12th MP, it is suggested that public consultation platform must be established at the state and district levels as a platform for the public to engage and consult on the management of the water sector matters. This platform is essential for the community and water users especially the indigenous people. The members shall be empowered and equipped with the capacity building and skills especially in conflict resolution and negotiation to ensure the effectiveness of the platform. This platform will be leveraged to support the National Water Council decisions. Adequate funds for non-structural capacity building towards IWRM, comprehensive AACB program at the PPPs through National Water Grant programme.

National Communication Plan

A strategic national communication plan must also be developed to ensure that the WST2040 is implemented effectively. It is recommended that a dedicated communications team is established to plan, execute, promote, and coordinate communications for WST2040 roadmap implementation. The communications team comprising communication professionals will continuously deliver consistent messaging to help achieve change of behaviour and mind-set towards water sector.

Impact & Outcomes-Based Approach

WST2040 needs a monitoring instrument or tools to measure the outcomes and impact of the strategies planned throughout the four Malaysian Plans. The instrument should include a review of progress and assessment in implementing the strategies, plans, and roadmaps of each WST2040 sub-sectors. It also should be able to review and build consensus on any action plan decided in the first cycle for future improvement of plans and roadmaps.

WST2040 moves and implements the strategies into the four phases. This will include the formation of a monitoring committee. The system will have to be designed based on the requirements of the monitoring committee.

1.3.2 TOR Scope 2 (Undertake Comparative Strategy Analysis/Business Models with other nations)

The list of the countries studied was United Kingdom, Australia, Sweden, Finland, Singapore, South Korea and the Mekong River Region countries (Table 3.1.1.2). Each of the countries' water management programme has its own niche and it must be observed and embedded into Malaysian condition. Almost all water management programs show the relation between the communities and the government entities.

Table 3.1.1.2. Countries studied

Countries	Best Practices
United Kingdom	1. The Our Rivers campaign was an unofficial public comment process, initiated by green non-governmental organizations in parallel to the Environment Agency's consultations, aimed at including local knowledge and more ambitious measures into the final River Basin Management plan (RBMPs) 2. Water framework directive (Europe)
Philippines	1. "Adopt an Estero Program" in 2012 was one of the programmes under the Environmental Management Bureau (DENR-EMB). In this programme, 430 Memoranda of Agreements (MOAs) were signed with 232 water bodies nationwide. This programme involves participation of the community in collecting and managing water quality data of the adopted water bodies. 2. Watershed Management Youth Council (WMYC). 3. Watershed Code was drafted and adopted in 2007 to integrate the various initiatives in the basin (Hearne 2010). 4. Promote watershed management advocacy among the Davao City student leaders and advocates. 5. Participation of women in terms of the provision, management, and safeguard water resources. Decision making in water resources management is no longer considered a strategic-level issue. 6. Flood Mitigation and Management Programme: FMMP transmitted warnings of possible flooding by two-way radio or mobile phone to village volunteers in the project areas. Red Cross volunteers in the villages then wrote up the forecasts on notice boards at prominent village locations and passed on through word-of-mouth. Management phases and institutional strengthening (top-down but bottom-up enablement) - Philippines had successfully conducted a river basin management or coordination amongst multi helix stakeholders. • Citywide Watershed Management Council (WMC) to author the Watershed Management Code. • 8river basins; management is integrated under the Watershed Management Ordinance. • In 1998, Talomo-Lipadas Rivers, the initiative on Philippines-Canadian Environmental and Economic Management Committee to increase the health of the river. • Davao River Conservation Coordinating Committee (DRCCC). • Local NGOs coordinate the role in effective participation, collaborating with Catholic Relief and Services (CRS). • 1974: the National Water Resources Board (NWRB) established to coordinate the use of water for different purposes. • 1999: Davao River Conservation Coordinating Committee (DRCCC). • 2007: The City Council approved the Watershed Management Code. • Performance and accountability - Who takes the leadership. • HELP (Hydrology for the Environment, Life and Policy) – Davao; management of city's water and environment. • HELP Davao Network and International training on water management (Khan,2011). • Twinning programme with Murrumbridgee 'HELP Demonstrational' River Basin in Australia has expanded the network of technical cooperation and exposure of the city government. • The framework under local government, a Local Executive Order was issued in the formation of city-wide Watershed Management Council (WMC).
Singapore	1. The Singapore Water Academy (SgWA) The Public Utility Board (PUB), Singapore's national water agency, has set up The Singapore Water Academy (SgWA), a leading training institution offering specialised programmes for water professionals both internationally and locally. The Academy develops competency-based curricula to build on current engineering competencies and develop future capabilities to enhance the engineering skills of the industry for the next phase of growth. 2. Active, Beautiful, Clean (ABC) Waters Programme. Under the Active, Beautiful, Clean Waters (ABC Programme, Singapore has optimized reservoirs, rivers, and canals beyond their traditional functions of channeling water and water storage. Pockets of community spaces now offer a host of recreational options for people to enjoy, transforming Singapore into a vibrant City of Gardens and Water. Some initiatives to recognize and boost volunteerism for the involvement:- 1. PUB introduced (Centre for Liveable Cities, 2017): (i) Watermark Awards that recognise individuals and organisations for their outstanding contributions towards the water cause. Recognition to organisations and members of the public who are keen in raising awareness on water conservation and organising water related activities are welcome as Friends of Water. 2. PUB recognised that there was a need to build capacities through certification and professional programmes towards ensuring liveable cities including (Centre for Liveable Cities, 2017): (i) ABC Waters Certification Scheme (ii) Green Mark Scheme (iii) ABC Waters Professional Programme

Countries	Best Practices
Mekong river region	Mekong Region Futures Institute (MERFI) activities include: 1. the analysis of development investment options by applying complex system tools and by improved cross-sectoral coordination. 2. the implementation of participatory processes to facilitate learning among decision-making agencies by eliciting, analysing and explaining cross-sector trade-offs of development investments among government agencies, universities and research institutions, and civil society. 3. the facilitation of cross-sector dialogue to share experiences about development investments and to minimise cross-sector trade-offs. 4. the development of license-free data and analytical tools provided to government agencies, including comprehensive training. 5. the training of government agency staff in the Greater Mekong Subregion (GMS) to assess sustainability-related outcomes of development decisions, promoting improved national efficiencies in: • sustainable national and regional development • maintenance and improvement of ecosystem services • community capacity to adapt to climate change • poverty reduction • wellbeing and more resilient livelihoods • ability to compete in the world market
Finland	1. Finnish Watercourse Restoration Network An open platform for all that provides information and experience on improving the status of water. Campaigns, information sharing via websites, newsletters and social media. Good practices for water protection and restoration, success stories, challenges and failures, use of aquatic ecosystem services. 2. Lake Vesijärvi Foundation • Secure funding for research, maintenance, and management efforts. • Improve the awareness of Lake Vesijärvi by many kinds of communication. • Promote efforts to improve the water quality of Lake Vesijärvi. • Prepare a plan for lake management. 3. Finnish Environment Institute SYKE Finnish Environment Institute SYKE offers expertise on vast management measures for rivers, streams and brooks, ranging fromsmall forestry brooks to large hydropower streams and offers deep ecological understanding with profound hydrological modelling capacity. The special areas of expertise include improving water status and using scientific knowledge in restoration. A multi-criteria assessment method helps in the comparison of cost-effective options and ensures stakeholder participation in the planning phase. Water quality and biological monitoring before and after restoration give information on how the goals of the restoration have been attained.
South Korea	Saemaul-Undong 'Community Driven Development' village programmes. Implementation of the SU movement took place in three successive stages that focused on basic infrastructure (Stage I); development (Stage II); and dissemination (Stage III), by which is meant to broadening of the populace who embraced the principles that led to the movement success in both medium and the long term. *Saemaul Undong's AACB and Public Participatory Platform Initiatives* 1. Training Programme – 1-week isolated training camp / 11-week training camp 2. Saemul Leadership Training 3. Training Institute for Saemul Leaders
Australia	Improve water governance: 1. the water advisory committee formed to see the water allocation and its engagements. The water advisory committee was formed from Water Resources Act 1976. 2. the Legislation in 1995 of the Water Management Act and Water Resources Act 1997 which enabled the establishment of catchment water management boards. 3. Natural Resources Management Act in 2004 which re-appealed the Water Resources Act (1997) as well as Soil Conservation and Land Care Act (1989). The main objective was to draw together organisations and individual across diversity sectors, linking the natural systems and interaction of economic, social and environment factors in decision-making. The Basin Community Committee (BCC) is the Public Participatory Platform that has helped the Commission successfully in obtaining and maintaining community interest, as well as their involvement and supports.

Countries	Best Practices
Germany	1. Rhine Net Program 2. Harmonizing Collaborating Planning (HarmoniCop) was designed to improve public participation. 3. This derived from new European Water Framework Directive incorporates the approach of River Basin Management Planning. Fifteen partners from Belgium, France, Germany, U.K., Hungary, Italy, Netherlands, Spain and Switzerland are involved in the project which each represent a unique network of water-related expertise. The project objective to generate useful information about public participation in River Basin Management Plan (RBMP) will be supported by external advisers constituting a stakeholder platform. Representatives from NGOs, local government, policy making, water industry and farming served as external advisers during project implementation. Since the beginning of the project in November 2002, the project partners have already received a lot of interest from the public. The project ends in October 2005.

1.3.3 TOR Scope 3 (Study Potential of the Nation's Water Sector Industry Taking into Consideration Current Global Markets Towards Marketing the Water Sector as a Dynamic New Economic Sector Capable of Driving the Nation's GDP Growth in the Future)

This Scope has already been reported on by Prof Mahendhiran.

1.3.4 TOR Scope 4 (Prepare a Transformation Strategy and Initiative Implementation Framework for each of the four phases, including the implementation agencies, estimated budgets and main target achievements based on the analysis undertaken and expert reviews)

The roadmap framework had been completed and approved by the Technical Committee at its meeting on 28 October 2020 and the Steering Committee at its meeting on 19 November 2020.

1.3.5 TOR Scope 5 (Undertake consultations with stakeholders and experts to finalise the proposed strategies and initiatives of the nation's Water Sector Transformation)

A total of 47 stakeholders' engagements were conducted as shown in Table 3.1.1.3 below:

Table 3.1.1.3. Stakeholder consultations

No.	Stakeholders Engagement	Dates	Platforms
1	Field Visit to Institut Pembangunan Modal Insan (IPMI) Zon Utara JPS	23 July 2020	Field Visit
2	Field Visit to TNB - ILSAS - Malim Nawar	23 July 2020	Field Visit
3	Field Visit to INTAN Northern Regional Campus (INTURA)	16 August 2020	Field Visit
4	Field Visit to Lembaga Kemajuan Pertanian MADA	16 August 2020	Field Visit
5	Field Visit to Institut Latihan Perindustrian Kangar	17 August 2020	Field Visit
6	Field Visit to Pusat Inovasi dan Produktiviti Pentadbiran Awam (PIPPA), Universiti Sains Malaysia	18 August 2020	Field Visit
7	Field Visit to Universiti sains Malaysia	18 August 2020	Field Visit
8	Field Visit to MPC Northern Region	18 August 2020	Field Visit
9	Field Visit to Institut Pembangunan Modal Insan (IPMI) JPS Zon Timur	25 August 2020	Field Visit
10	Field Visit to Institut Latihan FAMA Kota Bharu	25 August 2020	Field Visit
11	Field Visit to Akademi Perikanan Malaysia	26 August 2020	Field Visit
12	Field Visit to Pusat Latihan & Pembangunan Pengembangan (Plpp), Wilayah Timur	26 August 2020	Field Visit
13	Field Visit to INTAN Eastern Regional Campus (INTIM)	2 September 2020	Field Visit
14	Field Visit to KEMAS Training Centre Malacca	25 August 2020	Field Visit
15	Field Visit to Perbadanan Kemajuan Negeri Melaka (MITC)	25 August 2020	Field Visit
16	Field Visit to Institut Latihan Perindustrian Pasir Gudang	26 August 2020	Field Visit
17	Field Visit to UTM TTC (Pusat Latihan UTM)	27 August 2020	Field Visit
18	Field Visit to Institut Latihan FAMA (ILFPD)	28 August 2020	Field Visit

No.	Stakeholders Engagement	Dates	Platforms
19	Field Visit to Malaysian National Hydraulic Research Institute (NAHRIM)	4 September 2020	Field Visit
20	Field Visit to National Institute of Public Administration (INTAN)	4 September 2020	Field Visit
21	Field Visit to Institut Latihan KEMAS Kuantan (ILK)	1 September 2020	Field Visit
22	Field Visit to Pahang Skills Development Centre	1 September 2020	Field Visit
23	Field Visit to Pusat Informasi Sungai Penchala	13 April 2021	Field Visit
24	Discussion with Kelab Alami, Gelang Patah-NGO	27 August 2020	Physical
25	"Workshop Advocacy, Awareness Raising, Capacity Building & Public Participatory Platforms Sub-Sector Water Sector Transformation 2040 : Issues, Challenges and Opportunities"	8 October 2020	Hybrid (ASM/ Zoom)
26	Discussion with Water Warrior and UM Living Lab-NGO	15 December 2020	Online (Teams)
27	Meeting with Global Environment Centre (GEC)-NGO	16 December 2020	Online (Teams)
28	2nd Online Workshop on Water Sector Transformation 2040 By Awareness Raising, Advocacy and Capacity Building Sub-Sector (AACB Sub-Sector) – Module Development	8 January 2021	Online (Zoom)
29	Webinar on "Training Module for Government Officials to Accelerate the Implementation of IWRM"	12 January 2021	Online (Zoom/ FB live)
30	Discussion with Indah Green Waste Selangor-NGO	20 January 2021	Online (Teams)
31	Webinar on Community-Led River Basin Management in Kedah	11 February 2021	Online (Zoom/ FB live)
32	Discussion with Indah Water Academy	17 February 2021	Online (Teams)
33	Webinar on Dynamic Leadership Roles of Government Sector for Water Resources Management at Davao, Philippines	23 February 2021	Online (Zoom/ FB live)
34	Meeting with Malaysia Water Academy	26 February 2021	Online (Teams)
35	Webinar on Safeguarding and Rehabilitating Malaysian Rivers Role and Responsibility of One and All	31 March 2021	Online (Zoom/ FB live)
36	Discussion with Ministry of Education on AACB Academia Module Cluster 1. Research Sector and Policy Evaluation Education Program Feasibility Unit 2. Education Policy Planning and Research Division Office (Policy) Policy Issues and Analysis Unit 3. Division of National STEM Center Education Policy Planning and Research 4. Research and Development Unit Geography and Environmental Education Unit Curriculum Development Division (BPK)	2 April 2021	Online (Teams)
37	Discussion with Ministry of Higher Education on AACB Academia Module Cluster 1. Division - Research and PPRN Section 2. Policy Planning and Research Division	3 April 2021	Online (Teams)
38	Discussion with Ministry of Higher Education on AACB Academia Module Cluster 1. Department of Higher Education 2. Research Excellence Division Institutes of Higher Learning 3. Academic Excellence Division	3 April 2021	Online (Teams)
39	Discussion with National Union of the Teaching Profession (NUTP) on AACB Academia Module Cluster	4 April 2021	Online (Teams)
40	Webinar on The Paradigm Shift of Businesses and Industries towards Circularity in Water Management/Integrated Water Resource Management	24 February 2021	Online (Zoom/ FB live)

No.	Stakeholders Engagement	Dates	Platforms
41	Discussion with Global Environment Centre (GEC) RIVER Care Programme and River of Life POP at the River Education Centre and field visit to Pusat Informasi Sungai and Community	13 April 2021	Physical (Field Visit-Pusat Informasi sungai, Sungai Penchala)
42	Webinar on Promoting Sustainable Water Resource Management in Universities	26 April 2021	Online (Zoom/ FB live)
43	FOCUS GROUP DISCUSSION Water Sector Transformation 2040 By Awareness Raising, Advocacy and Capacity Building Sub-Sector (AACB Sub-Sector) with District Officers, Local Authorities and Chief Village of Muda River Basin, Petagas river and Baram River Basin.	4 May 2021	Online (Zoom)
44	Workshop on validation of AACB modules	19 July 2021	Online (Zoom)
45	AACB Community Module Validation Session Global Environment Centre (GEC), Water Warrior, WWF Malaysia, Jabatan Pengairan dan Saliran (JPS)	3 August 2021	Online (Google Meet)
46	Meeting with Kementerian Alam Sekitar dan Air (KASA) -Water and Sewerage	23 September 2021	Online (Zoom)
47	Pilot Study with Religious Leader and Community Leaders from Muda River Basin	30 September 2021	Online (Google Meet)

1.3.6 TOR Scope 6: To prepare the complete roadmap for the National Agenda on Water Sector Transformation 2040 (WST 2040 roadmap) for the reference and guide of the various ministries and agencies to implement project/programmes and activities towards achieving the aim of transforming the water sector

An AACB Sub-sectoral Roadmap is included in the AACB Final Report.

13.7 Immediately Implementable Projects for 12th MP (Table 3.1.1.4)

Table 3.1.1.4. Immediately Implementable Projects for 12th MP

Programmes	Lead Authority	Proposed Budget
- Training of 1 Focal Official in each 94 JPS District Offices for ToT. (RM 2,500/pax/training x 94 units) - Training of 222 Parliamentarian (Lump sum RM 3,000/pax/training x 222 units) - Training of 14 states' EXCO (RM 3,000/pax/training x 14 units) - Training of 1 official in each 14 SEPU at Federal & State levels. (RM 2,500/pax/training x 14 units) - Training of 1 official in each 154 Local Authorities (RM 2,500/pax/ training x 154 units) - Training of 1 official in each 171 District Offices. (RM 2,500/pax/training x 171 units) - Training of 27 Ministries' Officials at Federal and State Levels (RM 2,500/pax/training x 27 units)	KASA, KPKT, MOH	RM240,000 RM672,000 RM126,000 RM105,000 RM390,000 RM430,000 RM270,000
Training of 1 official each 14 Secretary offices (266 pax) at State and Federal levels. (RM 2,500/pax/training x 266 units)	KASA/KPKT/MOH	RM140,000
GIS map preparation for district and local authority boundary of 189 river basins & Web-based pollution mapping via sensor (Lump Sum RM10,000/ River Basin)	KASA/ KPKT/ MOH	RM2,040,000
Training of SMEs (i.e. small and medium enterprises, (9,340 pax)) for licensing and relicensing from 154 Local Authorities (2023 onwards) (Lump sum RM 2,500/pax/training x 9,340 units)	KASA/ KPKT/ MOH	RM3,850,000
- Developing a portal and digital AACB content such as video clips, posters, infographics and podcasts for 189 river basin's management (LS RM750,000) - Establishment of WST 2040 AACB Water Hub in 13 States and 3 F.T. for public participatory and effective decision-making processes of IWRM. (Lump sum RM 15,000 x 16 units) - 4 Training Events in every year (1 training = 4 days) (Lump Sum) - 1 Coordinator for IWRM Training with an FASc based at LESTARI, UKM (RM15,000/month) - 5 Assistants to facilitate IWRM Training based at LESTARI, UKM (RM 5,000/month) - Honorarium for Resource Person (RP) to facilitate IWRM Training (Lump sum RM10,000/pax/training x 1,567 pax)	KASA/ KPKT/ MOH	RM3,000,000 RM240,000 RM5,452,000 RM720,000 RM1,200,000 RM1,400,000
Train and retrain teachers on activities that are related to water resource management. Bahagian Pendidikan Guru (BPG) - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teacher professional development module on water sustainability by ASM. Institut Pendidikan Guru Malaysia (IPGM) - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	Ministry of Education (MOE)	Teacher Training RM 10,578,500 (0.5 day training/RM 50 for half day) **12MP:** RM 1,057,850 Training of Trainers RM 40,000 **12MP:** RM 10,000

Programmes	Lead Authority	Proposed Budget
Professional development program to familiarize teachers with climate science, active pedagogy and project design. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the teaching module on climate education. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid: i) Training of Trainers ii) Teachers Training	**Lead Authority** MOE **Collaborating Partners** ASM, ISTIC and Office for Climate Education, UNESCO	(12 hours training) **MP:** RM 350,400 RM 10,000
Develop teacher professional development workshop module and pedagogical activities (for formal and non-formal settings) on water sustainability and climate change adaptation.	**Lead Authority** KASA **Collaborating Partners** MOE, KASA, Humid Tropics Center (HTC - KL)	RM 20,000
Develop inquiry-based climate change pedagogical resources for formal and non-formal settings, including resources for teacher professional development.	**Lead Authority** MOE **Collaborating Partners** KASA (MGTC) and Office for Climate Education, UNESCO	RM 20,000
Offering courses related to water sustainability and climate change education in Program Ijazah Sarjana Muda Pendidikan (PISMP)	**Lead Authority** MOE & MOHE	RM 20,000
Incorporate elements of sustainable water resources management into relevant teaching programmes in public TVET institutions and private providers	**Lead Authority** MOE	RM 1,000,000
Develop a water and climate literacies assessment instrument	**Lead Authority** MOHE **Collaborating Partners** MOE, KASA	RM 20,000
Establish a whole-school approach to promote water and climate literacies through formal and non-formal settings and quadruple helix model	**Lead Authority** KASA **Collaborating Partners** MOHE, MOE	(RM 100 per school)\ RM 82,200
Expand digital platforms/tools for teaching and learning Develop simulation-based games, mobile platforms, virtual environments, and augmented reality tools to heighten curiosity and increase learner engagement.	**Lead Authority** MOE **Collaborating Partners** KASA, MOHE	RM 1,000,000
Educate present and future generations about climate change by providing tools to help students learn science and geography more fun and effectively.	**Lead Authority** MOE	RM 104,108,100 **12MP – 15MP:** Green House: RM92,910,000 Water Distillation Equipment: RM5,085,600 Meteorological Station: RM6,112,500

Programmes	Lead Authority	Proposed Budget
Establish one-stop educational resources and activities on water and climate change in Digital Educational Learning Initiatives Malaysia (DELIMa) platform.	**Lead Authority** MOE	RM 1,000,000
Train and retrain teachers on activities that are related to water resource management. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teaching module by ASM. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	Ministry of Education (MOE)	Teacher Training RM 10,578,500 (0.5 day training/RM 50 for half day) RM 1,057,850
Compile local and international case studies on the best practices of river/water management and climate change adaptation.	**Lead Authority** KASA **Collaborating Partners** MOE, KASA, Humid Tropics Center (HTC - KL)	RM 20,000
Strengthen collaboration and cooperation between TVET and industry, where more sessions or platforms for industry to share their experiences and expectations with the TVET students will be established	**Lead Authority** MOE	RM 1,000,000
Federal and state/local agencies arrange education programmes that involve learners use open government data related to water and climate change in data-driven decision making.	**Lead Authority** KASA **Collaborating Partners** MOE	(RM 100 per school) RM 82,200
Establish a single, searchable, user-friendly online resource for finding water- and climate-related education programmes and resources and funding opportunities as well as to showcase the project-based learning (PBL) activities that were conducted by schools (using a new or enhanced platform).	**Lead Authority** KASA **Collaborating Partners** MOE, MOHE, MOSTI	RM 1,000,000
To train lecturers on topics and activities that are related to water resource management.	Ministry of Higher Education (MOHE)	(1 day training/RM 100 for 1 day) RM 250,400
To compile success stories related to water resources management in HEIs (public and private)	Ministry of Higher Education (MOHE)	RM 20,000
To establish a database of resource persons (from public and private HEIs) in the field of water resource management	Ministry of Higher Education (MOHE)	RM 50,000
To mainstream water resource management as one of the priority research areas in RDCI.	Ministry of Higher Education (MOHE)	RM 20 million for **each MP**
Researchers' outreach to government agencies.	Ministry of Higher Education (MOHE)	RM 5 million for **each MP**
Researchers' outreach to industry.	Ministry of Higher Education (MOHE)	RM 5 million for **each MP**
Researchers' outreach to community.	Ministry of Higher Education (MOHE)	RM 5 million for **each MP**
To establish an interactive tool that encourage interactive communication between HEIs (public and private) and public	Ministry of Higher Education (MOHE)	RM 200,000
AACB "Training of Trainers"	KASA/DOE	RM 496,000
Water management certificate	KASA /EiMAS	RM 1.5 Million
CPD for water management	MOHR	RM 480,000
Water resource person network and directory	KASA	RM 500,000

Programmes	Lead Authority	Proposed Budget
Water best management practices communication	KASA	RM 500,000
Water incentives	MITI	RM 15 Million
Company tax exemption	MOF	RM 20 Million
Water Sustainability Award	KASA	RM750, 000
To converge the issues and needs of ENGOs and community leaders in increasing IWRM awareness.	KASA & state BKSA	RM7,670,000
To develop an apps Myriverbasin To establish a one-stop website through an apps to share/ link data needed for the community to decide on river basin To adopt an advanced technology in spreading awareness to community. Information	KASA & state BKSA	RM 1,000,000
To establish an information corner at the religious and community centre.	KASA & state BKSA	RM 40,000 (RM 100 per centres)
Notice board by the river	KASA/JPS	RM 200,000
To establish a formal platform/ state IWRM Training Centre. To reduce red-tape when dealing with complains from community.	KASA & state BKSA	(Consolidated at the Focus Area of People}
To incorporate IWRM/ IRBM in the structure or local plan, to minimize development impact on the river basin and reduce budget for disaster management.	KASA & state BKSA	Will be consolidated with the local plans/ IRBM plans

AACB Main Roadmap

2011	2012	12th MP 2013	2014	2015	13th MP (2026-2030)	14th MP (2031-2035)	15th MP (2036-2040)
Accelerating adoption of IWRM					Developing indigenous technology to be on par with international standards	Achieving economies of scale	Becoming the regional water industry hub
RM0	RM26,014,500	RM25,821,500	RM26,560,000	RM26,150,00	RM150,420,000	RM169,780,000	RM209,022,500
	AACB Training targeted to Quadruple Helix stakeholders to increase people's awareness and instil ownership & values toward water resources						
	Institutionalisation of Public Participatory Platform (PPP)						
	Facilitate the enforcement of policies and laws for better water governance via AACB Training						
	Government to form strategic partnership and establish resource person directory within their local/regional/ international network						
	Integrated and comprehensive data sharing and management						
	Resource person to publish and disseminate best water management practices through public communication means						
	Adequate funds for non-structural capacity building towards IWRM						
	Give tax incentives, awards and recognitions to water managers that managed to protect and upgrade the condition of their nearest waterbody						
	IWRM training centres and Pusat Informasi Sungai and others should have adequate online/on-site facilities considering the uncertainties						
	Nucleus and complimenting Training Centres at national and state level						
	Impact & Outcomes of the AACB Training Programmes						
People	Governance		Information and RDCI	Finance		Infrastructure and Technology	

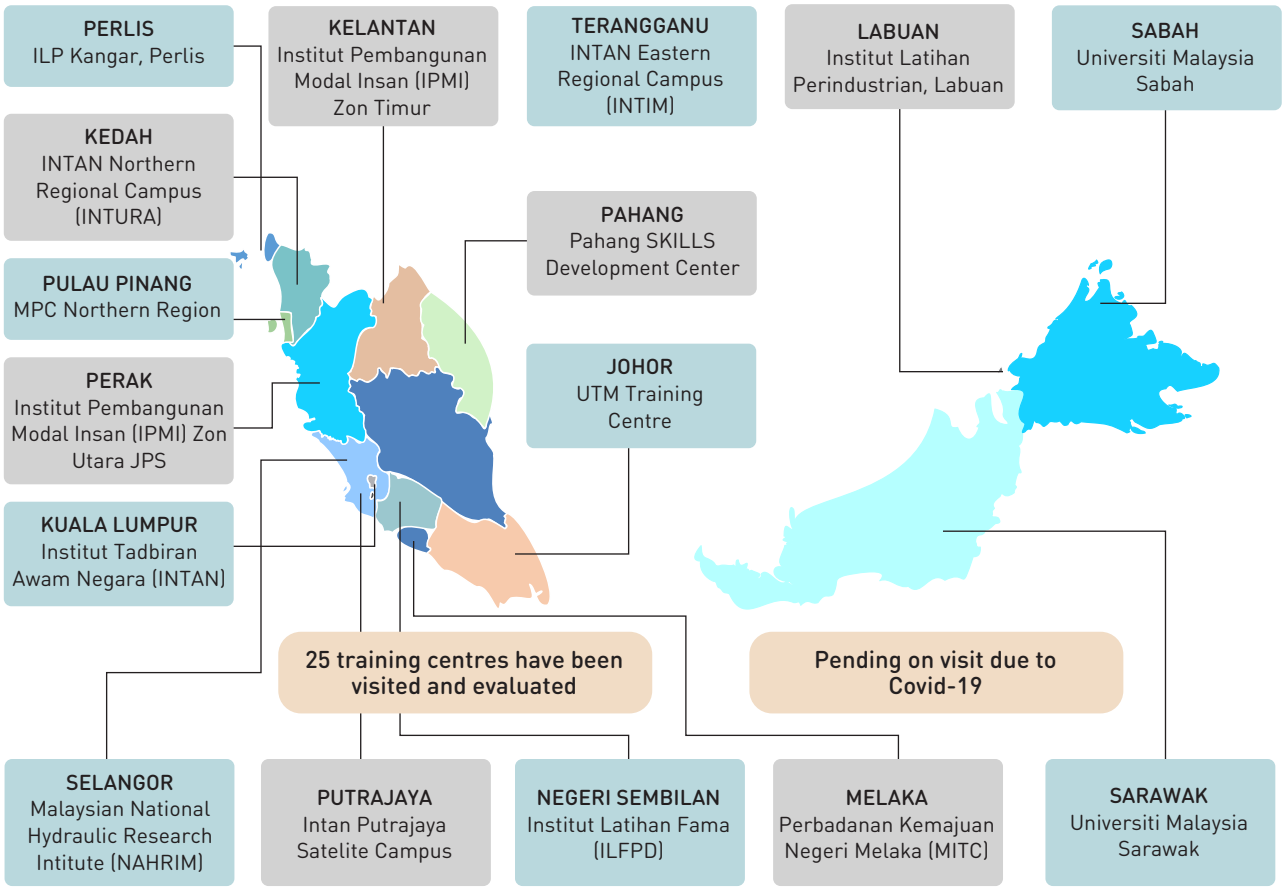
Proposed AACB Advocators Training

Malaysian Plan / AACB Clusters / Advocators	12th MP (2022–2025)	13th MP (2026–2030)	14th MP (2031–2035)	15th MP (2036–2040)
Government	**RM 49,075,000**	**RM 49,650,000**	**RM 51,050,000**	**RM 56,562,500**
Civil Servants (CS)	3396 CS	8360 CS	8360 CS	9445 CS
Local Govt:	1964	5105	5105	5515
State Govt:	140	965	965	965
Federal Govt:	1292	2290	2290	2965
Academia	**RM 250,400**	**RM 500,800**	**RM 751,300**	**RM 1,001,800 RM**
	RM 1,057,850	**RM 2,115,700**	**RM 3,173,550**	**4,231,400**
Lecturers (L)	2,504 (L)	5,008 (L)	7,513 (L)	10,018 (L)
Teachers(T)	21,157 (T)	42,314 (T)	63,471 (T)	84,628 (T)

Business Business Representatives (BR)	**RM 716,986.00** 740 BR	**RM 1,201,436.00** 1,240 BR	**RM 1,201,436.00** 1,240 BR	**RM 1,201,436.00** 1,240 BR
Community Community Leaders & ENGOs (CL & ENGOs)	**RM7,670,000** 1,500 CL & ENGOs	**RM15,300,000** 3,000 CL & ENGOs	**RM30,600,000** 6,000 CL & ENGOs	**RM61,200,000** 12,000 CL & ENGOs
Total	**RM44,013,250**	**RM68,062,500**	**RM86,070,850**	**RM122,430,080**

Proposed 16 Nucleus Training Centres

AACB Sub-Sector proposes 16 training centres to be one nucleus centre as below, to be supported by several complimenting centres in the same state.



1.3.8 Strategies, Targets and KPIs for the 4 MPs (one Table/MP) (Table 3.1.1.5)

Table 3.1.1.5. 12th Malaysia Plan

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Institutionalisation of public participatory platform (PPP) for the effective decision-making processes of IWRM (Government Cluster)	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. (RM 2,500/pax/ training x 94 units) - Training of 222 Parliamentarian (Lump sum RM 3,000/pax/training x 222 units) - Training of 14 states' EXCO (RM 3,000/pax/ training x 14 units) - Training of 1 official in each 14 SEPU at Federal & State levels. (RM 2,500/pax/ training x 14 units) - Training of 1 official in each 154 Local Authorities (RM 2,500/pax/training x 154 units) - Training of 1 official in each 171 District Offices. (RM 2,500/pax/training x 171 units) - Training of 27 Ministries' Officials at Federal and State Levels (RM 2,500/pax/ training x 27 units)	KASA/ KPKT/ MOH	Targeted Government Official trained (Number)	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. - Training of 222 Parliamentarian - Training of 14 states' EXCO - Training of 1 official in each 14 SEPU at Federal & State levels. - Training of 1 official in each 154 Local Authorities - Training of 1 official in each 171 District Offices. - Training of 27 Ministries' Officials at Federal and State Levels	RM240,000 RM672,000 RM126,000 RM105,000 RM390,000 RM430,000 RM270,000
Training module to enhance leadership roles of civil servants in order to facilitate the enforcement of policies and laws for better water governance. (government cluster)	Training of 1 official each 14 Chief Secretary offices (266 pax) at State and Federal levels. (RM 2,500/pax/training x 266 units)	KASA/KPKT/ MOH	Targeted Government Official trained (Number)	Training of 1 official each 14 Chief Secretary offices (266 pax) at state and federal levels.	RM140,000
	National Institute of Public Administration (INTAN) to incorporate the government and academic training modules in their curriculum	KASA/ JPA	Targeted Number of PTD Trained	PTD (40 pax X 6 training/year x RM 2,500)	RM14,400,000
To ensure flow of reliable data and information from relevant agencies to the local govt. for IWRM. (Government Cluster)	GIS map preparation for district and local authority boundary of 189 river basins & Web-based pollution mapping via sensor (Lump Sum RM10,000/River Basin)	KASA/ KPKT/ MOH	# of Pollution Mapping for 189 River Basins	95 main river basins (50%) mapped	RM2,040,000
Adequate funds for non-structural capacity building towards IWRM. (Government Cluster)	Training of SMEs (i.e., small and medium enterprises, (9,340 pax)) for licensing and relicensing from 154 Local Authorities (2023 and onwards) (Lump sum RM 2,500/pax/training x 9,340 units)	KASA/ KPKT/ MOH	# of SMEs trained	1552 SMEs	RM3,850,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
IWRM training centres such as Pusat Informasi Sungai and other should have adequate online/on-site facilities considering the uncertainties. (Government Cluster)	- Developing a portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management (LS RM750,000) - Establishment of WST 2040 AACB Water Hub in 13 States and 3 F.T. for public participatory and effective decision-making processes of IWRM. (Lump sum RM 15,000 x 16 units) - 4 Training Events in every year (1 training = 4 days) (Lump Sum) - 1 Coordinator for IWRM Training with an FASc based at LESTARI, UKM (RM15,000/ month) - 5 Assistants to facilitate IWRM Training based at LESTARI, UKM (RM 5,000/month) - Honorarium for Resource Person (RP) to facilitate IWRM Training (Lump sum RM10,000/pax/training x 1,567 pax)	KASA/ KPKT/ MOH	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed WST 2040 AACB Water Hub developed	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed 4 water Hub in central region operated	RM3,000,000 RM240,000 RM5,452,000 RM720,000 RM1,200,000 RM1,400,000
Reiterate importance of rivers as water resources for human and the environment (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. Bahagian Pendidikan Guru (BPG) - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teacher professional development module on water sustainability by ASM. Institut Pendidikan Guru Malaysia (IPGM) - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	KASA	The WST 2040 should cover 50% of the total teachers	21,157 teachers	Teacher Training RM 10,578,500 (0.5-day training/RM 50 for half day) RM 1,057,850
			Train 140 trainers	140 trainers	RM 10,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
	Develop teacher professional development workshop module and pedagogical activities (for formal and non-formal settings) on water sustainability and climate change adaptation.	KASA	The content for the module and pedagogical activities are developed during **12th MP**	The content for the module and pedagogical activities are developed during **12th MP**	RM 20,000
	Develop inquiry-based climate change pedagogical resources for formal and non-formal settings, including resources for teacher professional development.	KASA	The pedagogical resources are developed during **12th MP**	The pedagogical resources are developed during **12th MP**	RM 20,000
	Offering courses related to water sustainability and climate change education in Program Ijazah Sarjana Muda Pendidikan (PISMP)	KASA	The courses are developed and offered in **12th MP**	The courses are developed and offered in **12th MP**	RM 20,000
	Incorporate elements of sustainable water resources management into relevant teaching programmes in public TVET institutions and private providers	KASA	Relevant TVET programmes have been revised in **12th MP**	Relevant TVET programmes have been revised in **12th MP**	RM 1,000,000
	Develop a water and climate literacies assessment instrument	KASA	The instrument is developed during **12th MP**	The instrument is developed during **12th MP**	RM 20,000
	Establish a whole-school approach to promote water and climate literacies through formal and non-formal settings and quadruple helix model	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	822 schools	(RM 100 per school) RM 82,200
	Expand digital platforms/tools for teaching and learning Develop simulation-based games, mobile platforms, virtual environments, and augmented reality tools to heighten curiosity and increase learner engagement.	KASA	The online education platforms/ tools are developed during **12th MP**	The online education platforms/ tools are developed during **12th MP**	RM 1,000,000
	Educate present and future generations about climate change by providing tools to help students learn science and geography more fun and effectively. (8i's – Infrastructure)	KASA	Involving 2,445 secondary schools	2,445 secondary schools	RM 104,108,100 **12th MP – 15th MP:** Green House: RM92,910,000 Water Distillation Equipment: RM5,085,600 Meteorological Station: RM6,112,500
	Establish one-stop educational resources and activities on water and climate change in Digital Educational Learning Initiatives Malaysia (DELIMa) platform. (8i's – Infrastructure)	KASA	All schools can access the educational resources and activities in DELIMa.	The one-stop platform is developed during **12th MP**	RM 1,000,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Inculcation of local values in promoting sustainable water resources management (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teaching module by ASM. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training (8i's – Interaction, Intellectual Capital)	KASA	The WST 2040 should cover 50% of the total teachers (423,140) in Malaysia	21,157 teachers	Teacher Training RM 10,578,500 (0.5-day training/RM 50 for half day) **12th MP:** RM 1,057,850
	Compile local and international case studies on the best practices of river/water management and climate change adaptation. (8i's – Integrity, Institution)	KASA	Establish a committee to compile local and international case studies on the best practises of river/water management	The case studies on the best practises of river/water management are compiled during **12th MP**	RM 20,000
	Strengthen collaboration and cooperation between TVET and industry, where more sessions or platforms for industry to share their experiences and expectations with the TVET students will be established (8i's – Integrity, Institution)	KASA	Sessions or platforms for industry to share their experiences and expectations with the TVET students have been established in **12th MP**	Sessions or platforms for industry to share their experiences and expectations with the TVET students have been established in **12th MP**	RM 1,000,000
	Federal and state/local agencies arrange education programmes that involve learners use open government data related to water and climate change in data-driven decision making.	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	822 schools	(RM 100 per school) RM 82,200
	Establish a single, searchable, user-friendly online resource for finding water- and climate-related education programmes and resources and funding opportunities as well as to showcase the project-based learning (PBL) activities that were conducted by schools (using a new or enhanced platform).	KASA	The online platform is developed/ enhanced during **12th MP**	The online platform is developed/ enhanced during **12th MP**	RM 1,000,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Enhance the roles of researchers from higher education institutions (HEIs) in promoting sustainable water resources management (Academia Cluster)	To train lecturers on topics and activities that are related to water resource management.	KASA	The WST 2040 should cover 50% of the total lecturers (50,085 that includes professor, associate professor and lecturers) in Malaysia	2,504 lecturers	RM 2,504,300 (1 day training/RM 100 for 1 day) **12th MP:** RM 250,400
	To compile success stories related to water resources management in HEIs (public and private)	KASA	Establish a committee to compile success stories related to water resources management in HEIs (public and private)	The success stories are compiled during **12th MP**	RM 20,000
	To establish a database of resource persons (from public and private HEIs) in the field of water resource management	KASA	The database is made available online.	The database is established during **12th MP**	RM 50,000
	To mainstream water resource management as one of the priority research areas in RDCI.	KASA	The funding will be provided by Government	10 projects for **each Malaysia Plan (MP)**	RM 20 million for **each Malaysia Plan (MP)**
	Researchers' outreach to government agencies.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
	Researchers' outreach to industry.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
	Researchers' outreach to community.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
	To establish an interactive tool that encourage interactive communication between HEIs (public and private) and public	KASA	The interactive tool can be used in different platforms, such as Windows, Mac, Android, iOS etc.	The interactive tool is established during **12th MP**	RM 200,000
Holistic "Training of Trainers" capacity building for business and industry cluster stakeholders (Business & Industry Cluster)	AACB "Training of Trainers"	KASA/ DOE	# participant that has been trained	740 pax	RM716,986.00
Provide competency certification for business and industry stakeholders who have undergone the training (Business & Industry Cluster)	Water management certificate	KASA (EiMAS)	Giving competency certification for EHS and Sustainability Professionals of business and industry.	Certification mechanism established	RM 1.5 Million

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Provide Continuing Professional Development (CPD) point to those Professional Practitioners (i.e. BEM, MBOT, MGBC, PAM, etc) (Business & Industry Cluster)	CPD for water management	Ministry of Human Resource (MOHR)	CPD mechanism established	CPD mechanism established	RM 480,000
Government to form strategic partnership with business and industry and establish resource person directory within their regional network (Business & Industry Cluster)	Water resource person network and directory	KASA/ MITI	A directory of resource person is available for public access.	A directory of resource person is available for public access.	RM 500, 000
Resource person to publish and disseminate water best management practices in business and industry through public communication means (Business & Industry Cluster)	Water best management practices communication	KASA	# of event/meeting that been hold	50 events	RM 500,000
Introduce new category in Green Incentives that is related to water management project (Business & Industry Cluster)	Water incentives	MIDA	# of company or industries that receive water incentives.	50 companies	RM 15 million
Give tax incentives to business and industry that managed to protect and upgrade the condition of their nearest waterbody (Business & Industry Cluster)	Company tax exemption	MOF	# of company or industries that receive water incentives	16	RM 20 million

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Give awards and recognitions to business and industry that succeed in applying best management practices in their premises (Business & Industry Cluster)	Water Sustainability Award	KASA	# of event that be hold	50 events	RM 750,000
Increasing community awareness and instil ownership towards rivers and other water sources in their river basin. (Community Cluster)	To converge the issues and needs of ENGOs and community leaders in increasing IWRM awareness.	KASA & state BKSA	# of Advocators	1,500 pax	RM7,670,000
	To develop an apps Myriverbasin To establish a one-stop website through an apps to share/ link data needed for the community to decide on river basin To adopt an advanced technology in spreading awareness to community. Information	KASA & state BKSA	# of Advocators	Developed during 12th MP	RM1,000,000
	To establish an information corner at the religious and community centre.	KASA & state BKSA	# of information corner	400 information corners	RM 40,000 (RM 100 per centres)
	Notice board by the river		# of Notice board	400 rivers	RM 200,000
Empower community to effectively participate in IRBM to adapt to climate change and disaster risk reduction. (Community Cluster)	To establish a formal platform/ state IWRM Training Centre. To reduce red-taps when dealing with complains from community.	KASA & state BKSA	Establish a formal platform/ state IWRM Training Centre.	Training facility, and trainer fee	(Consolidated at the Focus Area of People)
	To incorporate IWRM/ IRBM in the structure or local plan, to minimize development impact on the river basin and reduce budget for disaster management.	KASA & state BKSA	Established task force/working committee	The federal government should set certain targets and provide sufficient funding for the state and local government	Will be consolidated with the local plans/ IRBM plans
National Communication Plan					

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
To enhance the communication, education, and public awareness through Strategic National Communication Plan	To expand the implementation of public outreach programme and participation	KASA	Established National Communication Plan	By 2022, the National Communication Plan must be launched	RM1,000,000
Public Participatory Platform (PPPs)					
To establish and encourage the water related PPPs	National Water Resource Grant	KASA	Number of Grant Applied	Community-based organisations (CBOs) such as Resident Associations, JKKK and Rukun Tetangga; Non-profit organisations, learning institutions and special interest groups who has interest in the management of their river basins and academia.	RM4,000,000 (RM1,000,000 per year)

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Institutionalization of public participatory platform (PPP) for the effective decision-making processes of IWRM (Government Cluster)	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. (RM 2,500/pax/training x 94 units) - Training of 222 Parliamentarian (Lump sum RM 3,000/pax/training x 222 units) - Training of 14 states' EXCO (RM 3,000/pax/training x 14 units) - Training of 1 official in each 14 SEPU at Federal & State levels. (RM 2,500/pax/training x 14 units) - Training of 1 official in each 154 Local Authorities (RM 2,500/pax/training x 154 units) - Training of 1 official in each 171 District Offices. (RM 2,500/pax/training x 171 units) - Training of 27 Ministries' Officials at Federal and State Levels (RM 2,500/pax/training x 27 units)	KASA/ KPKT/ MOH	Targeted Government Official trained ((Number	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. - Training of 222 Parliamentarian - Training of 14 states' EXCO - Training of 1 official in each 14 SEPU at Federal & State levels. - Training of 1 official in each 154 Local Authorities - Training of 1 official in each 171 District Offices. - Training of 27 Ministries' Officials at Federal and State Levels	RM240,000 RM672,000 RM126,000 RM105,000 RM390,000 RM430,000 RM270,000
Training module to enhance leadership roles of civil servants to facilitate the enforcement of policies and laws for better water governance. (Government Cluster)	- Training of 1 official each 14 Chief Secretary offices (266 pax) at State and Federal levels. (RM 2,500/pax/training x 266 units) - IWRM Expert in each 27 ministries at Federal (405 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/training x 405 units) - IWRM Expert in each 27 ministries at State (2,025 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/training x 2,025 units) - IWRM Expert in each 154 Local Authority (780 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 780 units) - IWRM Expert in each 171 District Office (860 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 860 units) - IWRM expert to coordinate each of the 16 National AACB WST Training Centers (240 pax). (Lump sum RM 10,000/pax/training x 240 units)	KASA/ KPKT/ MOH	Targeted Government Official trained (Number)	- Training of 1 official each 14 Chief Secretary offices (266 pax) at State and Federal levels. - IWRM Expert in each 27 ministries at Federal (405 pax) level under their jurisdiction for better coverage, monitoring and decision making. - IWRM Expert in each 27 ministries at State (2,025 pax) level under their jurisdiction for better coverage, monitoring and decision making. - IWRM Expert in each 154 Local Authority (780 pax) level under their jurisdiction for better coverage, monitoring and decision-making. - IWRM Expert in each 171 District Office (860 pax) level under their jurisdiction for better coverage, monitoring and decision-making. - IWRM expert to coordinate each of the 16 National AACB WST Training Centers (240 pax).	RM175,000 RM337,500 RM1,687,500 RM487,500 RM537,500 RM800,000
	- National Institute of Public Administration (INTAN) to incorporate the government and academic training modules in their curriculum	KASA/ JPA	Targeted Number of PTD Trained	PTD (40 pax X 6 training/year x RM 2,500)	RM18,000,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
To ensure flow of reliable data and information from relevant agencies to the local govt. for IWRM. (Government Cluster)	- Digitalization of WST 2040 AACB training module (Lump sum) - GIS map preparation for district and local authority boundary of 189 river basins & Web-based pollution mapping via sensor (Lump Sum RM10,000/River Basin)	KASA/ KPKT/ MOH	Update & Review	Update & Review	RM50,000 RM100,000
Adequate funds for non-structural capacity building towards IWRM. (Government Cluster)	Training of SMEs (i.e., small and medium enterprises, (9,340 pax)) for licensing and relicensing from 154 Local Authorities (2023 and onwards) (Lump sum RM 2,500/pax/training x 9,340 units)	KASA/ KPKT/ MOH	# of SMEs trained	2600 SMEs	RM6,500,000
IWRM training centres such as Pusat Informasi Sungai and other should have adequate online/ on-site facilities considering the uncertainties. (Government Cluster)	- Developing a portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management (LS RM750,000) - Establishment of WST 2040 AACB Water Hub in 13 States and 3 F.T. for public participatory and effective decision-making processes of IWRM. (Lump sum RM 15,000 x 16 units) - 4 Training Events in every year (1 training = 4 days) (Lump Sum) - 1 Coordinator for IWRM Training with an FASc based at LESTARI, UKM (RM15,000/ month) - 5 Assistants to facilitate IWRM Training based at LESTARI, UKM (RM 5,000/month) - Honorarium for Resource Person (RP) to facilitate IWRM Training (Lump sum RM10,000/pax/training x 1,567 pax)	KASA/ KPKT/ MOH	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed WST 2040 AACB Water Hub developed	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed. (Update) 12 water Hub in Central, north, Sabah & Sarawak region operated	RM750,000 RM60,000 RM6,815,000 RM900,000 RM1,500,000 RM2,800,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Reiterate importance of rivers as water resources for human and the environment (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. Bahagian Pendidikan Guru (BPG) - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teacher professional development module on water sustainability by ASM. Institut Pendidikan Guru Malaysia (IPGM) - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	KASA	The WST 2040 should cover 50% of the total teachers	63,471 teachers	(0.5-day training/ RM 50 for half day) RM 3,173,550
			Train 140 trainers	140 trainers	RM 10,000
	Professional development program to familiarize teachers with climate science, active pedagogy and project design. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the teaching module on climate education. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid: i) Training of Trainers ii) Teachers Training	KASA	Train 23,360 teachers	5,840 teachers	(12 hours training) RM 350,400
			Train 80 trainers	80 trainers	RM 10,000
	Establish a whole-school approach to promote water and climate literacies through formal and non-formal settings and quadruple helix model	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	2,466 schools	(RM 100 per school) RM 246,600
	Educate present and future generations about climate change by providing tools to help students learn science and geography more fun and effectively.	KASA	Involving 2,445 secondary schools	2,445 secondary schools	RM 104,108,100 **12MP – 15MP:** Green House: RM92,910,000 Water Distillation Equipment: RM5,085,600 Meteorological Station: RM6,112,500

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Strategy 2: Inculcation of local values in promoting sustainable water resources management (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teaching module by ASM. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	KASA	The WST 2040 should cover 50% of the total teachers (423,140) in Malaysia	63,471 teachers	(0.5-day training/ RM 50 for half day) RM 3,173,550
	Federal and state/local agencies arrange education programmes that involve learners use open government data related to water and climate change in data-driven decision making.	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	schools 2,466	(RM 100 per school) RM 246,600
Enhance the roles of researchers from higher education institutions (HEIs) in promoting sustainable water resources management (Academia Cluster)	To train lecturers on topics and activities that .are related to water resource management	KASA	The WST 2040 should cover 50% of the total lecturers (50,085 that includes professor, associate professor, and lecturers) in Malaysia	lecturers 7,513	(1 day training/RM 100 for 1 day) **14MP:** RM 751,300
	To mainstream water resource management as one of the priority research areas in RDCI.	KASA	The funding will be provided by Government	10 projects for **each MP**	RM 20 million for **each MP**
	Researchers' outreach to government agencies.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each MP**
	Researchers' outreach to industry.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each MP**
	Researchers' outreach to community.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each MP**
Holistic "Training of Trainers" capacity building for business and industry cluster stakeholders (Business & Industry Cluster)	"AACB "Training of Trainers	KASA/ DOE	# participant that has been trained	1,240 pax	RM 1,201,436

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Provide competency certification for business and industry stakeholders who have undergone the training (Business & Industry Cluster)	Water management certificate	(KASA (EiMAS	Giving competency certification for EHS and Sustainability Professionals of business and industry.	Certification mechanism established	RM 1.5 million
Provide Continuing Professional Development (CPD) point to those Professional Practitioners (i.e. (BEM, MBOT, MGBC, PAM, etc (Business & Industry Cluster)	CPD for water management	Ministry of Human Resource (MOHR)	CPD mechanism established	CPD mechanism established	RM 480,000
Government to form strategic partnership with business and industry and establish resource person directory within their regional network)Business & Industry Cluster)	Water resource person network and directory	KASA/ MITI	A directory of resource person is available for public access.	A directory of resource person is available .for public access	RM 500,000
Resource person to publish and disseminate water best management practices in business and industry through public communication means (Business & Industry Cluster)	Water best management practices communication	KASA	# of event/meeting that been hold	50 events	RM 500,000
Introduce new category in Green Incentives that is related to water management project (Business & Industry Cluster)	Water incentives	MIDA	# of company or industries that receive water incentives.	companies 50	RM 15 Million
Give tax incentives to business and industry that managed to protect and upgrade the condition of their nearest waterbody (Business & Industry Cluster)	Company tax exemption	MOF	# of company or industries that receive water incentives	companies 16	RM 20 MIllion
Give awards and recognitions to business and industry that succeed in applying best management practices in their premises (Business & Industry Cluster)	Water Sustainability Award	KASA	# of event that be hold	events 50	RM 750,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Increasing community awareness and instil ownership towards rivers and other water sources in their river basin. (Community Cluster)	To converge the issues and needs of ENGOs and community leaders in increasing IWRM awareness.	KASA & state BKSA	# of Advocators	pax 6000	RM30.6 Million
	To develop an apps Myriverbasin To establish a one-stop website through an apps to share/ link data needed for the community to decide on river basin To adopt an advanced technology in spreading awareness to community. Information	KASA & state BKSA	# of Advocators	pax 6000	RM30.6 Million
	To establish an information corner at the religious and community centre.	KASA & state BKSA	# of information corner	1,500 centres	RM 150,000 (RM 100 per centres)
	Notice board by the river		# of Notice board	1,500 rivers	RM 750,000 (RM 500 per river)
Empower community to effectively participate in IRBM to adapt to climate change and disaster risk reduction. (Community Cluster)	To establish a formal platform/ state IWRM Training Centre. To reduce red-taps when dealing with complains from community.	KASA & state BKSA	Establish a formal platform/ state IWRM Training Centre.	Training facility, and trainer fee	(Consolidated at the Focus Area of People)
	To incorporate IWRM/ IRBM in the structure or local plan, to minimize development impact on the river basin and reduce budget for disaster management.	KASA & state BKSA	Established task force/working committee	The federal government should set certain targets and provide sufficient funding for the state and local government	Will be consolidated with the local plans/ IRBM plans
Public Participatory Platform (PPPs)					
To establish and encourage the water related PPPs	National Water Resource Grant	KASA	Number of Grant Applied	Community-based organisations (CBOs) such as Resident Associations, JKKK and Rukun Tetangga; Non-profit organisations, learning institutions and special interest groups who has interest in the management of their river basins and academia.	RM5,000,000 (RM1,000,000 per year)

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Institutionalization of public participatory platform (PPP) for the effective decision-making processes of IWRM (Government Cluster)	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. (RM 2,500/pax/training x 94 units) - Training of 222 Parliamentarian (Lump sum RM 3,000/pax/training x 222 units) - Training of 14 states' EXCO (RM 3,000/pax/training x 14 units) - Training of 1 official in each 14 SEPU at Federal & State levels. (RM 2,500/pax/training x 14 units) - Training of 1 official in each 154 Local Authorities (RM 2,500/pax/training x 154 units) - Training of 1 official in each 171 District Offices. (RM 2,500/pax/training x 171 units) - Training of 27 Ministries' Officials at Federal and State Levels (RM 2,500/pax/training x 27 units)	KASA/ KPKT/ MOH	Targeted Government Official trained (Number)	- Training of 1 Focal Official in each 94 JPS District Offices for ToT. - Training of 222 Parliamentarian - Training of 14 states' EXCO - Training of 1 official in each 14 SEPU at Federal & State levels. - Training of 1 official in each 154 Local Authorities - Training of 1 official in each 171 District Offices. - Training of 27 Ministries' Officials at Federal and State Levels	RM1,175,000 RM840,000 RM210,000 RM175,000 RM1,925,000 RM2,137,500 RM3,375,000
Training module to enhance leadership roles of civil servants in order to facilitate the enforcement of policies and laws for better water governance. (Government Cluster)	- Training of 1 official each 14 Chief Secretary offices (266 pax) at State and Federal levels. (RM 2,500/pax/training x 266 units) - IWRM Expert in each 27 ministries at Federal (405 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/training x 405 units) - IWRM Expert in each 27 ministries at State (2,025 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/training x 2,025 units) - IWRM Expert in each 154 Local Authority (780 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 780 units) - IWRM Expert in each 171 District Office (860 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 860 units) - IWRM expert to coordinate each of the 16 National AACB WST Training Centers (240 pax). (Lump sum RM 10,000/pax/training x 240 units)	KASA/ KPKT/ MOH	Targeted Government Official trained (Number)	- Training of 1 official each 14 Chief Secretary offices (266 pax) at State and Federal levels. - IWRM Expert in each 27 ministries at Federal (405 pax) level under their jurisdiction for better coverage, monitoring and decision making. - IWRM Expert in each 27 ministries at State (2,025 pax) level under their jurisdiction for better coverage, monitoring and decision making. - IWRM Expert in each 154 Local Authority (780 pax) level under their jurisdiction for better coverage, monitoring and decision-making. - IWRM Expert in each 171 District Office (860 pax) level under their jurisdiction for better coverage, monitoring and decision-making. - IWRM expert to coordinate each of the 16 National AACB WST Training Centers (240 pax)	RM175,000 RM337,500 RM1,687,500 RM975,000 RM1,075,000 RM800,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
	- National Institute of Public Administration (INTAN) to incorporate the government and academic training modules in their curriculum	KASA/ JPA	Targeted Number of PTD Trained	PTD (40 pax X 6 training/year x RM 2,500)	RM18,000,000
To ensure flow of reliable data and information from relevant agencies to the local govt. for IWRM. (Government Cluster)	- Digitalization of WST 2040 AACB training module (Lump sum) - GIS map preparation for district and local authority boundary of 189 river basins & Web-based pollution mapping via sensor (Lump Sum RM10,000/River Basin)	KASA/ KPKT/ MOH	Update & Review	Update & Review	RM50,000 RM100,000
Adequate funds for non-structural capacity building towards IWRM. (Government Cluster)	Training of SMEs (i.e. small and medium enterprises, (9,340 pax)) for licensing and relicensing from 154 Local Authorities (2023 and onwards) (Lump sum RM 2,500/pax/ training x 9,340 units)	KASA/ KPKT/ MOH	# of SMEs trained	# of SMEs trained	RM6,500,000
IWRM training centres such as Pusat Informasi Sungai and other should have adequate online/ on-site facilities considering the uncertainties. (Government Cluster)	- Developing a portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management (LS RM750,000) - Establishment of WST 2040 AACB Water Hub in 13 States and 3 F.T. for public participatory and effective decision-making processes of IWRM. (Lump sum RM 15,000 x 16 units) - 4 Training Events in every year (1 training = 4 days) (Lump Sum) - 1 Coordinator for IWRM Training with an FASc based at LESTARI, UKM (RM15,000/ month) - 5 Assistants to facilitate IWRM Training based at LESTARI, UKM (RM 5,000/ month) - Honorarium for Resource Person (RP) to facilitate IWRM Training (Lump sum RM10,000/pax/training x 1,567 pax)	KASA/ KPKT/ MOH	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed WST 2040 AACB Water Hub developed	Portal and digital AACB content such as video clips, posters, infographics, and podcasts for 189 river basin's management developed 16 WST 2040 AACB Water Hub developed	RM750,000 RM60,000 RM6,815,000 RM900,000 RM1,500,000 RM7,000,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Reiterate importance of rivers as water resources for human and the environment (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. Bahagian Pendidikan Guru (BPG) - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teacher professional development module on water sustainability by ASM. Institut Pendidikan Guru Malaysia (IPGM) - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	KASA	The WST 2040 should cover 50% of the total teachers	84,628 teachers	(0.5-day training/RM 50 for half day) RM 4,231,400
			Train 140 trainers	140 trainers	RM 10,000
	Professional development program to familiarize teachers with climate science, active pedagogy, and project design. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the teaching module on climate education. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid: i) Training of Trainers ii) Teachers Training	KASA	Train 23,360 teachers	5,840 teachers	RM 350,400
			Train 80 trainers	80 trainers	RM 10,000
	Establish a whole-school approach to promote water and climate literacies through formal and non-formal settings and quadruple helix model	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	3,288 schools	RM 328,800
	Educate present and future generations about climate change by providing tools to help students learn science and geography more fun and effectively.	KASA	Involving 2,445 secondary schools	2,445 secondary schools	RM 104,108,100 **12th MP – 15th MP:** Green House: RM92,910,000 Water Distillation Equipment: RM5,085,600 Meteorological Station: RM6,112,500

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Inculcation of local values in promoting sustainable water resources management (Academia Cluster)	Train and retrain teachers on activities that are related to water resource management. BPG - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teaching module by ASM. IPGM - The training will be implemented in various approaches of training such as face to face, online, and hybrid. i) Training of Trainers ii) Teachers Training	KASA	The WST 2040 should cover 50% of the total teachers (423,140) in Malaysia	84,628 teachers	(0.5-day training/RM 50 for half day) RM 4,231,400
	Federal and state/local agencies arrange education programmes that involve learners use open government data related to water and climate change in data-driven decision making.	KASA	The WST 2040 should cover 50% of the total schools (16,440) in Malaysia	3,288 schools	RM 328,800
Enhance the roles of researchers from higher education institutions (HEIs) in promoting sustainable water resources management (Academia Cluster)	To train lecturers on topics and activities that are related to water resource management.	KASA	The WST 2040 should cover 50% of the total lecturers (50,085 that includes professor, associate professor and lecturers) in Malaysia	10,018 lecturers	RM 1,001,800
	To mainstream water resource management as one of the priority research areas in RDCI.	KASA	The funding will be provided by Government	10 projects for **each Malaysia Plan (MP)**	RM 20 million for **each Malaysia Plan (MP)**
	Researchers' outreach to government agencies.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
	Researchers' outreach to industry.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
	Researchers' outreach to community.	KASA	The funding will be provided by Government	Government will provide **yearly operation fund** to researchers.	RM 5 million for **each Malaysia Plan (MP)**
Holistic "Training of Trainers" capacity building for business and industry cluster stakeholders (Business & Industry Cluster)	AACB "Training of Trainers"	KASA/ DOE	# Participant that has been trained	1,240 pax	RM 1,201,436

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Provide competency certification for business and industry stakeholders who have undergone the training (Business & Industry Cluster)	Water management certificate	KASA (EiMAS)	Giving competency certification for EHS and Sustainability Professionals of business and industry.	Certification mechanism established	RM 1.5 million
Provide Continuing Professional Development (CPD) point to those Professional Practitioners (i.e. BEM, MBOT, MGBC, PAM, etc) (Business & Industry Cluster)	CPD for water management	Ministry of Human Resource (MOHR)	CPD mechanism established	CPD mechanism established	RM 480,000
Government to form strategic partnership with business and industry and establish resource person directory within their regional network (Business & Industry Cluster)	Water resource person network and directory	KASA/ MITI	A directory of resource person is available for public access.	A directory of resource person is available for public access.	RM 500,000
Resource person to publish and disseminate water best management practices in business and industry through public communication means (Business & Industry Cluster)	Water best management practices communication	KASA	# of event/meeting that been hold	50 events	RM 500,000
Introduce new category in Green Incentives that is related to water management project (Business & Industry Cluster)	Water incentives	MIDA	# of company or industries that receive water incentives.	50 companies	RM 15 million
Give tax incentives to business and industry that managed to protect and upgrade the condition of their nearest waterbody (Business & Industry Cluster)	Company tax exemption	MOF	# of company or industries that receive water incentives	16	RM 20 million
Give awards and recognitions to business and industry that succeed in applying best management practices in their premises (Business & Industry Cluster)	Water Sustainability Award	KASA	# of event that be hold	50 events	RM 750,000

Main Strategies	Programmes	Lead Authority	Proposed KPI	Targets	Proposed Budget
Increasing community awareness and instil ownership towards rivers and other water sources in their river basin. (Community Cluster)	To converge the issues and needs of ENGOs and community leaders in increasing IWRM awareness.	KASA & state BKSA	# of Advocators	12000 pax	RM 61.2 million
	To develop an apps Myriverbasin To establish a one-stop website through an apps to share/ link data needed for the community to decide on river basin To adopt an advanced technology in spreading awareness to community. Information	KASA & state BKSA	# of Advocators	12000 pax	RM 61.2 million
	To establish an information corner at the religious and community centre.	KASA & state BKSA	# of information corner	2,000 centres	RM 200,000 (RM 100 per centres)
	Notice board by the river	KASA & state BKSA	# of Notice board	2,000 rivers	RM 1,000,000 (RM 500 per river)
Empower community to effectively participate in IRBM to adapt to climate change and disaster risk reduction. (Community Cluster)	To establish a formal platform/ state IWRM Training Centre. To reduce red-taps when dealing with complains from community.	KASA & state BKSA	Establish a formal platform/ state IWRM Training Centre.	Training facility, and trainer fee	(Consolidated at the Focus Area of People)
	To incorporate IWRM/ IRBM in the structure or local plan, to minimize development impact on the river basin and reduce budget for disaster management.	KASA & state BKSA	Established task force/ working committee	The federal government should set certain targets and provide sufficient funding for the state and local government	Will be consolidated with the local plans/ IRBM plans
Public Participatory Platform (PPPs)					
To establish and encourage the water related PPPs	National Water Resource Grant	KASA	Number of Grant Applied	Community-based organisations (CBOs) such as Resident Associations, JKKK and Rukun Tetangga; Non-profit organisations, learning institutions and special interest groups who has interest in the management of their river basins and academia.	RM5,000,000 (RM1,000,000 per year)

AACB had identified **58 Targets** and **58 KPIs** for the four Malaysia Plans. The details are given in its Final Report (**Volume 2**).

1.3.9 Conclusion

The study has reviewed 26 national policies and a total of 47 stakeholder's engagements have been conducted by AACB throughout the study along with 24 engagements during the field visit to training centres. Moreover, 22 engagements with relevant ministries, department and agencies were conducted.

The AACB sub-sector has established four-cluster training modules, namely Government Cluster, Business & Industry Cluster, Community Cluster, and Academia Cluster. Based on the gaps identified through policy review, literature review, qualitative research and stakeholder's engagement. The roadmap of AACB WST2040 has been proposed based on the clusters, respectively.

2.0 INTEGRATED WATER SECTOR DATA CENTRE (IWSDC)

2.1 Introduction to the IWSDC Sub-Sectoral Study

The Twelfth Malaysia Plan 2021-2025 (12th MP) affirms the government's commitment to transform the water sector from one that is merely providing a supporting role to all economic and social activities to one that is vibrant as an economic sector whilst ensuring high levels of water security for sustainable development and growth. This transformation is set to continue through the 13th MP, 14thMP, and the 15th MP as envisaged in the Water Sector Transformation (WST2040). The themes of this WST2040 over the respective Malaysia Plans are as shown in Figure 3.1.2.1.

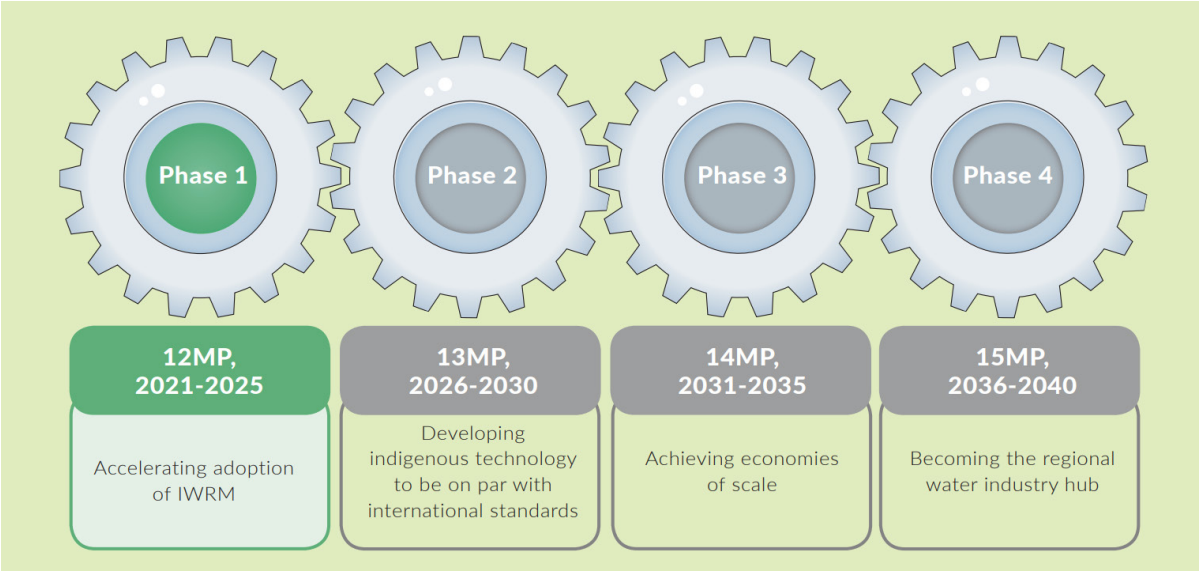


Figure 3.1.2.1. WST2040 themes

Source: (Economic Planning Unit, 2021)

Under the Twelfth Plan, one of the targets under the WST2040, and in line with SDG Goal No. 6: Clean Water and Sanitation, is the establishment of the Integrated Centre for Water Data and R&D&C&I by 2025, as shown in Figure 3.1.2.2 below.

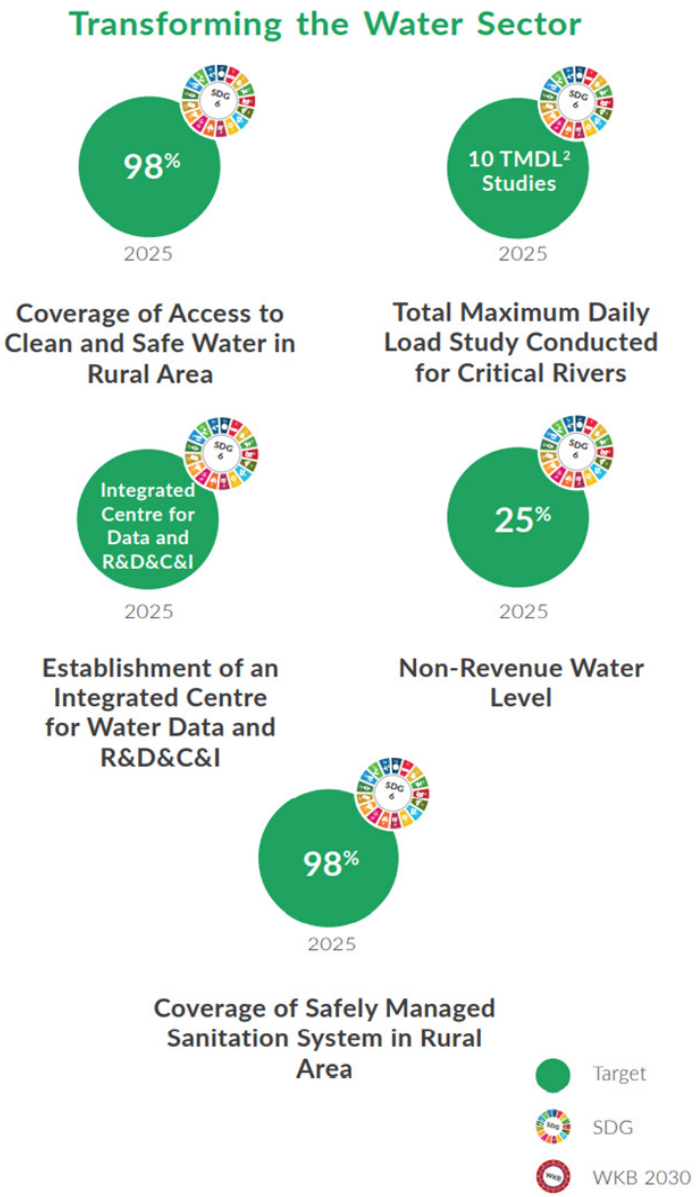


Figure 3.1.2.2. Integrated centre for water data and R&D&C&I under 12th MP

Source: (Economic Planning Unit, 2021)

The long-term plan is related to Strategy C1: *Towards the establishment of an independent water data and information statutory body* and Strategy under Focus Area C – *Enhancing the Data-driven Decision-making for Sustainability* of Phase 1 of the WST2040 (MEA, 2019). Another is Strategy C2 – *Integrating research on water through the establishment of the Water Research Consortium.* This is also envisioned to be an independent statutory body.

The idea of establishing an Integrated Water Data Centre (IWSDC) is for it to be a precursor towards the formation of those two institutions stated under strategies C1 and C2. At the onset, IWSDC will also be structured to provide the environment to initiate and encourage water research consortiums.

7.3.2 Objectives of the IWSDC Sub-Sectorial Study

The objective of this Sub-Sectorial Study is "to establish the IWSDC which will become a single-point reference centre and provide reliable and consistently high-quality water data and information that includes primary data (water-related data) and secondary data (non-water data related to water)".

IWSDC is seen as a "Game Changer" under WST2040, which will have the characteristics as follows:

i) Becoming a single-point water resource centre and provide fast, reliable and consistently high-quality water data and information that includes primary data and secondary data to inspire trust and confidence and support science-based decision making by each and all water stakeholders,
ii) Acting as a platform that facilitates "unlocking the value of data" that is otherwise suppressed.
iii) A platform for the development of "Space as the next frontier for water management technology" towards advanced and leading-edge innovations and commercialisation.
iv) Having the capacity to manage standardised data based on local and international standards,
v) Empowering people by providing access to data and information and thereon establishing a formal and structured public participatory platform that includes opportunities to participate in Open Science and crowdsourcing initiatives for water management,
vi) A platform for Water Research Collaboration as a precursor to the initiative to establish an independent Water Research Consortium statutory body for Research, Development, Innovation and Commercialisation (RDIC) activities, which through this, Public-Private sector research programs and projects could be formulated and implemented,
vii) A focal point for data and information and RDIC for a National Water Hub that is subsequently envisioned to mature into a Regional Water Hub, and,
vii) Developing water management governance tools and procedures and processes (e.g. water accounting report, water auditing report and water for environment among others) and generating strategic reports as additional services in the present water management spectrum such as Water Security Assessment, Water-Energy-Food Nexus Management, Water Footprint and Virtual Water Assessments.

Scope 1: Review and Analyse Current Policies with View to Improvement

2.3.1 Laws and Directives Review

A total of nineteen (19) Laws and one (1) Directive were reviewed in identifying the gaps as well as opportunities in the current legal sphere in relation to data sharing and RDIC. The analysis is conducted with the view of enhancing water and water related data sharing water data and information in the country, as well as strengthening RDIC activities. The most relevant laws are summarised in Table 3.1.2.1 below:

Table 3.1.2.1. Legal summary review

No.	Law Reviewed	Ministry Involved	Key Features	Summary Review and Recommendations for Improvements or for Supporting Policy
1	Official Secrets Act 1972	All Ministries	Any document could be declared a "Top Secret", "Secret", "Confidential" or "Restricted" by a Minister, the *Menteri Besar* or Chief Minister of a State or such public officer appointed under section 2B of the Act.	The 'perceived threat' of breaching the OSA impedes the fluidity of data sharing in Malaysia, since virtually any government document could be classified as a secret. As a result, most Government departments prefer to be on the safe side of the law and are only willing to release, through a tedious process, limited data to the public. Over time, this perception and wariness have developed into an entrenched culture, where sharing of all types data is deemed as compromising national security. Recommendation: A new, affirmative data sharing policy and data sharing law to facilitate, simplify and strengthen data sharing practices and culture amongst public officers.
2	Ministerial Functions Act 1969	All Ministries	The Ministerial Functions Act 1969 contains provisions for declaring the functions and the transfer of functions of Ministers, for declaring the styles and titles of Ministers. It also defines the list of departments or agencies under each Ministry.	While the delineation under the Act is necessary for administrative cohesion and fluidity of the government, it has also led to setting up of rigid sectorial and ministerial/departmental boundaries between organisations. Any data or information collected by a department or agency, for example, is solely for the purpose of executing the department or agency's expressed roles and functions, hence, not planned, designed and managed for sharing with other institutions and the public. Recommendation: A new, affirmative data sharing policy and data sharing law to facilitate, simplify and strengthen data sharing practices and culture amongst public officers.
3	Statistics Act 1965 (Revised 1989)	Prime Minister's Department (PMD)	Provides authority to DOSM to collect and interpret statistics for the purpose of furnishing information required in the formation or carrying out of Government policy in any field or otherwise required for Government purposes or for meeting the needs of trade, commerce, industry, or agriculture (including forestry, fishing, and hunting).	The Statistics Act 1965 is currently being reviewed for an amendment to strengthen and update DOSM's roles in-line with the proposed establishment of Majlis Statistik dan Data Negara (MSDN) as well as a *Pusat Analitik Data Raya Negara* (PADRN). Recommendation: To include 'water data and statistics' in the amendment of Statistics Act 1965 to strengthen water data and statistics collection in the country.
4	Fees Act 1951 (Revised 1978)	All Ministries	Provide for levy of fees and payments for licences, permits and other matters to be leviable in subordinate courts and public offices.	Current fee to procure data and information is a financial disincentive as well as an addition of bureaucracy to data sharing process. Recommendations: To utilise Section 10 of the Act, which provides authority to Heads of Departments to give remission of fees or payments. In the long term, to review Fees Act with the objective of eliminating imposition of fees since it is already a function of the respective organisations and budgeted for in the Government's financial system.

2.3.1.2 Policy Review

A total of twenty (20) policies, masterplan, guidelines, framework, plan, and blueprint have been reviewed in identifying the gaps as well as opportunities in the current policies in relation to data sharing and RDIC. The most relevant ones are summarised as per Table 3.1.2.2 below:

Table 3.1.2.2. Policy, blueprint, initiative and framework summary review

No.	Policy Reviewed	Ministry Involved	Key Features	Summary Review and Recommendations for Improvements or for Supporting Policy
1	National Security Policy 2021-2025 (NSP 2021-2025)	Prime Minister's Department (PMD) (under National Security Council)	The newly updated NSP 2021-2025 has developed a Comprehensive Security Matrix. Water security has been listed water as a national security item under the core value of 'sustainable development'.	This pronouncement by the NSP means that there is now an urgent need to develop tools to clearly report the state of water security in the country. Recommendation: The production of Annual National Water Security Reports for the National Security Council (MKN). The report will provide information on the level of confidence in our nation's water security in terms of water quantity, water quality and water safety status.
2	National Water Resources Policy 2012 (NWRP)	Ministry of Environment and Water (KASA)	The NWRP has several strategies and action plans that are relevant to water data sharing, data standardisation, disaster risk preparedness, and public empowerment, as the following: 1) Develop a comprehensive water resources information system, strengthen database framework, and establish information networks on water resources, 2) Develop national water resources related standards. (Such as quality, volume, environmental flow, and waterbody health), 3) Provide mechanisms for sharing of information and access between stakeholders, 4) Adopt a National Disaster Risk Reduction, Preparedness and Response Plan related to water resources, and 5) Enhance public inclusiveness and engagement in water resources matters	The strategy to develop a comprehensive water resources information system and enhance data sharing is being realised through the development of *Sistem Maklumat Sumber Air* (SMSA). KASA is also developing the *Data Industri Pekhidmatan Air Negara Berserta Spatial Mapping Yang Interaktif* (DIPAN-SMI), which is a database on water resources, water supply and sewerage sectors. Recommendations: 1) Further strengthening water and water-related data integration, data value realisation and coordinated water RDIC activities through the establishment of an integrated water sector data centre. 2) To strengthen public inclusion, engagement, and empowerment through the establishment of a formal, national level stakeholders' participation platform.
3	Digital Economy Blueprint (2021-2030) (MyDIGITAL)	Ministry of Science, Technology, and Innovation (MOSTI)	Key strategies include: 1) Position MAMPU as the sole agency to drive public sector digital transformation, including utilisation of MyGDX for data utilisation and facilitate data sharing by agencies. 2) Enhance one stop MyGovernment portal by incorporating services offered by state governments and selected private companies.	Many of the initiatives under DIGITAL require a seamless data sharing environment. Currently, data sharing is still not streamlined, and impeded by restrictive data sharing law. This will hamper the policy's objectives of a digitally driven, high-income nation and a regional leader in digital economy. Recommendation: Establishment of an affirmative data sharing policy and data sharing law.

No.	Policy Reviewed	Ministry Involved	Key Features	Summary Review and Recommendations for Improvements or for Supporting Policy
4	Government Open Data Initiative (ODI) 2014		The Public Sector Open Data portal was developed by MAMPU to support the Government Open Data Initiative. The portal allows the government open data to be easily accessed centrally from an official source.	Despite the ODI, users of Government's data still face several issues including outdated data, data provided is not granular and data provided is not always in useful (machine readable) format. This is because MAMPU has minimal power to direct and enforce the data sharing agenda on data providing agencies. Recommendations: 1) Establishment of an affirmative data sharing policy and data sharing law. 2) Streamlining of data sharing arrangement and management amongst government agencies 3) Increase data skills capacity of MAMPU and government agencies
5	National Science, Technology, and Innovation Policy (NSTIP) 2021-2030	Ministry of Science, Technology, and Innovation (MOSTI)	Under Initiative A4: To create an independent body that is responsible for planning, managing, evaluating, and monitoring the country's RDIC activities. This includes formulating national RDIC direction, managing funds, monitoring direction, and reviewing performance. Under Strategy D: Encouraging Open Data Sharing to drive national innovation through collaboration and reduction of overlap in RDIC activities Under Initiative D1: Establishment of Malaysia Open Science Platform (MOSP) to encourage data, information and resources sharing amongst RDIC players. Under Initiative E2: Intensify integration of knowledge and technological innovation development through cross-disciplinary research efforts. STIE Surge Programme: Creation of a Digital Tsunami through increased R&D activities in IR4.0 technology	All strategies and initiatives mentioned are in-line with the ones proposed under WST2040 IWSDC sub-sectoral study. Efforts should be made to align WST2040 RDIC planning, coordination, and management with the NSTIP 2021–2030. Recommendations: 1) Linking WST2040water research consortium with the national RDIC body. 2) Enhance adoption open data sharing, Open Science in water sector. 3) Encourage cross-disciplinary and cross-sectorial collaborative RDIC efforts between water sector and others.

No.	Policy Reviewed	Ministry Involved	Key Features	Summary Review and Recommendations for Improvements or for Supporting Policy
6	10-10 Malaysian Science, Technology, Innovation and Economy (*My*STIE) Framework	Ministry of Science, Technology, and Innovation (MOSTI)	The 10-10 *My*STIE Framework is an integration of 10 key Malaysian socio-economic drivers with 10 global leading science and technology drivers aligned to Malaysia's strengths and needs. It provides a systematic approach to transform Malaysia into a knowledge-intensive economy by design.	'Water and food' are listed as one of the key socio-economic drivers under the Framework. Opportunities in water sector RDIC laid-out under the 10-10 *My*STIE Framework include: 1) Connected water supply lines using Artificial Intelligence (AI) and Internet of Things (IoT) sensors for predictive maintenance 2) Drought and flood forecasting for effective reservoir management and early disaster mitigation 3) AI and deep learning algorithms to monitor quality and predict future availability of transboundary water resources for the food industry 4) Real-time monitoring of biological environmental sensors in water supplies using autonomous microscopes for early supply threat detection 5) Nanomaterials for efficient water desalination and water treatment plants Recommendation: The water sector RDIC opportunities identified under 10-10 *My*STIE Framework should be a guide for developing RDIC efforts under WST2040.
7	National Space Policy (NSP) 2030	Ministry of Science, Technology, and Innovation (MOSTI);	Under Thrust 2: Focus on Space technology, infrastructure and applications that are of significant and critical importance to the country including planning and management of natural resources and the environment and disaster management Under Thrust 3: Driving the development of space science and technology as well as building local expertise to: 1) Understand and manage natural and man-made phenomena climate change, natural disasters, and unsustainable development. 2) Develop RDIC activities, industry development, and infrastructure utilisation. Under Thrust 4: Contributing the economy by providing access to space technology and applications for other sectors	The NSP 2030 sets the overall way forward for space technology to become a key component to nation building, including resource planning, management and monitoring as well as enhancing RDIC activities. Recommendation: Space technology to become a cornerstone technology for WST2040 in areas such as water resources planning, management and monitoring as well as RDIC related activities.

7.3.2 Scope 2: Undertake Comparative Strategy Analysis and Business Models

The Study has undertaken the desktop comparative analysis for water and data management in Australia, South Korea, India, Singapore, the United Kingdom and Canada. The analysis is shown in Table 3.1.2.3 below:

Table 3.1.2.3 Comparative Analysis

No.	Country Studied	Areas Studied	Summary of Findings
1.	Australia	Legal and policy, technology, water governance tools, data sharing	Under the Meteorology Act 1955 and the Commonwealth Water Act 2007, The Australian Bureau of Meteorology is given the responsibility in compiling and delivering comprehensive water data and information via Australian Water Resources Information System (AWRIS). The AWRIS is a secure repository for all water-related data and a means to deliver high quality water information. The country also practices water accounting where Australia Water Accounting Standards was developed to quantify water governance.
2.	South Korea	RDIC, technology, data integration and sharing	The country is known for Smart Water City concept, whereby the data is integrated throughout the entire water supply processes (from treatment to tap). At the same time, this data can be accessed by the public in real-time such as status of water process and water quality, among others. South Korea is also renowned for its numerous water technologies related to IWRM and clean water.
3.	India	Data integration, data sharing	Integrated water data collected from water related agencies and are made available on India-WRIS website and can be accessed by public with no cost. The data is continuously provided on real-time basis for immediate action and planning. In India-WRIS, the standardised water related information system is available at the state/national level. All hydrological data is available in public domain and all water related data is integrated with well-defined procedures and formats.
4.	Singapore	RDIC, Technology	The country had initiated the "Four National Taps" programme for a sustainable water supply from four water sources – Water from Local Catchment, Imported Water, NEWater (high-grade reclaimed water) and Desalinated Water. The adoption of water membrane technology for water production, treatment and recycling process has made Singapore renowned to the world as the nation aims to become self-sufficient, with 40% of water from recycling, 30% from desalination, and 20% from rainwater collection
5.	The United Kingdom	Governance (Law)	The Freedom of Information Act 2000 was established to give people in the UK the general right of access to information that is held by most public authorities. It is aimed at promoting a culture of transparency and accountability across the public sector in the UK. It enables a better-informed public and better understanding how public authorities carry out their duties.
6.	Canada	Governance (Law)	The country enacted Access to Information Act 1985 that was formed to provide access to information under the control of the government of Canada and provide proactive publication of certain information. This Act was formed to enhance the accountability and transparency of federal institutions to promote an open and democratic society, and to enable public debate on the conduct of these institutions.

7.3.3 Scope 3: Study Potential of the Nation's Water Sector Industry

Water as an Economic Sub-Sectorial study has completed the write-up on this scope.

7.3.4 Scope 4: To prepare the framework for the implementation strategy and the water sector transformation initiative for the four phases, including proposing the implementing agencies, budget estimates and the main achievement targets based on analyses undertaken as well as expert reviews

The roadmap framework had been completed and approved by the Technical Committee at its meeting on 28 October 2020 and the Steering Committee at its meeting on 19 November 2020.

7.3.5 Scope 5: Undertake Consultations with Stakeholders and Experts

The study team promotes the idea of transformation in the water management during the engagements with the key stakeholders. This includes to change the mind-set on data sharing and data openness to the public. The consultations include one (1) Task Force Members meeting, eighteen (18) Focus Group Discussions (FGDs), one (1) site visit and twelve (12) Subject Matter Experts (SME) meeting. The listing is shown in Table 3.1.2.4.

Table 3.1.2.4. List of engagements

No.	Event	Ministry	Department/Agency	Date
1.	FGD No. 1 with Department of Irrigation and Drainage (DID)	Ministry of Environment and Water (KASA)	Department of Irrigation and Drainage (DID)	21 July 2020
2.	Addendum FGD No. 1 with Department of Irrigation and Drainage (DID)	KASA	Department of Irrigation and Drainage (DID)	28 July 2020
3.	FGD No. 2 with National Water Research Institute Malaysia (NAHRIM)	KASA	National Water Research Institute Malaysia (NAHRIM)	8 September 2020
4.	IWSDC Task Force Meeting No. 1	Various	Various	23 September 2020
5.	FGD No. 3 with Department of Statistics Malaysia (DOSM)	Prime Minister's Department (PMD)	Department of Statistics Malaysia (DOSM)	26 October 2020
6.	SME Meeting No. 1 – Systems Architecture	-	Millenium Radius Sdn Bhd (MRSB)	2 November 2020
7.	FGD No. 4 with Malaysian Space Agency (MYSA)	Ministry of Science, Technology and Innovation (MOSTI)	Malaysian Space Agency (MYSA)	17 November 2020
8.	SME Meeting No. 2 - RDIC in the Water Sector	KASA	NAHRIM	9 December 2020
9.	SME Meeting No. 3 - SME on Space Technology	MOSTI	MYSA	14 December 2020
10.	FGD No. 5 with Department of Environment (DOE)	KASA	Department of Environment (DOE)	17 February 2021
11.	*Mesyuarat Mengenai Projek Pembangunan Data Industri Perkhidmatan Air Negara Beserta Spatial Mapping Yang Interaktif* (DIPAN SMI)	KASA	Economic Planning Unit (EPU)-KASA	19 February 2021
12.	FGD No. 6 with Muda Agricultural Development Authority (MADA)	Ministry of Agriculture and Food Industries (MAFI)	Muda Agricultural Development Authority (MADA)	1 March 2021
13.	FGD No. 7 with Department of Mineral and Geoscience Malaysia (JMG)	Ministry of Energy and Natural Resources (KeTSA)	Department of Mineral and Geoscience Malaysia (JMG)	5 March 2021
14.	FGD No. 8 with Sewerage Services Department (JPP)	KASA	Sewerage Services Department (JPP)	12 March 2021

No.	Event	Ministry	Department/Agency	Date
15.	FGD No. 9 with Tenaga Nasional Berhad (TNB Generation Power Sdn Bhd) – TNB Hyrdopower	-	Tenaga Nasional Berhad (TNB Generation Power Sdn Bhd)	15 March 2021
6.	FGD No. 10 with Malaysian Meteorological Department (METMalaysia)	KASA	Malaysian Meteorological Department (METMalaysia)	24 March 2021
17.	SME Meeting with No. 4 - Space Technology	MOSTI	MYSA	25 March 2021
18.	***Perbincangan Penyelarasan WST2040 dan Projek*** DIPAN SMI	KASA	-	29 March 2021
19.	SME Meeting No.5 – All SMEs	Various	Various	30 March 2021
20.	SME Meeting No. 6 – All SMEs	Various	Various	4 April 2021
21.	FGD No. 11 with Department of Agriculture (DOA)	MAFI	Department of Agriculture	9 April 2021
22.	FGD No. 12 with DID Sarawak	KASA	DID Sarawak	14 April 2021
23.	FGD No. 13 with DID Sabah	KASA	DID Sabah	16 April 2021
24.	SME Meeting No. 7 - on Space Technology	MOSTI	MYSA	23 April 2021
25.	SME Meeting No. 8 SME (Financial)	-	-	8 August 2021
26.	Site Visit to Kerian Gramanry Area	KASA	DID Perak	9 August 2021
27.	SME Meeting No. 9 - Financial and Systems Architecture	-	-	12 August 2021
28.	FGD No. 14 with Malaysian Digital Economy Corporation (MDEC)	Ministry of Communications and Multimedia	Malaysian Digital Economy Corporation (MDEC)	20 August 2021
29.	SME Meeting No. 10 - Financial and Systems Architecture	-	-	12 August 2021
30.	FGD No. 15 with Malaysian Industry-Government Group for High Technology (MIGHT)	PMD	Malaysian Industry-Government Group for High Technology (MIGHT)	9 September 2021
31.	SME Meeting No. 11 – Financial	-	-	15 September 2021
32.	SME Meeting No. 12 – Financial	-	-	18 September 2021

7.3.6 Scope 6: The Roadmap of WST2040

The IWSDC roadmap will be submitted with the ISWDC Final Report.

In addition to fulifilling the study scope, the sub-sectors were requested to provide listings on Immediately Implementable Projects, Targets and KPIs.

7.3.7 Immediately Implementable Projects

The IWSDC sub-sectorial study Immediately Implementable Projects are shown in Table 3.1.2.5.

Table 3.1.2.5. Immediately implementable projects, targets and KPIs

No.	Strategy	Potential Projects under 12th MP	Target	KPI	Timeframe
1.	Establish IWSDC	Establishment of IWSDC 12th MP 2022 – Design Study 2023 – Interim Establishment 2025 – Full-scale Establishment	One stop centre for water and water-related data in the Country.	1. Complete IWSDC Physical Infrastructure, Technology, and Organisation 2. IWSDC ready for Operations 3. Production of Annual Strategic Reports 4. Linkages and collaborative platform for RDIC to water and water-related data managers, researchers (100%) 5. Establishment of data standards	12th MP (2023 – Interim) (2025 – Full-scale)
2.	Pilot Projects	Pilot Projects in four river basins: 1. Sg Perak River Basin (Perak) 2. Sg Linggi River Basin (N. Sembilan/ Melaka) 3. Sg Padas River Basin (Sabah) 4. Sg. Miri River Basin (Sarawak)	1. New tools and applications for IWRM and RDIC through space technology: - Surveillance - Monitoring 2. Complete database for River Basins: - Sg Perak - Sg Linggi - Sg Padas - Sg Miri	1. Space Technology Applications in Water Management: - AI approach to water catchment monitoring - Water quality modelling via Remote Sensing and Artificial Intelligence - Irrigation monitoring management for Paddy Fields 2. Ground-based Data Applications Framework: - Disaster Risk Reduction - Stakeholders Management - WFE Nexus - IR4.0WS - Water Footprint & Virtual Water - AACB - Climate Change - Water Accounting - Water Auditing - Environmentally Sensitive Areas (ESA) Monitoring and Indigenous Knowledge	RMKe-12
3.	Data Sharing Initiatives and Incentives	1. Data Sharing Agreement/ Arrangement 2. Data Sharing Policy Review 3. Data Sharing Law Review 4. Review of Fees Act 1951 5. Review of Statistics Act 1965 by DOSM	Establishment of Data Sharing Initiatives and Incentives to facilitate seamless data sharing	1. Data Sharing Agreement/Arrangement 2. Data sharing policy or 'Freedom of Information Policy' 3. Data sharing law or 'Freedom of Information Law' 4. Zero rate fees under Fees Act 1951 5. Water as an item in Statistics Act 1965 review and amendments	RMKe-12 and RMKe-13
4.	Governance Tools and System Develo-pment	1. Water Accounting Tools and System 2. Water Auditing Tools and System	Establishment of Water Governance Tools and System to be adopted by Federal and State Agencies, Water Operators, Private Sector and NGO	1. Production of Annual Strategic Reports in Water Accounting, Water Auditing and Water Security 2. Adoption of Water Accounting and Water Auditing System	RMKe-12 and beyond
5.	Space Technology RDIC Projects and Ground-based RDIC Projects	1. Space Technology application projects on River Basin Management for entrepreneurs (including Citizen Developers) 2. Ground based data Applications for Advanced Science Businesses	A platform that enables opportunities in Space Technology applications and Ground-based IR4.0 applications in water management for RDIC projects	1. New services, products and businesses based on Space Technology 2. Reports on River basin management status including ESA status, monitoring and surveillance	1. RMKe-12 and beyond 2. RMKe-12 and beyond

Meanwhile, the roadmap summary by RMK (12, 13, 14 and 15) are shown in Table 3.1.2.6 to Table 3.1.2.9

Table 3.1.2.6. IWSDC roadmap for RM Ke-12

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
1	Establish IWSDC	Establish IWSDC *Design study in 2022 A) Physical Infrastructure: 1. Physical space (rental, maintenance) 2. Existing data collection station modification B) Technology: 3. Software, Hardware, Network, Security 4. Big Data Analytics 5. Blockchain 6. Artificial Intelligence 7. Data standards C) Organisation: 8. Institutional Set Up 9. Human Resources 10. Capacity Building and Training Program 11. Linkages and Platform for RDIC to water and water-related data managers, and researchers D) IWSDC Operation 1. Maintenance 2. Upgrading 3. Salaries	KASA	IWSDC Phase 1	Physical Infrastructure: 1. Establishment of IWSDC 2. Establishment of software, hardware, network and security systems 3. Seamless data Integration, distribution Technology 4. Standardised data 5. Extensive capabilities in space technology big data analytics, blockchain and artificial intelligence 6.Locally owned businesses, industries, products, technologies, software that is of international reknown Organisation 7. Human resources and institutional setup 8. Capacity building and training programmes established	RM 213.62 mil
2	Publication of Annual Strategic Reports	1. Stakeholder management report 2. Virtual Water reports 3. Water Footprint reports 4. Water-Food-Energy Nexus reports 5. Water for Environment and Biodiversity reports 6. Water and Climate Change reports 7. Water Efficiency reports 8. Water Quality Monitoring 9. Disaster Risk Management reports 10. Water safety plan reports 11. Rainfed agriculture monitoring reports 12. River Basin Management Status reports: ESA, Monitoring, Surveillance	KASA	Production of Annual Strategic Reports 1/Year	Annual Strategic Reports on the water management spectrum	

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
3	Begin Space Technology RDIC Projects	Space Technology application projects on River Basin Management for entrepreneurs (including Citizen Developers)		3 RDIC Projects in RMK 12	New services, products and businesses based on Space Technology	RM 213.62 mil
4	Begin Ground-based RDIC Projects	Ground based data Applications for Advanced Science Businesses		3 RDIC Projects in RMK 12	Reports on River basin management status including: ESA status, monitoring and surveillance	
5	River Basin Pilot Projects	A) Sg Perak River Basin Pilot Project a) Space Technology Applications in Water Management 1. AI approach to water catchment monitoring 2. Water quality modelling via Remote Sensing and Artificial Intelligence 3. Irrigation monitoring management for Paddy Fields b) Ground-based Data Applications Framework: 1. Disaster Risk Reduction 2. Stakeholders Management 3. WFE Nexus 4. IR4.0WS 5. Water Footprint & Virtual Water 6. AACB 7. Climate Change 8. Water Accounting 9. Water Auditing 10. Environmentally Sensitive Areas (ESA) Monitoring and Indigenous Knowledge B) Sg Linggi River Basin C) Sg Padas River Basin D) Sg Miri River Basin	KASA	a) No. of Projects b) No. of Projects (1 Each)	1. New tools and applications for IWRM and RDIC through space technology: - Surveillance - Monitoring 2. Complete database for Pilot River basins	
6	Integrated River Basin Management System Solution for all other River Basins	A) Space Technology Applications in Water Management B) Ground-based Data Applications		Pilot Project expansion into 12 RBMU		
7	Data Sharing Agreement/ Arrangement	Data Sharing Agreement/Arrangement	KASA	1 Agreement /arrangement	Data Sharing Agreement/Arrangement	

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
8	Governance Tools and System Development and early Adoption	A) Water Accounting 1. Water Accounting Tools 2. Water Accounting System B) Water Auditing 1. Water Auditing Tools 2. Water Auditing System C) Water Security		A) 1 Water Accounting Tool B) 1 Water Auditing Tool C) Production of Strategic Reports	Annual Strategic Reports on 1. Water Accounting 2. Water Auditing 3. Water Security Water governance tool and system adoption	
9	International open data alliance / partnership	Malaysia to be part of an international open data alliance / partnership	MCMM	1 Open Data alliance/partnership	Malaysia to be signatory of 1 Open Data Alliance/Partnership	
10	Establish Stakeholder Management Platform Register of Stakeholders Capacity Building Programmes	Water Stakeholder's Platform A) Annual Stakeholder Management Report B) Stakeholder Linkages in Water Sector C) Adoption and sharing of AACB training modules	KASA	A) No. Annual Stakeholder Management Report B) Linkages to 191 RBMU C) No. of modules by AACB	Water Stakeholder's Platform A) Annual Stakeholder Management Report B) Stakeholder Linkages in Water Sector C) Adoption and sharing of AACB training modules	

Table 3.1.2.7. IWSDC roadmap for RMKe-13

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
1	IWSDC platform ready to support RDIC players, agencies, organisations from Federal Government, State Government, Universities, Private sectors, NGOs, Individuals	IWSDC fully established	KASA	IWSDC Phase 2	Phase 2 - 2026 - IWSDC Core Team is established - Ready to support development of indigenous technologies, businesses, applications - Establish IWSDC as a statutory body - Identify and establish a Water Hub	RM 415.00 mil
2	Continuation of Annual Strategic Report Publication	Refer to items No. 1 to 12 in RMKe-12		Production of Annual Strategic Reports 1/Year	Annual Strategic Reports on the water management spectrum	
3	Continuation of Space Technology RDIC Projects	Space Technology application projects on River Basin Management for entrepreneurs (including Citizen Developers)	KASA	10 RDIC Projects in RMK 13	New services, products and businesses based on Space Technology	
4	Continuation of Ground-based RDIC Projects	Ground based data Applications for Advanced Science Businesses		10 RDIC Projects in RMK 13	Reports on River basin management status including: ESA status, monitoring and surveillance	
5	Pilot Project Expansion	Integrated River Basin Management System Solution for all other River Basins A) Space Technology Applications in Water Management B) Ground-based Data Applications		IRBM System Solution in 30 RBMU	1. Tools and applications for IWRM and RDIC through space technology: - Surveillance - Monitoring 2. Complete database for RBMU	
6	Existing Policies and Laws Review New Data Sharing Policy and Law	A) Data Sharing Policy Review B) Data Sharing Law Review C) Review of Fees Act 1951 D) Review of Statistics Act 1965 by DOSM	JPM	New data sharing policy and law Review of Fees Act 1951	A) Data sharing policy or 'Freedom of Information Policy' B) Data sharing law or 'Freedom of Information Law' C) Zero rate fees under Fees Act 1951 D) Water as an item in Statistics Act 1965 review and amendments	

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
7	Governance Tools and System Adoption in Major River Basins by Federal Agencies, State Agencies, Water Operators, Research Institutions, Private Sector, NGOs	Refer to items (A), (B) and (C) in RMKe-12	KASA	Tool and system expansion into 10 Major rivers	Annual Strategic Reports on 1. Water Accounting 2. Water Auditing 3. Water Security Water governance tool and system adoption	RM 415.00 mil
8	Continuation of Register of Stakeholders Continuation of Capacity Building Programmes	Refer to items (A), (B) and (C) in RMKe-12		A) No. Annual Stakeholder Management Report B) Linkages to 191 RBMU C) No. of modules by AACB	Water Stakeholder's Platform A) Annual Stakeholder Management Report B) Stakeholder Linkages in Water Sector C) Adoption and sharing of AACB training modules	

Table 3.1.2.8. IWSDC roadmap for RMKe-14

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
1	Expansion of IWSDC functions	IWSDC Expansion	KASA	IWSDC Phase 3	Phase 3 - 2030 - Expansion and scaling up of RMKe-12-RMKe-13 objectives	RM 667.40 mil
2	Continuation of Annual Strategic Report Publication	Refer to items No. 1 to 12 in RMKe-12		Production of Annual Strategic Reports 1/Year	Annual Strategic Reports on the water management spectrum	
3	Expansion of Space Technology RDIC Projects	Space Technology application projects on River Basin Management for entrepreneurs (including Citizen Developers)	KASA	30 RDIC Projects in RMK 14	New services, products and businesses based on Space Technology	
4	Expansion of Ground-based RDIC Projects	Ground based data Applications for Advanced Science Businesses		30 RDIC Projects in RMK 14	Reports on River basin management status including: ESA status, monitoring and surveillance	
5	Pilot Project Expansion	Integrated River Basin Management System Solution for all other River Basins A) Space Technology Applications in Water Management B) Ground-based Data Applications		IRBM System Solution in 50 RBMU	1. Tools and applications for IWRM and RDIC through space technology: - Surveillance - Monitoring 2. Complete database for RBMU	
6	Expansion of Governance Tools and System Adoption in Major River Basins by Federal Agencies, State Agencies, Water Operators, Research Institutions, Private Sector, NGOs	Refer to items (A), (B) and (C) in RMKe-12	KASA	Tool and system expansion into 15 Major rivers	Annual Strategic Reports on 1. Water Accounting 2. Water Auditing 3. Water Security Water governance tool and system adoption	
7	Expansion of Register of Stakeholders Expansion of Capacity Building Programmes	Refer to items (A), (B) and (C) in RMKe-12		A) No. Annual Stakeholder Management Report B) Linkages to 191 RBMU C) No. of modules by AACB	Water Stakeholder's Platform A) Annual Stakeholder Management Report B) Stakeholder Linkages in Water Sector C) Adoption and sharing of AACB training modules	

Table 3.1.2.9. IWSDC roadmap for RMKe-15

No.	Initiative	Projects	Lead / Implementing Agency	KPI	Output	Total Estimated Cost
1	Scaling up of IWSDC as a Regional Water Hub	IWSDC as the Regional Water Hub	KASA	IWSDC Phase 4	Phase 4 – 2036 1. IWSDC as the Regional Water Hub with Advanced Space Technology products and services in water management 2. Establishment of Water Research Consortium	RM 781.00 mil
2	Continuation of Annual Strategic Report Publication	Refer to items No. 1 to 12 in RMKe-12		Production of Annual Strategic Reports 1/Year	Annual Strategic Reports on the water management spectrum	
3	Regional Hub of Space Technology RDIC Projects	Space Technology application projects on River Basin Management for entrepreneurs (including Citizen Developers)	KASA	50 RDIC Projects in RMK 15	New services, products and businesses based on Space Technology	
4	Regional Hub of Ground-based RDIC Projects	Ground based data Applications for Advanced Science Businesses		50 RDIC Projects in RMK 15	Reports on River basin management status including: ESA status, monitoring and surveillance	
5	Pilot Project Expansion	Integrated River Basin Management System Solution for all other River Basins A) Space Technology Applications in Water Management B) Ground-based Data Applications		IRBM System Solution in 95 RBMU	1. Tools and applications for IWRM and RDIC through space technology: - Surveillance - Monitoring 2. Complete database for RBMU	
6	Complete Governance Tools and System Adoption in Major River Basins by Federal Agencies, State Agencies, Water Operators, Research Institutions, Private Sector, NGOs	Refer to items (A), (B) and (C) in RMKe-12	KASA	Tool and system expansion into 20 Major rivers	Annual Strategic Reports on 1. Water Accounting 2. Water Auditing 3. Water Security Water governance tool and system adoption	
7	Expansion and continuation of Register of Stakeholders Expansion and continuation of Capacity Building Programmes	Refer to items (A), (B) and (C) in RMKe-12		A) No. Annual Stakeholder Management Report B) Linkages to 191 RBMU C) No. of modules by AACB	Water Stakeholder's Platform A) Annual Stakeholder Management Report B) Stakeholder Linkages in Water Sector C) Adoption and sharing of AACB training modules	

IWSDC had identified **46 Targets** and **46 KPIs** for the 4 Malaysia Plans. The details are given in its Final Report (Volume 3).

Table 3.1.2.10. Summary of IWSDC costing

A.	Capital Expenditure (Perbelanjaan Pembangunan) 2021 2022 RM (mil) RM (mil)	12th MP						13th MP	14th MP	15th MP	Notes
		2023	2024	2025	Total	2026-2030	2031-2035	2036-2040			
No.		RM (mil)	RM (mil)	RM (mil)	RM (mil)	RM (mil)	RM (mil)	RM (mil)			
1	IWSDC Setup		5.00	42.30	6.40	0.00	53.70	35.70	42.10	47.90	
2	Pilot Projects:							-	-	-	
a)	Sg Perak River Basin (Perak)			2.00	2.98	2.10	7.08	-	-	-	
b)	Sg Linggi River Basin (N. Sembilan/Melaka)				2.98	4.10	7.08	-	-	-	
c)	Sg Padas River Basin (Sabah)				2.98	4.10	7.08	-	-	-	
d)	Sg Miri River Basin (Sarawak)				2.98	4.10	7.08	-	-	-	
	Total	0.00	5.00	44.30	18.33	14.40	82.02	35.70	42.10	47.90	

B.	Operational Expenditure (Perbelanjaan Mengurus) 2021 2022 RM (mil) RM (mil)	12th MP						13th MP	14th MP	15th MP	
		2023	2024	2025		Total	2026-2030	2031-2035	2036-2040			
No.		RM (mil)	RM (mil)	RM (mil)		RM (mil)	RM (mil)	RM (mil)	RM (mil)			
1	IWSDC Operations and Maintenance	0.00	0.00	7.70	31.00		34.00	72.70	198.30	254.30	322.10	
2	Integrated River Basin Management System	-	-	-	-		42.00	42.00	105.00	175.00	95.00	Continuation of pilot projects for all 191 river basins
3	Strategic Reports	-	-	-	-		2.20	2.20	11.00	11.00	11.00	
4	RDIC Projects	-	-	2.00	2.00		2.00	6.00	60.00	180.00	300.00	RDIC projects include Space and Ground RDIC projects: e.g space imaging software, public participation applications (See Water Hub UK)
5	Data Sharing Initiatives and Incentives	-	-	-	1.25		1.25	2.50	-	-	-	
6	Governance Tools and System Development	-	-	-	3.00		3.20	6.20	5.00	5.00	5.00	
7	Open Data	-	-	-	-		-	-	-	-	-	
8	Stakeholder Platform	-	-	-	-		-	-	-	-	-	Costs are covered under the IWSDC Set Up Costs
	Total	0.00	0.00	9.70	37.25		84.65	131.60	379.30	625.30	733.10	

Table 3.1.2.11. Summary of IWSDC costing per MP

Costing Per RMK	12th MP RM (mil)	13th MP RM (mil)	14th MP RM (mil)	15th MP RM (mil)
Capital Expenditure (*Perbelanjaan Pembangunan*)	82.02	35.70	42.10	47.90
Operational Expenditure (*Perbelanjaan Mengurus*)	131.60	379.30	625.30	733.10
Total	213.62	415.00	667.40	781.00

1.3.19 Conclusions

The main reason why data ecosystem in Malaysia is in such a fragmented state is due to the sectorial governance and management approach, coupled with a lack of affirmative data sharing policy and law. The water sector RDIC scenario in the country is also limited by lack of coordinated strategic approach, lack of access to data, and lack of funding, which ultimately results in Malaysia's inability to turn water wealth into economic wealth.

Thus, the formation of IWSDC will require a shift from the present paradigm in water sector data management towards a new and transformative way of water data integration, management, and applications. The structure, operations, and outputs of IWSDC are designed to catalyse the achievement of WST2040 objectives (water security and water as an economic opportunity), as well as support the enabling driver (empowering people) and four enablers (governance, information and RDIC, infrastructure and finance). The IWSDC will also support the implementation of 12th MP vision of a prosperous, inclusive, and sustainable Malaysia as well as the WKB2030 vision of a more equitable sharing of prosperity in society.

The IWSDC will also apply advanced space technology by taking advantage of the launch of a high-resolution satellite in 2025 by MYSA to spur the development of space remote sensing technology in water management. This will be supported by applications of big data analytics and artificial intelligence. This will complement the 10-10 *My*STIE framework and the MyDIGITAL.

Furthermore, more than just being a platform for integrating data, the IWSDC will also be a centre for creating wealth in water. This will be accomplished by being an integrated platform to facilitate collaborations in RDIC. This RDIC collaboration platform is expected to excite a broad section of the society and industries for new and exciting opportunities towards higher levels of science and technology application and promote the development of nationally owned innovative products of international standards. Subsequently, this collaborative platform could be the impetus for the formation of a water research consortium which could elevate RDIC in the water sector to the next level.

In summary, in-line with the WST2040 Plan, and as mandated by 12th MP Development Plan, the IWSDC shall be designed as a game changer in water management. It shall integrate data collection and processes in-line with common standards and good practices, all water data as well as relevant non-water data. The IWSDC shall aim to feed "trusted" data to all end-users and be used as a basis for science-based decision-making, especially in federal-state, state-state and inter-sector negotiations. It shall facilitate the empowerment of the public in water management and be a catalyst to spur a prolific RDIC and invigorate the water industry and businesses.

3.0 IR 4.0 IN THE VARIOUS WATER SUB-SECTORS (IR4.0WS)

3.1 Background/Introduction of Sub-Sectoral Study

Water services infrastructure may still be improved particularly in rural areas and islands, whereby technology adoption is lacking in increasing operational efficiency and fulfilling demand, and thus jeopardising socio-economic growth. In addition, the high Non-Revenue Water (NRW) losses continue to increase due to mainly leakages from the ageing infrastructure such as pipes and connections coupled with the lack of asset management establishing exact location in particular underground pipes. The existing water and sewerage infrastructure, including the irrigation systems, are also underutilised and some not fully optimised. Generally, infrastructure for resource recovery of water and wastewater treatment by-products is also not ready to support the waste-to-wealth initiatives. The water sector also has not fully leveraged on technological evolutions, which are crucial to efficiently manage water resources and usage. Due to high consumption of water and poor public awareness creation programme and implementation, river pollution threats demand increased attention which subsequently result in higher cost for raw water services and maintenance.

The availability of water resources continues to be threatened mainly by non-proper land use and climate change. This is coupled with the lack of optimisation of alternative water resources, such as groundwater, lakes and flood ponds, recycled water, rainwater harvesting, air water generators and desalination particularly in water stress areas. Water-related disasters are becoming more intensified and further exacerbated due to the reactive approach in solving the problem.

The proposed strategies for sustainability enabler consisted of two key recommendations applicable for the water sector i.e., reviewing environmental laws and legislation by considering current issues and future challenges and maximising resource utilisation efficiency through zero waste management concept by adapting the principles of circular economy. As stated in the Twelfth Malaysia Plan, 2021–2025, Chapter 9 on Enhancing Energy Sustainability and Transforming the Water Sector, the circular economy concept will be implemented in the entire water sector value chain, whereby enabling policies and legislations shall be introduced to govern the ecosystem for the circular economy.

The rise of digital water has previously been documented by the International Water Association (IWA), an organisation with membership in 140 countries worldwide. Forming the largest international network of water professionals aiming towards a water wise world, IWA discovered the promising opportunity for digital water technologies for water professionals in emerging economies. For example, dynamic and data-driven models may help integrate and optimise smart pumps, valves, sensors and actuators whereby real-time information may be shared with customers via their smartphones (The Source, 2018). IWA has also published its policy on Digital Water in 2018 (Source: https://iwa-network.org/publications/digital-water/). As Malaysia faces mounting water tensions with some areas exposed to vulnerable scarcity, declining water quality, excessive floods etc., this study investigated the potential rise of digital water as a transformational pathway in making the sector more resilient to its customer, while simultaneously fuel the economic development. This agrees with the aspirations put forward in the Twelfth Malaysia Plan, 2021-2025, whereas the water sector will be restructured to enable it to be a significant contributor to national growth and wealth creation through a 20-year transformation agenda. The ST2040 will be developed to set the strategic direction towards positioning the sector as a dynamic growth engine, while ensuring water security for all. By 2040, it is envisaged that Malaysia will become the regional water industry hub.

3.2 Objectives of Sub-Sectoral Study

This study aims to promote integrated, data-driven, and transparent water planning and decision-making leveraging on big-data analytics, artificial intelligence (AI), IR4.0 and (RDIC). Considering existing challenges, the evidence-based data would be the basis for decision-making under the 12th MP. An integrated database with consistent and high-quality data will provide stronger basis for IWRM implementation through operationalizing of IRBM, considering water-food-energy nexus for future demand of water resources. In addition to data and information collection, in the long-term, this would also be catalyst for national data and technology development ownership in line with the IR4.0 and Big Data Analytics for all aspects of water management, including flood, drought and disaster management support systems.

These aspirations will be realised through the following objectives:

i) To examine the current and past trends of the development of digital water and IR4.0 initiatives for the water sub-sectors in Malaysia.
ii) To set the bench marking and assess the current status of our Malaysia water sector digital water as compared to the developed countries.

3.3 To identify new potential models to be developed to enhance national development Scope of the sub-sectoral study according to the TOR and with reference to the EPU's five focus areas and the relevant eight Foci (game changers/study expectations)

The scope of the study according to the TOR covers:

i) Undertaking comprehensive reviews and analyses on current policies, literature and expert reports which are related to IR 4.0 in the water sector with a view for improvement.
ii) Undertaking comparative strategy analyses or business models or case study, bench-marking and best practices with other nations.
iii) Study potential of the nation's water sector industry taking into consideration current global markets towards making the water sector as a dynamic new economic sector capable of driving the nation's GDP growth in the future.
iv) Preparation of a transformation strategy and initiative implementation framework based on secondary data collection from relevant agencies and stakeholders.
v) Undertaking consultations with stakeholders and experts with the aim of finalising the proposed strategies and initiatives of Malaysia's IR 4.0 initiatives; and
vi) Preparation of a roadmap on the National Agenda for the Water Sector Transformation towards achieving the targeted transformation objectives for IR4.0 in the various water sub-sectors

The scope of the study according to the reference of the relevant 8i STI Ecosystem Enablers are as follows:

i) **Infrastructure** (Physical & Natural) – Quality and sophistication of the infrastructure that supports the growth and development of the industry and the broader economy.
ii) **Infostructure** (Digital infrastructure) – Digital infrastructure that provides seamless integration of multiple value chains within and across the industries and communities. These systems provide seamless flow of information for market intelligence and strategic decision making.
iii) **Intellectual Capital (**Talent stock) – Skills (technical, entrepreneurial and leadership) and knowledge (general and specialised) of the talent stock.
iv) **Integrity** (Good governance) – Governance systems to manage processes and ensure commitment to continuous improvements and adherence to best practices.
v) **Incentives** (fiscal and non-fiscal) – Incentives to encourage R&D, adoption of new technologies, innovation, commercialisation of local technology, and market expansion, including globalisation of local technology.
vi) **Institutions** (Governance bodies) – Quality of the institutions of governance (e.g. regulatory bodies, industry associations, institutions of learning / research institutes etc.) that support systematic development of markets, industries and communities.
vii) **Interaction** (Strategic partnerships) - Level and quality of collaboration, co-creation and knowledge sharing amongst stakeholders.
viii) **Internationalisation** (Global best practices & standards) - Depth and breadth of engagement with global knowledge and innovation networks, institutions of governance and global supply chains.

3.4 TOR Scope 1 (Review and Analyse Current Policies with a view to Improvement)

3.4.1 Current Policies Reviewed and Analysed

Malaysia's development is information and technology driven. The economy is also knowledge dependent (Abdullah et al., 2018). The launch of vision 2020 marked the start of the knowledge-based economy in Malaysia (Ariffin & Letchumanan, 2020). This required a widespread use of information, communication and technology amongst private and public sectors in Malaysia (Abdullah, et al., 2018). With an increase in the amount of information being shared over the Internet, the industries became vulnerable to cyber security, hence the need to develop a policy that would help the industries against some of the cyber security issues, including intrusion, hacking, harassment, fraud, denial of service attacks and malicious

code (Teoh, & Mahmood, 2017). This paper reviews cybersecurity guidelines for IR 4.0 that serves as a reference for manufacturing companies in Malaysia that are moving towards Industry 4.0.

The Ministry of Science, Technology and Innovation (MOSTI) of the government of Malaysia conducted a study in the year 2005 with the aim of developing a cyber security policy that would be used in addressing the cyber security challenges that were facing the country; hence, threatening the e-sovereignty of the country (Ariffin & Letchumanan, 2020). The study assessed the prevailing cyber security risks situation within the Critical National Information Infrastructure sectors (Teoh & Mahmood, 2017). The study also ensured that the critical infrastructure was protected to levels that commensurate the risks faced, as well as developed and established a comprehensive action plans and roadmap that were to be used to implement Cyber Security Framework. The results of the study were presented and adopted by the National Information Technology Council on 7 April 2006. This was preceded by the development of the National Cyber Security Guidelines Industry 4.0 (Abdullah et al., 2018).

There are ten sectors in Malaysia that were considered as The Critical National Information Infrastructure. These included banking and finance, national defense and security, energy, information and communication, water, transportation, government, health services, food & agriculture and emergency services (Ariffin & Letchumanan, 2020).

The national National Cyber Security Guidelines Industry 4.0 was implemented in three phases. The first phase addressed the immediate measures and concerns that were to be taken to implement cyber security immediately (Ariffin, & Letchumanan, 2020). These measures included identification of stop-gap measures addressing the underlying vulnerabilities of the CNII information security. The second phase concentrated on building of the infrastructure that was needed for cyber security. It also included the setting-up of necessary processes, systems, mechanisms and standards (Abdullah et al., 2018). The third phase focused on maintenance of the efforts that were presented in the other two phases (Hamzah et al., 2018).

The policy governance structure involved an establishment of the National Cyber Security Coordination Committee, which consisted of the senior security officials from the sectors that were entrusted with the operation of CNII of the country (Tan, Vergara, Phan, Khan, & Khan, 2020). However, the duties of cyber security governance were placed under the national security council after the amendment of the duties of the ministers. However, the secretariat is controlled by the Cyber Security Malaysia, coordinating the efforts of NCSP and proposing the way forward in order to achieve the objectives (Abdullah, et al., 2018). The National Cyber Security Coordination Committee is answerable to the e-Sovereignty committee that is under the leadership of the Deputy Prime Minister. The Committee then reports to the National IT Council under the leadership of the Prime Minister (Hamzah et al., 2018).

3.4.2 Proposals for Improvement of Policy (ies)

The National 4IR Policy was recently launched in July 2021 arising from the need to be a technological nation which has prompted the government to draft a relevant policy. The National 4IR Policy sets out to facilitate a technologically enabled public service delivery system and set to give the public the convenience of accessing services within reach of their fingertips.

The National 4IR Policy supports the country's development policies such as Shared Prosperity Vision 2030 (SPV 2030) and five-year Malaysia Plans. It sets to transform Malaysia into a high income nation driven by technology and digitalisation. The National 4IR Policy, has four policy thrusts for society, business, and the government as follows:

i) First, to equip the people with 4IR related knowledge and skillsets.
ii) Second, to form a nation with connectivity through the development of digital infrastructure.
iii) Third, to provide appropriate rules for future needs, so that they are flexible according to technological changes.
iv) Fourth, to accelerate innovation and adoption of 4IR technology.

The four thrusts involve empowering people with 4IR relevant knowledge and skills; boosting nationwide connectivity through development of digital infrastructures; lay out appropriate rules for future needs that adapt to technological changes, as well as accelerating innovation and adoption of 4IR technologies.

The four thrusts would be implemented based on 16 strategies, 32 national initiatives, and 60 sectoral initiatives that had been identified by the government. The four thrusts also intended to reduce the potential social-related risks that could be derived from 4IR, elements of trust, inclusivity, cyber security, ethics, and values will be inculcated in all initiatives. At the core of the policy, the 4IR will be driven by five foundational technologies to build local capabilities including:

- Artificial Intelligence (AI);
- Internet of Things (IoT);
- blockchain and distributed ledger technology (DLT);
- advanced materials supported by cloud computing; and
- big data analytics (BDA).

The National 4IR Policy will lead to better work-life balance, improved convenience, safer streets, value-added jobs, higher incomes, improved social wellbeing, and more responsible environmental sustainability. Through the adoption of the National 4IR, the Malaysian Wellbeing Index (MyWI) is projected to climb to 136.5 by 2030, in contrast to 124.4 in 2018. Malaysia is also predicted to remain at the top 20 in the Global Innovation Index by 2030 and expected to achieve an increase of 30% productivity across all sectors compared to 2020. The implementation of 4IR Policy will have immense benefits for 10 key sectors: manufacturing, transportation and logistics, healthcare, education, agriculture, utilities, finance and insurance, professional, scientific, and technical services, wholesale, and retail trade, as well as tourism.

3.5 TOR SCOPE 2 (UNDERTAKE COMPARATIVE STRATEGY ANALYSIS/BUSINESS MODELS WITH OTHER NATIONS)

3.5.1 What were the countries studied and their strategies/business models as compared to Malaysia's in the sub-sector?

The webinars and referential literatures have provided a basis for the following summary of observations for countries including Japan, South Korea, Singapore, and German. In addition, the global organisation IWA is also included based on its contribution to the first white paper signifying a clear framework for the rise of digital water in several country members, including Singapore.

Japan

Japan is known for its strong ICT capabilities comprising high speed Internet infrastructure and 5G deployment. Japan promotes its strong R&D culture via competitive national universities while allocating a large proportion of GERD by business sector and emphasising on experimental research. Japan possesses a strong government-driven partnerships and R&D incentives, whereby strong indigenous private sector is supported by MNCs covering ICT, electronics, energy etc. Its global outreach is supported largely by dispatching experts in ODA programs and conduct international courses.

South Korea

South Korea has strong ICT capabilities and is supported with 5G infrastructure and dedicated networks for IOT deployment. Its strong R&D culture is supported by policies encouraging STEAM education while maintaining involvement of world-class tertiary institutions. A large proportion of GERD by business sector also support the R&D activities with specific emphasis on experimental research. South Korea receives a proactive public governance through government-led and funding for large scale water management projects with 5G infrastructure dedicated networks for IoT deployment. It incorporates the IWRM into existing and future Smart City development with digitalisation of water resource management in place. South Korea features its global outreach via K-water global participation through ODA programmes and water management solutions worldwide.

Singapore

Singapore leads digitilisation of water sector by having 5G deployment and providing nationwide access to high-speed broadband network. Its strong R&D culture is supported via collaborations with top universities consisting of global water experts. Singapore also supports R&D culture with policies emphasising on STEM education. It has a highly coordinated and self-regulated public water agency which is based on a public driven fiscal and non-fiscal support for private sector and academia water-related development. The IWRM plan is integrated through holistic cross-sectoral policy framework development. Singapore owns over 200 water companies with 25 research centres generating SGD2.5 billion in annual value-add. Its global outreach is driven by the Singapore Water Academy programmes and local SMEs international collaborations.

Germany

Germany is fully equipped with 5G infrastructure and dedicated networks for IoT deployment. Their businesses are supported by top-notch industries and business sectors with collaboration with top universities driving strong R&D culture for IoT in various sectors. In Germany, the government has minimal interference in terms of data ownership. The IWRM plan in Germany is narrow focused on water utilities and providers with minimal mention of the sewerage sector. However, Germany receives strong support from business entities i.e., Bentley in supporting IR4.0 implementation throughout their business operations. Their global outreach is led by German Water Partnership strengthening international collaborations.

A ten-point criterion system was derived from the webinar following inputs and critical elements across the various water sub-sectors as proposed by the stakeholders. These criterions were assigned with appropriate weightage to reflect its level of priority among stakeholders. Computation of criteria rating and weightage were then utilised to summarise the status of digitilisation of the participating ministries/ agencies/departments, respectively. The absence of an international benchmarking criteria for IR 4.0 in water sub-sectors, has certainly presented a remarkable opportunity for Malaysia to develop its own standard referencing based on the localized scenario that is of international applicability. Based on the countries studies, the criteria for preliminary benchmarking of the IR4.0 for water sub-sectors and the average scoring derived are summarised as follows:

i) Internet accessibility (Scoring: 7.5)
This criterion aims to access the state of existing coverage of internet facilities for all that must cover both the urban and rural areas. An average score of 7.5 for internet accessibility across water stakeholders from various states indicates that internet coverage in Malaysia is more than 75% however less than 100%.

ii) Data center (Scoring: 3.33)
A data center shall be dedicated for the implementation of IR4.0 for water sub-sectors and shall be completed with IT infrastructures to collect data on the operation of the business on holistic manner including sharing of information with various stakeholders. An average score of 3.33 indicates that establishment of data center in water sub-sectors in Malaysia is much localised and not wholesome. Example includes plant monitoring and its related localised operations.

iii) Integrated system (Scoring: 4.17)
All data shall be integrated for the business, with other related sectors whether to use as part of the business or contributes as required by other, i.e. water supply may require information from river management etc. An average score of 4.17 shows that the existing system, might largely measures its own business operations while most probably reaching to a mixed mode of own and other related to business operations.

iv) Guidelines and procedures (Scoring: 3.33)
Availability of risk management, crisis management, mitigation measures and standard operating procedures for data management using IT system. Scoring of 3.33 for guidelines and procedures suggests that the various water stakeholders' guiding documents might be under planning and yet to be implemented.

v) Steering committee/ task force (Scoring: 3.33)
Availability of permanent committee/team that is looking into development of the IR Water 4.0 or similar with vision on adopting the system with target date to implement holistically. Scoring of 3.33 reflects the planning stage for establishment of steering committee or special task force; however, yet to be implemented.

vi) Policy, laws, regulation, guidelines etc. (Scoring: 3.33)
Policy, laws, regulation, act established on data management and IT infrastructure which is also outlined in this study. It is clear from the scoring that the water related policy, laws, act & regulation, and guidelines are still under planning and yet to be implemented.

vii) Readiness / coordination / adaptability (Scoring: 3.3)
Existing coordination on IR4.0 for water sub-sectors including readiness to transform and adopt for water transformation whereby some elements shall be changed or retained accordingly for IR4.0 implementation in the sector. Not all things need to be changed, some of them will be retained. The average score of 3.3 obtained, points out that the decision makers, management and stakeholders are all having the necessary knowledge of IR4.0 however the co-ordination and readiness to transform and adopt very much dependent on the planning which is underway at present.

viii) Phases and scope (Scoring: 2.5)
In this study, the phases of transformation shall be determined by each sub-sector according to desired scopes of IR4.0 implementation in the sector. The average score of 2.5 indicates that the phases and scopes are under planning and yet to be implemented.

ix) Readiness of IT infrastructure (Scoring: 3.33)
Completeness of IT Infrastructure i.e., full facilities, storage, satellite etc. and benefits which shall be reaped from the transformation by stakeholders involved. The scoring suggests that water stakeholders' IT infrastructures completeness still under planning and yet to be implemented.

x) Communication / interaction systems (Scoring: 7.5)
Availability of Mobile Apps for water consumers i.e., smart phones suage, websites, transmission to respective stakeholders etc. Communication/ interaction system scoring of 7.5 illustrates that the existing system of communication with stakeholders from top management to consumers is available at more than 50% and has target for implementation within 5 years. The planning however has not been commissioned yet.

3.6 TOR SCOPE 3 (STUDY POTENTIAL OF THE NATION'S WATER SECTOR INDUSTRY TAKING INTO CONSIDERATION CURRENT GLOBAL MARKETS TOWARDS MARKETING THE WATER SECTOR AS A DYNAMIC NEW ECONOMIC SECTOR CAPABLE OF DRIVING THE NATION'S GDP GROWTH IN THE FUTURE)

This Scope has been written on by Prof Mahendhiran Nair

3.7 TOR SCOPE 4 (PREPARE A TRANSFORMATION STRATEGY AND INITIATIVE IMPLEMENTATION FRAMEWORK FOR EACH OF THE FOUR PHASES, INCLUDING THE IMPLEMENTATION AGENCIES, ESTIMATED BUDGETS AND MAIN TARGET ACHIEVEMENTS BASED ON THE ANALYSIS UNDERTAKEN AND EXPERT REVIEWS)

The roadmap framework had been prepared by the study team and approved by the Technical Committee at its meeting on 28 October 2020 and by the Steering Committee at its meeting on 19 November 2020.

3.8 TOR SCOPE 5 (UNDERTAKE CONSULTATIONS WITH STAKEHOLDERS AND EXPERTS WITH THE AIM OF FINALISING THE PROPOSED STRATEGIES AND INITIATIVES OF THE NATION'S WATER SECTOR TRANSFORMATION)

3.8.1 A Table listing of the Ministries, Agencies, CSOs consulted, including dates, venues and attendance (on-line or physical) is given below (Table 3.1.3.1).

Table 3.1.3.1. Listing of consultations with stakeholders and experts

No.	Description of Activity	Ministry/Agency/CSOs/NGOs	Mode of Activity	Date
1	Data collection and consolidation-Part 1	Kementerian Alam Sekitar dan Air (KASA)	Physical Meeting	24/12/2020
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Pengurusan Aset Air Berhad (PAAB)		
		Jabatan Pengairan dan Saliran (JPS)		
		Jabatan Mineral dan Geosains, Malaysia (JMG)		
		Malaysia Green Technology Centre (MGTC)		
		Malaysian Water Engineers Action Committee (MyWAC)		
		Indah Water Konsortium (IWK)		
2	Data collection and consolidation-Part 2	Kementerian Alam Sekitar dan Air (KASA)	Virtual Meeting	16/2/2021
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Pengurusan Aset Air Berhad (PAAB)		
		Jabatan Pengairan dan Saliran (JPS)		
		Jabatan Mineral dan Geosains, Malaysia (JMG)		
		Malaysia Green Technology Centre (MGTC)		
		Malaysian Water Engineers Action Committee (MyWAC)		
		Indah Water Konsortium (IWK)		
		National Hydraulic Research Institute of Malaysia (NAHRIM)		
		MIMOS Berhad		
3	Presentation on Roadmap to Water Sector Transformation 2040 to German Embassy	German Water Partnership	Virtual meeting	3/3/2021
4	Focus Group Discussion with Jabatan Pengairan dan Saliran on NAWABS System	Jabatan Pengairan dan Saliran (JPS) Team	Virtual meeting	11/3/2021
5	Focus Group Discussion with Jabatan Mineral & Geosains, Malaysia on Big Data Analytics Groundwater (GroW)	Jabatan Mineral & Geosains (JMG) Team	Virtual meeting	14/3/2021
6	Presentation on Roadmap to Water Sector Transformation 2040 to Regional Director of Internation Water Association	International Water Association (IWA)	Virtual meeting	26/3/2021
7	Webinar on IR4.0 Water for Sub-sectors: An International Water Association Experience	Invitation extended to KASA, SPAN, PAAB, JPS, JMG, NAHRIM, MGTC, IWK, MyWAC, all Task Force Chair and WST 2040 Project Management Committee.	Virtual meeting	29/4/2021
8	Webinar on IR4.0 Water for Sub-sectors: The German Experience	Experts from Germany. Invitation extended to KASA, SPAN, PAAB, JPS, JMG, NAHRIM, MGTC, IWK, MyWAC, all Task Force Chair and WST 2040 Project Management Committee.	Virtual meeting	5-7/5/2021

No.	Description of Activity	Ministry/Agency/CSOs/NGOs	Mode of Activity	Date
9	Virtual Workshop on IR4.0 Water for Sub-sectors: Experts Engagement	Kementerian Alam Sekitar dan Air (KASA)	Virtual W/shop	7/6/2021 - 11/6/2021
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Pengurusan Aset Air Berhad (PAAB)		
		Jabatan Pengairan dan Saliran (JPS)		
		Jabatan Mineral dan Geosains, Malaysia (JMG)		
		Malaysia Green Technology Centre (MGTC)		
		Malaysian Water Engineers Action Committee (MyWAC)		
		Indah Water Konsortium (IWK)		
		MIMOS Berhad		
		Economic Planning Unit (EPU)		
		Kementerian Pertanian & Industri Makanan (MAFI)		
		Kementerian Utiliti Sarawak (MOU)		
		Kementerian Perumahan dan Kerajaan Tempatan (KPKT)		
		Kementerian Pembangunan Luar Bandar (KPLB)		
		Agensi Pengurusan Bencana Negara (NADMA)		
		Jabatan Bomba dan Penyelamat Malaysia (BOMBA)		
		Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI)		
		Kemajuan Pekebun Kecil Perusahaan Getah (RISDA)		
		Rancangan Tempatan Seberang Perai (RTSP) Butterworth		
		Jabatan Pengairan Saliran (JPS) Langkawi		
		Federation of Malaysian Consumer Association (FOMCA)		
10	Focus Group Discussion	Jabatan Pertanian Sabah Jabatan Perikanann Sabah Jabatan Pengairan Sabah	Virtual Meeting	10/5/2021

No.	Description of Activity	Ministry/Agency/CSOs/NGOs	Mode of Activity	Date
10	Virtual Workshop on IR4.0 Water for Sub-sectors: Experts Engagement	Kementerian Alam Sekitar dan Air (KASA)	Virtual W/shop	7/6/2021 - 11/6/2021
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Pengurusan Aset Air Berhad (PAAB)		
		Jabatan Pengairan dan Saliran (JPS)		
		Jabatan Mineral dan Geosains, Malaysia (JMG)		
		Malaysia Green Technology Centre (MGTC)		
		Malaysian Water Engineers Action Committee (MyWAC)		
		Indah Water Konsortium (IWK)		
		MIMOS Berhad		
		Economic Planning Unit (EPU)		
		Kementerian Pertanian & Industri Makanan (MAFI)		
		Kementerian Utiliti Sarawak (MOU)		
		Kementerian Perumahan dan Kerajaan Tempatan (KPKT)		
		Kementerian Pembangunan Luar Bandar (KPLB)		
		Agensi Pengurusan Bencana Negara (NADMA)		
		Jabatan Bomba dan Penyelamat Malaysia (BOMBA)		
		Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI)		
		Kemajuan Pekebun Kecil Perusahaan Getah (RISDA)		
		Rancangan Tempatan Seberang Perai (RTSP) Butterworth		
		Jabatan Pengairan Saliran (JPS) Langkawi		
		Federation of Malaysian Consumer Association (FOMCA)		
11	Stakeholders' Engagement Sabah & Sarawak-Phase II	Jabatan Perkhidmatan Pembetungan Sarawak (JPP Sarawak)	Virtual Meeting	23/7/2021
		Jabatan Pengairan Saliran (JPS) Sarawak		
		Majlis Biodiversiti & Sumber Air Sabah (MBSA) Jabatan Ketua Menteri		
		Jabatan Pengairan Saliran (JPS) Sabah		
		Jabatan Perkhidmatan Pembetungan Sabah (JPP Sabah)		
		Jabatan Bekalan Air Luar Bandar (JBALB Sarawak)		

No.	Description of Activity	Ministry/Agency/CSOs/NGOs	Mode of Activity	Date
12	Stakeholders' Engagement IT Personnel	Kementerian Sains, Teknologi & Inovasi Unit (MOSTI)	Virtual Meeting	28/7/2021
		Unit Pemodenan Tadbiran & Perancangan Pengurusan Malaysia (MAMPU)		
		Kementerian Alam Sekitar & Air (KASA)		
		Kementerian Utiliti Sarawak (MOU)		
		Jabatan Pengairan & Saliran (JPS)		
		Jabatan Mineral & Geosains Malaysia (JMG)		
		Indah Water Konsortium Sdn Bhd (IWK)		
		Jabatan Alam Sekitar (JAS)		
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Pengurusan Aset Air Berhad (PAAB)		
		MIMOS Berhad		
		Malaysian Green Technology Corporation (MGTC)		
		National Hydraulic Research Institute of Malaysia (NAHRIM)		
		Syarikat Air Darul Aman Sdn Bhd (SADA)		
		Langkawi Development Authority (LADA)		
		Air Kelantan Sdn Bhd (AKSB)		
		Jabatan Air Negeri Sabah (JANS)		
		LAKU Management Sdn Bhd. Sarawak		
		Perbadanan Bekalan Air Pulau Pinang (PBAPP)		
		Bahagian Bekalan Air (BBA) Labuan		
		Pengurusan Air Paip Pahang (PAIP)		
		Sarawak Water Board (SWB)		
13	Stakeholders' Validation Meeting-Part I: Budget, Costing & Roadmap	Kementerian Sains, Teknologi & Inovasi Unit (MOSTI)	Virtual Meeting	26/8/2021
		Kementerian Alam Sekitar & Air (KASA)		
		Kementerian Utiliti Sarawak (MOU)		
		Jabatan Pengairan & Saliran (JPS)		
		MIMOS Berhad		
		Jabatan Alam Sekitar (JAS)		
		Langkawi Development Authority (LADA)		
		Air Kelantan Sdn Bhd (AKSB)		
		Perbadanan Bekalan Air Pulau Pinang (PBAPP)		
		Jabatan Air Negeri Sabah (JANS)		

No.	Description of Activity	Ministry/Agency/CSOs/NGOs	Mode of Activity	Date
14	Stakeholders' Validation Meeting-Part II: Langkawi IT Model	Kementerian Alam Sekitar & Air (KASA)	Virtual Meeting	13/9/2021
		Kementerian Pertanian & Industri Makanan (MAFI)		
		Bahagian Pengairan dan Saliran (BPSA)		
		Jabatan Pengairan & Saliran (JPS) Perlis		
		Jabatan Pengairan & Saliran (JPS) Pulau Pinang		
		Jabatan Pengairan & Saliran (JPS) Langkawi		
		Jabatan Pengairan & Saliran (JPS)		
		Syarikat Air Darul Aman Sdn Bhd (SADA)		
		Langkawi Development Authority (LADA)		
		Lembaga Kemajuan Wilayah Kedah (KEDA)		
		Small Medium Industries Corporation Malaysia (SME Corp)		
15	Stakeholders' Validation Meeting-Part III: IT Infrastructure & Technology.	Kementerian Sains, Teknologi & Inovasi Unit (MOSTI)		
		Kementerian Alam Sekitar & Air (KASA)		
		Kementerian Pertanian & Industri Makanan (MAFI)		
		Kementerian Utiliti Sarawak (MOU)		
		Jabatan Pengairan & Saliran (JPS)		
		MIMOS Berhad		
		Jabatan Alam Sekitar (JAS)		
		Pengurusan Aset Air Berhad (PAAB)		
		Suruhanjaya Perkhidmatan Air Negara (SPAN)		
		Jabatan Pengairan & Saliran (JPS)		
		Jabatan Mineral & Geosains Malaysia (JMG)		
		Indah Water Konsortium Sdn Bhd (IWK)		
		Syarikat Air Darul Aman Sdn Bhd (SADA)		
		Langkawi Development Authority (LADA)		
		Air Kelantan Sdn Bhd (AKSB)		
		Perbadanan Bekalan Air Pulau Pinang (PBAPP)		
		Bahagian Bekalan Air (BBA) Labuan		
		Jabatan Bekalan Air Negeri Terengganu (JBANT)		
		Jabatan Air Negeri Sabah (JANS)		

3.9 TOR SCOPE 6 (PREPARE A COMPLETE ROADMAP FOR THE NATIONAL AGENDA ON THE WST2040 FOR THE VARIOUS MINISTRIES AND AGENCIES INFORMATION AND GUIDE FOR THE IMPLEMENTATION OF PROGRAMMES AND ACTIVITIES TOWARDS ACHIEVING THE TARGETED TRANSFORMATION OBJECTIVES).

The roadmap for IR 4.0 for water sub-sectors was derived from a series of discussion and virtual workshops involving relevant stakeholders and strategic partners in the sector and is attached with the Final Report. A consensus and agreement on a plan and costs required for the period of transformation have been outlined as follows:

i) Preparation of the water sector towards IR 4.0 and the use of smart technology to drive the development of the water sector entirely.
ii) Establishment of centres of excellence (COE) as the basis for strategic planning and decision making as well as a driver to the development of expertise, local innovation in the water sector.
iii) Comprehensive and significant improvement in the concept of Integrated Water Resources Management (IWRM), Water Technology Innovation (WTI), Economies of Scale (EoS), Regional Water Hub (RWH). Here we have agreed to use Artificial Intelligence (AI) technology as the main core in the development and transformation of this water.
iv) Sustainable water management with the concept of AI-Driven and also be part of the development of Smart Citizen, Smart City & Smart Nation.
v) Provision of comprehensive infra-structure and info-structure for current water needs and use by each sector and consumers.
vi) Development of a new business model to drive the country's water industry

3.10 Implementation of a strategic program (Private-Public Partnership) to position the water sector as a new economic sector of the country.

3.10 IMMEDIATELY IMPLEMENTABLE PROPOSALS /PROJECTS AND THE STRATEGIES, TARGETS AND KPIS FOR IR4.0 FOR WATER SUB-SECTORS

The Immediately Implementable Proposals /Projects is shown in Table 3.1.3.2 and the Strategies, Targets and KPIs for IR4.0 for water sub-sectors is shown in Table 3.1.3.3 respectively below:

Table 3.1.3.2. Immediately Implementable Projects for IR4.0WS for water sub-sectors

No.	IR Water 4.0 Sub Sector	Remarks
1	Change of policy and governance for IR4.0 implementation for water sub-sectors	Improvement to existing key policies and governance as recommended in our report submission have to firstly be in placed to govern and guide the implementation of IR Water 4.0 moving forward. A more simplified approval authority and structure for governance would also help to expedite the improvement process towards smooth and successful implementation of IR Water 4.0.
2	Telecommunications & Satellite Technology	The recent news published on 29 September 2021 announced that the Malaysian government's 5G wholesale network operator Digital Nasional Berhad (DNB) has struck a 10-year partnership with Swedish telco equipment vendor Ericsson in helping to make DNB's stated target of bringing 5G coverage to 80 % of the country's population by 2024 a reality. The Malaysia's first 5G network is expected to be launched in Kuala Lumpur, Putrajaya and Cyberjaya in the initial phase of the rollout. Hence, establishment of telecommunications and satellite technology incorporating IR4.0 shall focus on: i. Roll out 5G - Improving and expanding network services & coverage. ii. Using Satellite (data) to improve water sub-sectors especially in soil loss and erosion mapping, asset monitoring & maintenance, water quality monitoring, and flood prediction. iii. Smart Connectivity systemic approach including Long Term Evolution for Machine (LTE-M), narrowband internet of things (NB-IOT), Category (CAT), Category M1 (CAT-M1) etc.
3	Establish Langkawi Island as the pilot project for IR4.0 for water sub-sectors implementation	Langkawi being the first UNESCO Global Geopark in Southeast Asia and also nation's aspiration in making the island one of the top 10 world's tourism destination, has rendered all qualifying criteria to be adopted for IR4.0WS pilot project. This model will serve as an ideal simulation platform for seamless execution for bigger framework later. The model shall include: i. Establishment of Innovation & Research and Development Centre (Centre of Excellence) i.e. Vertical AI Centre of Excellence (VAICE) The establishment of CoE dedicated shall leverage on the 5 key factors of Malaysia Digital Economy Blueprint: MyDigital to attract investments enabling the formation of a digital ecosystem in Malaysia. The CoE for water sub-sectors transformation shall focus on re-skilling and education of business entities to champion IR4.0WS in water businesses through the establishment of National Water Data Centre (NAWDAC). i. Digitalization all existing manual water ecosystem – Hardware, Software, & Peopleware ii. Inclusion of Big Data Analytic & Data Warehouse - Data sharing & Integration Framework iii. Blockchain & Artificial Intelligence (Framework)

Table 3.1.3.3. Strategies, Targets and KPIs for IR 4.0 for water sub-sectors

Focus areas	No	Strategy & Target	KPI	Details[a]	Phase I		Phase II	Phase III	Phase IV
					2022	2025	2030	2035	2040
People	1	Establish of Innovation & Research and Development Centre (Centre of Excellence) i.e. VAICE	Number of talents produce by the center	No	10,000 pax (3k / head)	133,000 pax (3k / head)	166,500 pax (3k / head)	166,500 pax (3k / head)	166,500 pax (3k / head)
	2	Develop Malaysia Smart Water & Smart Citizen	Number of Smart Device per premise	No	-	350k premises	1MIill premises	5Mill premises	5Mill premises
Governance	3	Establish new laws and policies for data sharing	Data Sharing Metrics / Criteria	%	20%	50%	20%	5%	5%
	4	Improve and enhance existing laws and policies for data sharing	Data Sharing Metrics / Criteria	%	20%	50%	20%	5%	5%
Infrastructure & Technology	5	Digitalize all existing manual water ecosystem (i.e., hardware, software, peopleware)	Percentage of digitalisation (transformation)	%	20%	40%	20%	10%	10%
	6	Develop Big Data Analytic & Data Warehouse	Numbers of ministries/agencies/NGO in water sector	%	30%	40%	10%	10%	10%
	7	Establish Platform for infrastructure (including infostructure) that caters for IR4.0 for water sub-sectors	Numbers of ministries/agencies/NGO in water sector	%	20%	30%	30%	10%	10%
	8	Develop Blockchain & Artificial Intelligence Framework	Development phases for BC & AI in: a) Langkawi (as a model) b) National Water Data Centre (NAWDAC)	%	70%	30% 50%	20%	20%	10%
	9	Enhance Technology advancement	Percentage of digitalisation (transformation) Based on identified 10-10 *My*STIE, MyDigital & Future Technology	%	-	50%	20%	20%	10%
	10	Implement Water Wise & Smart Cities	Percentage of identified potential sites / cities	%	-	45%	30%	15%	10%

[a] Quantification of KPI percentage (%) shall be determined during the detailed study upon implementation of relevant strategies.

IR4.0WS had identified **36 Targets** and **36 KPIs** for the four Malaysia Plans. The details are given in its Final Report (**Volume 5**).

4.0 WATER-FOOD-ENERGY-NEXUS (WFE NEXUS)

4.1 Background to the Study

Water, food, and energy are tightly interconnected strategic resources, and due to these interconnections emphasis has emerged in the past decade on the water-food-energy (WFE) nexus (Vogt et al., 2010; Endo et al., 2020). To give an indication of these interconnections, consider that roughly 8% of global water withdrawals are used in energy generation, and as much as 70% for agriculture. Energy is also required in the transport and fertilisation of crops, which themselves require the use of water. In some cases, water needs to be pumped and treated; these processes too utilise energy. Food production and its associated supply chains, meanwhile, are responsible for roughly 30% of global energy demand, and can also be used in the production of biofuels (Hoff, 2011).

The significant interactions that exist between water, food, and energy may result in competition, synergies, and a multitude of trade-offs between various sectors or interest groups, and at present, planning, foresight, and the implementation of policies affecting these resources is largely performed separately (Ghodsvali et al., 2019). Yet Malaysia – and indeed many other nations – cannot continue to rely on the same finite water, food, and energy resources far into the future without significant changes in existing policy, regulatory, and institutional arrangements which address these strategic resources in isolation of one another, precisely due to the intricate interlinkages that play out across water, food, and energy.

The nexus approach provides an integrated manner through which to balance various policy choices relating to water, food, and energy, and better manage the extraneous pressures placed on these resources by megatrends such as population growth, climate change and pollution, economic development, and urbanisation, as well as challenges related to governance and the wider political economy. This study analyses specific contexts of the two-way (i.e. water-food, water-energy, and food-energy) and three-way (i.e. water-food-energy) nexuses across select river basins in Malaysia. Based on this understanding, several recommendations are proposed, including the use of policy instruments and changes to existing governance and/or institutional structures, to allow for the mainstreaming of nexus approaches and concepts, as well as the deployment of technologies to address challenges and take advantage of opportunities offered by the utilisation of such approaches in order to better manage resource security across the water, food, and energy sectors. This will allow the Malaysian government to better balance trade-offs and synergies of current and future policy targets and directions across these – and, given the centrality of water to economic growth, other – sectors.

4.2 Objectives of the Subsectoral Study

The Study has the following objectives:

i) Mapping of the key nexus stakeholders from both the public and private sectors as well as those from academic centres of excellence.
ii) Identifying key 'nexus arenas', where the quest for security in one area has compromised others, across Malaysia. These will cover both the two- and three-way nexus interactions that commonly play out across the country.
iii) This study develops in-depth analyses of key nexus flashpoints, such as water pumping, large-scale solar, hydropower, and biogas, amongst others, as the basis for developing seven concrete policy recommendations or strategies that will allow a mainstreaming of the nexus approach, situate it within the broader framework of the circular economy and sustainable development, and in doing so allow the WFEN approach to contribute significantly to the achievement of strategic resource security in Malaysia.
iv) Ultimately, the study team endeavours to prepare a WFEN roadmap that contributes towards the complete roadmap for the National Agenda on Water Sector Transformation 2040.

1.3 TOR SCOPE 1: REVIEW AND ANALYSIS OF CURRENT POLICIES

Table 3.1.4.1 shows the review of the current Policies in the Nexus context.

Table 3.1.4.1. Review of current policies in the nexus context

Focus Area	Policies/Institutions	Review Notes
Governance: Strategic Resource and Development Planning	Water Industry Act 2006 National Water Services Commission 2006 National Agrofood Policy 2011–2020 National Biofuel Policy 2006 National Renewable Energy Policy and Action Plan 2010 11th MP	In terms of overall strategic resource planning, while this review highlighted elements are evident within sectors, there is little evidence of a cross-sectoral strategic organisational arrangement to plan from a multi-sectoral point of view. Furthermore, there is little evidence of long-term capabilities to undertake cross-sectoral assessment such as through strategic foresight.
Governance: Institutional Arrangement to Govern Nexus Planning	*Majlis Sumber Air Negara* Department of Irrigation and Drainage *Majlis Sumber Air* Negeri Selangor, Sabah, Kedah	Implementing the nexus approach requires a multi-tiered structure that coordinates across the levels of government, including at the river basin (vertically); and across the different sectors and stakeholders (horizontally). While each individual sector (water, energy and food) is already complex and fragmented, the review demonstrates that two potential successful models, in situ initiatives (such as the integrated agriculture development areas), that are able to take into consideration the contexts at the appropriate scale; and an integrated approach that facilitates partnership, including with the private sector (i.e. palm oil industry). In the context of nexus and the water sector, two frameworks are required to be established, an institutional framework at the federal level that integrates the water sector, including the DID and a governance structure at the river basin that incorporates nexus thinking.
Governance: Policy Design, Targets, and Instruments	National Agrofood Policy 2011–2020 11th MP National Water Resources Policy 2012 Green Technology Master Plan 2017–2030 Climate Change Policy 2009 Malaysia Smart City Framework 2018 National Urbanisation Policy 2019 National Transport Policy 2019–2030	See Table 2 for a review of policy targets across the water, food, and energy sectors.
People: Capacity Building and CEPA on WFE Nexus	11th MP National Agrofood Policy 2011–2020 National Water Resources Policy 2012 Green Technology Master Plan 2017–2030	As a new area, there is a need for capacity building towards developing the ability to identify of the WFE nexus challenges and opportunities. This requires modelling expertise capabilities to develop nexus models in the context of Malaysia and in the contexts of river basins. Currently, no policies or initiatives are known to develop WFE nexus modelling capabilities, or even mainstream nexus approaches into cross-sectoral or sectoral policy initiatives.
Infrastructure and Technology: Technological and Infrastructure Facilitation and Investment	Four-Fuel Diversification Policy (1981) Renewable Energy Act (2011) Large-Scale Solar 1, 2, 3 (2017–2020)	The review found that no policy tool is currently available to facilitate innovation, investments and/or funding for pilot projects related to nexus; the concept is still new and requires experimental infrastructure and technology deployment.

Focus Area	Policies/Institutions	Review Notes
Information and RDIC: Monitoring and Evaluation Systems	National Water Balance Management System (NAWABS)	Although nexus is assessed in the chapter, it does not provide information that is sufficient to monitor progress and identify potential WFE nexus hotspots. Indicators on water use for energy production at the facility level are not available. There is also no periodical measure of water intensity of major crops to provide comparison of water use efficiency and its relation with accumulated yield. This challenge is also linked to the lack of policy targets as well as a monitoring and evaluation framework generally. The lack of information also inhibits investments and private sector participation. Advancements in technology through IR 4.0 and big data analytics provide the basis for investment decisions and innovation by identifying the problem in the first place. The nexus flashpoints are highly contextual and there is a need for accessible and usable data to be available to further identify the phenomenon and problems in the first place, and subsequently identifying the responses through an evidence-based approach.
Economics and Finance: Economic Instruments	National Agrofood Policy 2011–2020 11th MP National Water Resources Policy 2012 Green Technology Master Plan 2017–2030 National Energy Efficiency Action Plan 2015	Economic instruments can provide both incentives and disincentives to compel actors to implement policy objectives. In relation to the nexus approach, there is no evidence found of cross-sectoral use of economic instruments. This includes the absence in use of instruments such as water pricing for agriculture and irrigation (such as through mixed tariff based on consumption) for the water-food nexus. Similarly, for potable water production (energy-water nexus), from our preliminary analysis, the potable water production and wastewater treatment's electricity tariffs may fall under TNB's Tariff band D (low voltage industrial tariff) of 29.0 sen/kWh. Electricity tariff for agricultural activities may fall under "Special Agricultural Consumer" - under TNB's Tariff band H1 (Medium Voltage General, Special Agriculture Tariff) of 22.6 sen/kWh. There is currently also a lack of clear incentives for applying technologies that encourage nexus thinking.

Table 3.1.4.2 shows the policy targets across the WFE Sectors in the nexus context.

Table 3.1.4.2. Policy targets across the WFE sectors in the nexus context

Policy	Policy Target	Nexus Pressures	Nexus Opportunities
Water Security Policy Targets			
All shall have access to safe, adequate, and affordable water supply, hygiene, and sanitation (NWRP 2012).	• No policy targets	Insufficient allocation due to pollution from food production Availability for energy production	Set integrated and cross-sector standards relating to food and energy security
Water for food and rural development (NWRP 2012)	• No policy targets	Competing priorities	Opportunity to link to food and development issues
Water for Economic development (NWRP 2012)	• No policy targets	Competing priorities	Opportunity for provision of water to link to food and energy production
Food Security Policy Targets			
Increase in SSL from 2010 – 2020 (National Agrofood Policy 2011–2020)[1]	• Paddy from 71.4% to 69.8% (reduction) • Fruits from 65.8% to 76.3% • Vegetables from 41.2% to 67.6% • Fish from 101.7% to 110.4%	Increase in water for irrigation Increase in land for fruits and vegetables Increase in pollution due to aquaculture	More optimum usage of resources, including water for paddy Hybrid systems for food and energy production

1 Please note that the National Agrofood Policy 2021–2030 is currently being drafted

Policy	Policy Target	Nexus Pressures	Nexus Opportunities
Water Security Policy Targets			
Optimum land use (National Agrofood Policy 2011-2020)	Reduction in land use for agriculture from 922,000 hectare (2010) to 841,000 hectare (2020).	Risk of reduction in production and not meeting SSL	More optimum usage of water and energy
Increase land size for commodity plantations (National Commodities Policy 2011-2020)[2]	Increase in land use from 5.9 hectares (2010) to 6.9 hectares (2020) Cap oil palm to 6.5 hectares by 2023 (now 5.8 hectares)	Competing land for food and energy production (including biofuels and biogas production) Ability to increase energy production through biofuels	Integrated and circular economy approaches such as through utilising by products and waste (biomass) for biogas production
Increase in irrigation intensity (National Agrofood Policy 2011-2020)	Increase in irrigation intensity from 20 to 50 metres per hectare	Competing priorities. Increased water consumption for food production	Policy target on irrigation efficiency in granary areas
Energy Security Policy Targets			
Increase renewable energy mix	Achieve 20% Renewable Energy Mix by 2025 Produce 2.5 GW through Large Scale Solar (LSS), (10% of electricity demand) 4% of energy from hydro by 2022	Competing priorities including land for LSS versus land for agrofood production Impacts of hydro to downstream activities including food production	Floating solar and other technological solutions Nexus approach for multi-purpose dams

4.4 COMPARATIVE STRATEGY ANALYSIS

This section looks into international best practices on WFEN theory and applications across the rural-urban divide from multi-scale perspectives, including local, state, river basin, national, and transboundary perspectives. These best practices are segmented into five areas based on their relevance to the WFEN in the context of Malaysia, and in particular, are in line with key policy recommendations of this study.

The following approaches to mainstreaming the WFEN are reviewed in detail:

1) **Establishing River Basin Organisations (RBOs)** to govern nexus dynamics at the river basin-level, in particular where there are cross-sectoral (or cross-border) challenges affecting resource availability and use.
2) **Establishing a WFEN Centre of Excellence (CoE)** to facilitate the adoption and mainstreaming of nexus approaches and concepts, in particular its role as a knowledge and research hub for matters relating to the WFEN, as well as disseminating this knowledge for the benefit of the various stakeholders involved and facilitate the deployment of technologies to address resource security concerns.
3) **Establishing river basin-level hydrological databases and related decision-support systems** to inform policymaking. This review highlights the importance of facilitating big data collection and monitoring, and the application of this data to generate insights into the development of nexus solutions at the river basin-level.
4) **Using economic and other policy instruments to address nexus issues**. These include economic incentives and disincentives (e.g. subsidies or punitive measures such as penalties), the use of cross-sectoral targets, revised institutional arrangements, informational tools, and others.
5) **Facilitating investment in and deployment of infrastructure and technologies to support mainstreaming of WFEN** to allow for nexus approaches to contribute to sustainable economic growth, including approaches to public-private partnerships in generating investment through voluntary agreements or incentives. Innovating financing arrangements are also analysed as a means towards generating the necessary investment to enhance particularly water sector infrastructure.

2 Please note that the National Commodities Policy 2021–2030 is currently being drafted

In addition to these five approaches, technological applications which address the WFEN are reviewed. The first is large-scale solar projects in the form of floating solar and agrivoltaics, which primarily address the opportunity costs associated with land-use dedicated to solar farms (water use in solar power generation is not a significant concern due to its low water intensity), which can crowd out land otherwise used for food production, or which remains forested. The second technological application of interest is hydropower, where countries have taken steps to transform existing water reservoirs into multipurpose dams aimed at improving flood control and water reliability and mitigating pollution and GHG emissions. Water treatment plants are also analysed, in the context of nascent and advanced technologies which address energy use in the process of treating water, and finally, attention is paid to energy use in the lifting and pumping of water, which is a particular concern in water-stressed river basins in Malaysia which require water pumping to meet irrigation (and other) demands.

4.5 POTENTIAL OF THE NATION'S WATER SECTOR INDUSTRY

This Scope has been reported on by Prof N Mahendhiran's task force.

4.6 TRANSFORMATION STRATEGY

This section charts out a long-term strategy towards strategic resource management through the utilisation of nexus approaches in supporting integrated water resources management (IWRM) and sustainable development. This strategy is based on three foundational elements: 1) governance and the development of an accommodating enabling environment for the mainstreaming of nexus approaches; 2) the deployment of experimental and indigenous nexus infrastructure; and 3) the development of an integrated water-food-energy ecosystem. Within each of these pillars are specific recommendations which lead to their achievement, and these are briefly outlined below:

i) ***Governance and Enabling Environment***

a. Identifying nexus hotspots and subsequent action to reduce the Water Stress Index (WSI) in river basins of high intensity of food- and energy-sector activities (e.g. river basins where rice production features prominently, or where water is withdrawn for the purposes of energy generation).
b. Establishing a multi-tiered institutional arrangement, including the establishment of a National Water Department (NWD), RBOs, WFEN CoE, and a WFEN Technical Guide and Manual.

ii) ***Experimental Nexus Infrastructure***

a. Conducting capacity-building, and communication, education, and public awareness campaigns/ initiatives to address the lack of human capital related to the WFEN in Malaysia at present. In order to do this, the WFEN CoE must be institutionalised and empowered, and steps must be taken to initiate and strengthen R&D into the nexus and into nexus modelling at the river basin-level in Malaysia.
b. Piloting infrastructure and technology to support the mainstreaming of nexus approaches and initiatives, a bottom-up approach with financing drawn from public and private sources.

iii) ***Integrated WFE Ecosystem***

a. Establishing a database with detailed hydrological information for use as a policy decisionmaking tool at the river basin-level. This includes the development of modelling systems which cover critical or stressed river basins. It requires the inclusion of indicators relevant to the WFEN, and more broadly to megatrends such as population growth and those related to climate variabilities, such as sea-level rise, changing rainfall patterns, storm surges and high tides, and pollution.
b. Increasing the use of economic instruments to promote resource efficiency and the mainstreaming of nexus approaches, including the undertaking of assessments of the economic value of water across river basins and using this as the foundation to develop the specific instruments to encourage shifts in behaviours which promote greater resource use efficiency.

4.7 STAKEHOLDER CONSULTATIONS

Table 3.1.4.3 shows the Stakeholder Consultations held in 2021.

Table 3.1.4.3. WFE Nexus Stakeholder consultations

No.	Agency	Date	Venue	Attendance
1.	MADA	10/3/2021	Ibu Pejabat MADA	En. Nik Kun Nik Man, Pengarah Bahagian Perancang Pn. Siti Mariam Bt Md Rejab, Pegawai Hal Ekonomi Pn Siti Hajar, Bahagian Padi En. Khalil, Bahagian Perancang
2	LAP	10/3/2021	Ibu Pejabat LAP	En. Shamsul Kamar, Jurutera Kanan Pn. Fadzillah, Bahagian Operasi En. Lokman, Jurutera Pn. Balkhis, Bahagian Operasi
3	IADA Seberang Perak	11/3/2021	Ibu Pejabat IADA Seberang Perak	En. Nor Azlan Awaludin, Ketua Bahagian Kejuruteraan
4	JPS Perak	11/3/2021	Ibu Pejabat JPS Perak	En. Mohd Zaidi bin Mokhtar (Bahagian Pengurusan Sumber Air dan Hidrologi, BSAH) Ir. Sasitharan A/l Manikam (Bahagian Pengurusan Sungai) Cik Norzalina Anis bt. Mohd Ibrahim Cik Nordiana bt. Mohd Nor (BSAH)
5	Persatuan Aktivis Sahabat Alam (KUASA)	12/3/2021	Ibu Pejabat KUASA	En Hafizudin Nasarudin, Konsultant KUASA Cik Nurul Syuhada
6	WD Solar Sdn Bhd	15/3/2021	Ibu Pejabat WD Solar, Sepang	Cik Hafizah
7	TNB Hydro Generation Sdn Bhd	29/3/2021	Online	En. Kamal Hj Azhar En. Mohd Rozi En. Wan Rafiq (TNB Sg Perak) En. Farid (TNB Hq)
8	NUR Generation Power Plant	8/4/2021	Ibu Pejabat NUR Generatio Power Plant	En. Khairil (Chief engineer), En. Jafry (Head of Operations), En. Chan (Distribution), En. Khoo (Engineering), En. Iswardi (Operations), En. Musri (Chemical)
9	IADA Pulau Pinang	9/4/2021	Ibu Pejabat IADA Pulau Pinang	En. Mohd Nor Hafiz Bin Noor Azmi (IADA Pulau Pinang) En Fadhil (JPS Pulau Pinang)

4.8 ROADMAP FOR THE NATIONAL AGENDA ON WST2040

The roadmap (Table 3.1.4.4) proposed by the WFE Nexus subsector features six overarching strategies across the areas of governance, capacity-building, information and RDCI, finance, and infrastructure and technology. These strategies comprised nine initiatives that are proposed to be undertaken by the Malaysian Government throughout the course of the next 20 years and are segregated into five-year blocks to coincide with future Malaysia Plans.

Table 3.1.4.4. WFE Nexus Sub-sectoralroad map to achieve the WST2040 agenda

Strategy	Initiatives	Details	12th MP (Accelerating IWRM)	13th MP (Water Technology Innovation)	14th MP (Economies of Scale)	15th MP (Becoming the Regional Water Hub)
1 Governance **Reduce 'Water Stress Index' (WSI) and 'Water Exploitation Index' (WEI) in relation to food and energy sectors, i.e. across nexus hotspots**	1. Reduce water stress in areas with high water demand from irrigation, as **measured by the Water Stress Index (WSI)**.	Coordinated by the proposed RBO in collaboration with KASA/ KETSA/MAFI	Reducing river basins from 'Severe Stress' to 'Stress', in major granary areas and/or where WSI is currently above **0.4 (out of 1)** (Muda, Selangor, Johor, Perak, Bernam)	Reducing river basins from 'Severe Stress' and 'Stress' to 'Stress', in major granary areas and/ or where WSI is currently above **0.3** (Muda, Selangor, Johor, Perak, Bernam, Kelantan)	Reducing river basins from 'Stress' to 'Low Stress' in major granary areas and/or where WSI is currently above **0.2** (Muda, Selangor, Johor, Perak, Bernam, Kelantan, Linggi, Padas, Pahang)	Reducing river basins from 'Stress' to 'Low Stress' in major granary areas and/or where WSI is currently above **0.1** (Muda, Selangor, Johor, Perak, Bernam, Kelantan, Linggi, Padas, Pahang)
2 Governance **Establish a strengthened, multi-tiered institutional arrangement to govern WFEN approaches across policy cycles and undertake policy reviews, assessments, and reviews related to WFEN**	2. **Establish a National Water Department** (NWD) to manage interactions between water and food, energy, and other sectors, encouraging a holistic view of water/water industries	Establishment of a NWD under KASA	Organisational change management and transformation	Streamlining budgets to reduce redundancies and through strategic reallocations into new areas of growth	N/A	N/A
	3. Establish a **River Basin Organisation (RBO)** to better incorporate WFEN approaches within the water, food, and energy sectors including investment facilitation	Establishment of an RBO under KASA	Needs assessment of existing river basin/water authorities and establish policy and legislation to incorporate WFEN	Establishment of RBO (appropriate level of governance from the perspective of WFEN because issues are river-basin-specific) **in remaining water-stressed states with major granary areas** (e.g. IADA Penang, KADA (Kelantan), MADA, IADA Seberang Perak, IADA Terengganu Utara)	Undertake review and evaluation of RBO's performance in incorporating WFEN	N/A
	4. Develop informational policy instruments including a **WFEN Technical Guide & Manual**	Development of WFEN Technical Guide & Manual by National Water Department (NWD) along with WFEN CoE, KASA.	Development of a national-level WFEN Technical Guide	Development of a WFEN Technical Guide and Manual for river basins covered under Roadmap Strategy 1 (major granary areas with WSI above 0.4)	Development of a WFEN Technical Guide and Manual for river basins covered under Roadmap Strategy 1 (WSI above 0.3)	Development of a WFEN Technical Guide and Manual for river basins covered under Roadmap Strategy 1 (WSI above 0.2)

Strategy	Initiatives	Details	12th MP (Accelerating IWRM)	13th MP (Water Technology Innovation)	14th MP (Economies of Scale)	15th MP (Becoming the Regional Water Hub)
3 People **Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus**	1. Establish a **WFEN Centre of Excellence** (CoEs) with cross-training program with established CoEs.	Establish a WFEN CoE at relevant GRI in Malaysia	Establish a pilot WFEN CoE at NAHRIM–ISIS	Assess pilot WFEN CoE and benchmark functions and performance against international and other established CoEs	Formalise permanent status of WFEN CoE	N/A
	2. Initiate and strengthen **R&D in WFE Nexus/Nexus Modelling** in Malaysia	River basin coverage of models/ modelling systems developed, such as IIASA and CSIRO, covering critical river basins exhibiting high WSI by WFEN CoE (NAHRIM)	Perform needs and gaps assessments to identify priority areas/river basins and the required expertise (decision support system (DSS), requires 2-3 resource persons) Development of the required expertise/human capital, such as coding, programming, machine learning, in the context of the water sector and all associated activities Once the previous is complete, to develop DSS covering these river basins	Establish a team (i.e. recruitment) within the WFEN CoE to monitor, analyse, maintain, and upgrade modelling covering resource interlinkages across identified stressed/critical river basins	Establish the contributions of the WFEN CoE through the development of DSS covering stressed river basins and potentially specific infrastructure/activities within river basins (i.e. dams, granary areas)	Domestic and international export of expertise developed on WFEN DSS (commercialisation)
4 Information & RDCI **Establish a database with usable information as a policy decision tool at the basin level**	1. Establish a DSS for WFEN, including the development of a hydrological database with improved monitoring of water catchment areas, alongside the development of modelling systems covering critical/ stressed river basins	Development and maintenance of a hydrological database by KASA and WFEN CoE	Development of a national-level hydrological (hydrosocial) database, system integration and user interface by a consultant with the required expertise/capability	Development of a hydrological database for critical/stressed river basins identified by WFEN CoE	Maintain/upgrade hydrological database for critical/stressed river basins identified by WFEN CoE	Maintain/upgrade hydrological database for critical/stressed river basins identified by WFEN CoE
5 Finance **Increase the use of economic instruments to promote resource efficiency and nexus approach**	1. Undertake assessments on the economic value of water at river basin levels	Comprehensive studies conducted by WFEN CoE covering major/ stressed river basins	Comprehensive study covering five major river basins with significant economic value across PM and Sabah/Sarawak	Comprehensive studies covering major/stressed river basins across Malaysia	Revise studies of stressed river basins across Malaysia	Establish a platform for dissemination of economic valuation expertise

Strategy	Initiatives	Details	12th MP (Accelerating IWRM)	13th MP (Water Technology Innovation)	14th MP (Economies of Scale)	15th MP (Becoming the Regional Water Hub)
6 Infrastructure and Technology **Piloting infrastructure and technology to support WFEN approaches/ initiatives**	1. WFEN CoE undertakes pilot projects to address WFEN challenges and opportunities in critical/stressed river basins identified	Catalysing investment in indigenous infrastructure and technology related to WFEN (by WFEN CoE)	Identification and experimentation/piloting of infrastructure, materials, technologies to address WFEN issues/opportunities (e.g. drip irrigation, graphene, LSS, biogas, solar pumps, ORS)	Incentivise private investment for new infrastructure, materials, technology and for technology-upgrading	Mainstreaming/expansion of established experiments/ pilots	Regional and international marketing or export of indigenous infrastructure, materials, technologies used to address domestic WFEN issues/opportunities and achieve financial independence and sustainability through commercialisation of initiatives

4.9 IMMEDIATELY IMPLEMENTABLE PROJECTS FOR THE 12TH MP

Table 3.1.4.5 lists the immediately implementable projects

Table 3.1.4.5. List of immediately implementable projects

Initiative	Details	12th MP Objectives
1. **Establish a National Water Department** (NWD)	Establishment of a NWD under KASA. The NWD is to manage interactions between water and food, energy, and other sectors nationwide, encouraging a holistic view of water/water industries	Reorganise institutional mandates to position the NWD as the lead authority on water-related matters in Malaysia.
2. Establish a **River Basin Organisation (RBO)**	Establishment of an RBO under KASA. The RBO is to better incorporate WFEN approaches within the water, food, and energy sectors, including investment facilitation	Needs assessment of existing river basin- or state-level water authorities and establish policy and legislation to incorporate WFEN
3. Develop informational policy instruments including a **WFEN Technical Guide & Manual**	Development of WFEN Technical Guide & Manual by National Water Department (NWD) along with WFEN CoE, KASA.	Development of a national-level WFEN Technical Guide
4. Establish a pilot **WFEN Centre of Excellence** (CoE)	Establish a WFE Nexus Centre of Excellence at NAHRIM	Institutionalise the pilot WFEN CoE at NAHRIM to engage in activities related to the WFEN (refer to road map and recommendations)
5. Initiate the development of an **ecosystem to support WFEN Modelling** in Malaysia	Development of modelling systems, such as IIASA and CSIRO, at the river basin level. These would cover critical river basins exhibiting high WSI. To be coordinated by the WFEN CoE (NAHRIM)	Identify priority areas/river basins and perform needs and gap assessments to identify the required expertise (decision support system (DSS) alone requires several experts) Development of the required expertise/ human capital, in areas such as coding, programming, machine learning, in the context of the water sector and all associated activities (i.e. covering all interlinkages with energy, and food).
6. **Establish a DSS for WFEN**, including the development of a hydrological database	Development and maintenance of a hydrological database by KASA and WFEN CoE to improve monitoring of water catchment areas, alongside the development of modelling systems covering stressed and/or important river basins	Development of a national-level hydrological (hydrosocial) database, system integration and user interface by consultants with the required expertise
7. Undertake **assessments on the economic value of water** at river basin levels	Comprehensive studies led by WFEN CoE covering major/stressed river basins	Comprehensive study covering five major river basins with significant economic value across PM and Sabah/Sarawak
8. Undertake pilot projects to address WFEN challenges and opportunities in critical/ stressed river basins identified through infrastructure, materials, and technology	Catalysing investment in indigenous infrastructure and technology related to WFEN (by WFEN CoE)	Identification and experimentation/piloting of infrastructure, materials, technologies to address WFEN issues/opportunities (e.g. drip irrigation, graphene, LSS, biogas, solar pumps, ORS)

4.10 STRATEGIES, TARGETS AND KPIS FOR THE 4 MPS

Tables 3.1.4.6 to 3.1.4.9 lists the strategies, targets and KPIs over the four phases.

12th Malaysia Plan

Table 3.1.4.6. Strategies, objectives, and KPIs for the 12th Malaysia Plan

Strategy	Initiatives	Objectives	KPI
Establish a strengthened, multi-tiered institutional arrangement to govern WFEN approaches across policy cycles and undertake policy reviews, assessments, and reviews related to WFEN	**Establish a National Water Department** (NWD)	Reorganise institutional mandates to position the NWD as the lead authority on water-related matters in Malaysia.	Reducing river basins from 'Severe Stress' to 'Stress', in *major granary areas* and/or where WSI is currently above **0.4 (out of 1)** (Muda, Selangor, Johor, Perak, Bernam)
	Establish a **River Basin Organisation (RBO)**	Needs assessment of existing river basin- or state-level water authorities and establish policy and legislation to incorporate WFEN	
	Develop informational policy instruments including a **WFEN Technical Guide & Manual**	Development of a national-level WFEN Technical Guide	
Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus	Establish a pilot **WFEN Centre of Excellence** (CoE)	Institutionalise the pilot WFEN CoE at NAHRIM to engage in activities related to the WFEN (refer to Roadmap and recommendations)	
	Initiate the development of an **ecosystem to support WFEN Modelling** in Malaysia	Identify priority areas/river basins and perform needs and gap assessments to identify the required expertise (decision support system (DSS) alone requires several experts) Development of the required expertise/ human capital, in areas such as coding, programming, machine learning, in the context of the water sector and all associated activities (i.e. covering all interlinkages with energy, and food).	
Establish a database with usable information as a policy decision tool at the basin level	**Establish a DSS for WFEN**, including the development of a hydrological database	Development of a national-level hydrological (hydrosocial) database, system integration and user interface by consultants with the required expertise	
Increase the use of economic instruments to promote resource efficiency and nexus approach	Undertake **assessments on the economic value of water** at river basin levels	Comprehensive study covering five major river basins with significant economic value across PM and Sabah/Sarawak	
Piloting infrastructure and technology to support WFEN approaches/ initiatives	Undertake pilot projects to address WFEN challenges and opportunities in critical/ stressed river basins identified through infrastructure, materials, and technology	Identification and experimentation/ piloting of infrastructure, materials, technologies to address WFEN issues/ opportunities (e.g. drip irrigation, graphene, LSS, biogas, solar pumps, ORS)	

13th Malaysia Plan

Table 3.1.4.7. Strategies, objectives, and KPIs for the 13th Malaysia Plan

Strategy	Initiatives	Objectives	KPI
Establish a strengthened, multi-tiered institutional arrangement to govern WFEN approaches across policy cycles and undertake policy reviews, assessments, and reviews related to WFEN	Establish a National Water Department (NWD)	Streamlining budgets to reduce redundancies and through strategic reallocations into new areas of growth	Reducing river basins from 'Severe Stress' and 'Stress' to 'Stress', in major granary areas and/or where WSI is currently above 0.3 (Muda, Selangor, Johor, Perak, Bernam, Kelantan)
	Establish a River Basin Organisation (RBO)	Establishment of RBO (appropriate level of governance from the perspective of WFEN because issues are river-basin-specific) in remaining water-stressed states with major granary areas (e.g. IADA Penang, KADA (Kelantan), MADA, IADA Seberang Perak, IADA Terengganu Utara)	
	Develop informational policy instruments including a WFEN Technical Guide & Manual	Development of a WFEN Technical Guide and Manual for river basins covered under Roadmap Strategy 1 (major granary areas with WSI above 0.4)	
Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus	Establish a pilot WFEN Centre of Excellence (CoE)	Assess pilot WFEN CoE and benchmark functions and performance against international and other established CoEs	
	Initiate the development of an ecosystem to support WFEN Modelling in Malaysia	Establish a team (i.e. recruitment) within the WFEN CoE to monitor, analyse, maintain, and upgrade modelling covering resource interlinkages across identified stressed/critical river basins	
Establish a database with usable information as a policy decision tool at the basin level	Establish a DSS for WFEN, including the development of a hydrological database	Development of a hydrological database for critical/stressed river basins identified by WFEN CoE	
Increase the use of economic instruments to promote resource efficiency and nexus approach	Undertake assessments on the economic value of water at river basin levels	Comprehensive studies covering major/ stressed river basins across Malaysia	
Piloting infrastructure and technology to support WFEN approaches/ initiatives	Undertake pilot projects to address WFEN challenges and opportunities in critical/stressed river basins identified through infrastructure, materials, and technology	Incentivise private investment for new infrastructure, materials, technology and for technology-upgrading	

14th Malaysia Plan

Table 3.1.4.8. Strategies, objectives, and KPIs for the 14th Malaysia Plan

Strategy	Initiatives	Objectives	KPI
Establish a strengthened, multi-tiered institutional arrangement to govern WFEN approaches across policy cycles and undertake policy reviews, assessments, and reviews related to WFEN	**Establish a National Water Department** (NWD)	Completed under 13th MP	Reducing river basins from 'Stress' to 'Low Stress' in major granary areas and/or where WSI is currently above **0.2** (Muda, Selangor, Johor, Perak, Bernam, Kelantan, Linggi, Padas, Pahang)
	Establish a **River Basin Organisation (RBO)**	Undertake review and evaluation of RBO's performance in incorporating WFEN	
	Develop informational policy instruments including a **WFEN Technical Guide & Manual**	Development of a WFEN Technical Guide and Manual for river basins covered under Roadmap Strategy 1 (WSI above 0.3)	
Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus	Establish a pilot **WFEN Centre of Excellence** (CoE)	Formalise permanent status of WFEN CoE	
	Initiate the development of an **ecosystem to support WFEN Modelling** in Malaysia	Establish the contributions of the WFEN CoE through the development of DSS covering stressed river basins and potentially specific infrastructure / activities within river basins (i.e. dams, granary areas)	
Establish a database with usable information as a policy decision tool at the basin level	**Establish a DSS for WFEN**, including the development of a hydrological database	Maintain/upgrade hydrological database for critical/stressed river basins identified by WFEN CoE	
Increase the use of economic instruments to promote resource efficiency and nexus approach	Undertake **assessments on the economic value of water** at river basin levels	Revise studies of stressed river basins across Malaysia	
Piloting infrastructure and technology to support WFEN approaches/initiatives	Undertake pilot projects to address WFEN challenges and opportunities in critical/stressed river basins identified through infrastructure, materials, and technology	Mainstreaming/expansion of established experiments/pilots	

15th Malaysia Plan

Table 3.1.4.9. Strategies, Objectives, and KPIs for the 15th Malaysia Plan

Strategy	Initiatives	Objectives	KPI
Establish a strengthened, multi-tiered institutional arrangement to govern WFEN approaches across policy cycles and undertake policy reviews, assessments, and reviews related to WFEN	**Establish a National Water Department** (NWD)	Completed under 13th MP	Reducing river basins from 'Stress' to 'Low Stress' in major granary areas and/or where WSI is currently above **0.1** (Muda, Selangor, Johor, Perak, Bernam, Kelantan, Linggi, Padas, Pahang)
	Establish a **River Basin Organisation (RBO)**	Completed under 14th MP	
	Develop informational policy instruments including a **WFEN Technical Guide & Manual**	Development of a WFEN Technical Guide and Manual for river basins covered under roadmap Strategy 1 (WSI above 0.2)	
Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus	Establish a pilot **WFEN Centre of Excellence** (CoE)	Completed under 14th MP	
	Initiate the development of an **ecosystem to support WFEN Modelling** in Malaysia	Domestic and international export of expertise developed on WFEN DSS (commercialisation)	
Establish a database with usable information as a policy decision tool at the basin level	**Establish a DSS for WFEN**, including the development of a hydrological database	Maintain/upgrade hydrological database for critical/stressed river basins identified by WFEN CoE	
Increase the use of economic instruments to promote resource efficiency and nexus approach	Undertake **assessments on the economic value of water** at river basin levels	Establish a platform for dissemination of expertise and knowledge on economic valuations of water	
Piloting infrastructure and technology to support WFEN approaches/initiatives	Undertake pilot projects to address WFEN challenges and opportunities in critical/stressed river basins identified through infrastructure, materials, and technology	Regional and international marketing or export of indigenous infrastructure, materials, technologies used to address domestic WFEN issues/opportunities and achieve financial independence and sustainability through commercialisation of initiatives	

WFE Nexus had identified **113 Targets** and **113 KPIs** for the 4 Malaysia Plans. The details are given in its Final Report (Volume 5).

4.11 CONCLUSION AND RECOMMENDATIONS

Conclusion

This report covers several aspects of the water-food-energy nexus as it pertains to Malaysia, highlighting the various WFEN interactions present across the country at the intersections of the water, agriculture, and energy sectors most prominently. These interactions sometimes involve, or are affected by, other key factors or variables such as land use or climate change. This analysis has contextualised the many challenges and opportunities facing the security and sustainability of Malaysia's key strategic resources from the perspective or lens of the WFEN ecosystem.

These nexus interactions, issues, and opportunities, as well as our reviews of international best practices within WFEN approaches and critical analyses of the water, food, and energy security issues facing Malaysia have been used to identify our policy recommendations. These recommendations have the objectives of enhancing resource efficiency and security, contributing to a future of water, food, and energy security and sustainability. These also aim to spearhead the transition of water into an economic good and the water sector as an economic driver, as well as enhance Malaysia's realisation of resource sustainability. Recommendations cover areas as varied as technological gamechangers and impacts, to governance and institutions, to economics, financing, and incentivisation, amongst others, that are relevant to the development of nexus solutions.

Recommendations

The transformation strategy recommended by the WFEN sub-sector comprised six strategies as described below:

1. **Identify nexus hotspots and Reduce 'Water Stress Index' (WSI) in relation to food and energy sectors**: To enhance identification and monitoring of WFE nexus, the WSI is proposed to be adopted as an indicator to identify nexus hotspots. The aim is to reduce river basins from 'severe stress' to 'stress', 'low stress' or 'not stressed' in major granary areas.
2. **Establish a multi-tiered institutional arrangement**: Three initiatives are proposed under this strategy to transform towards in-situ development and integrated governance and transitioning towards IWRM.
   - Establish a National Water Department (NWD) to manage interactions between water and food, energy, and other sectors, encouraging a holistic view of water/water industries;
   - Establish a River Basin Organisation (RBO) at every state to better incorporate WFEN approaches within the water, food, and energy sectors including investment facilitation; and
   - Develop informational policy instruments including a WFEN Technical Guide & Manual
3. **Capacity building, communication, education and public awareness**: To address the lack of capacity, two initiatives are proposed: -
   - Establish a WFEN Centre of Excellence (CoEs) consisting of technical and policy expertise; and
   - Initiate and strengthen R&D in WFE Nexus/Nexus Modelling in Malaysia
4. **Piloting infrastructure and technology to support WFEN approaches/initiatives**
   As a novel concept, pilot projects are required to test the nexus solutions in the context of Malaysia. This process should be bottom up and led by innovation from the private sector and facilitated by the government. For example, an establishment of a pilot project fund that accepts proposals from the private sector to address specific issues related to nexus challenges could be established.
5. **Establish a database with usable information as a policy decision tool at the basin level**: Establish a DSS for WFEN, including the development of a hydrological database with improved monitoring of water catchment areas, alongside the development of modelling systems covering critical/stressed river basins
6. **Increase the use of economic instruments to promote resource efficiency and nexus approach:** This includes undertaking assessments on the economic value of water at river basin levels. From these assessments, the appropriate mechanisms that can enhance the economic value and potential of river basins will be identified.

5.0 VIRTUAL WATER AND WATER FOOTPRINT (VW&WF)

5.1 Background /Introduction of Sub-Sectoral Study

A report on Virtual Water (VW) and Water Footprint (WF) is significant as it assesses a country's water consumption at various levels. VW measures the amount of water embedded in the production, import and export of commodities, products or services. On the other hand, WF calculates the ways freshwater resources are used by humans and the impacts of the production system on water resources. To account for Malaysia's VW and WF, this study adopted a hybrid approach to conducting the Water Footprint Assessment (WFA) comprising two main methodological approaches; the Water Footprint Assessment (WFA) and the Life Cycle Assessment Approach (LCA). The WFA is employed to calculate human activities' water consumption and pollution, which estimates the volume of direct and indirect freshwater consumption and classifies them into green, blue and grey water. Meanwhile, the LCA, a standardised, international approach on water footprint through ISO 14046, is also used to calculate the potential environmental impacts on water use from the cradle to the grave.

VW and WF inventory assessment following the WFA and LCA approaches have successfully derived valuable information regarding direct and indirect water consumption and trade within and outside Malaysia. Following the ISO 14046, the WFA was conducted in four phases; determining the goal and scope definition, conducting the WF inventory analysis, examining the WF impact assessment and interpreting the results. This study primarily focuses on the WF inventory assessment of the amount of freshwater embedded in the consumption and pollution in products/services. The evaluation involves deriving a WF inventory assessment of various sectors in Malaysia. After initial findings on multiple sectors are obtained, six essential sectors in Malaysia are strategically chosen to be highlighted: oil palm, rubber, paddy, rubber glove, semi-conductor, and tourism. These sectors were selected based on their contribution to Malaysia's Gross Domestic Product (GDP) and the water consumption in producing product outputs, which provides valuable inputs to the subsequent WFA stage and therefore presented as case studies in the report. Another reason for selecting paddy is for food security.

The study aims to calculate Malaysia's VW and establish a WF inventory of several essential economic sectors and proposes the incorporation of WF elements for water governance in the country at different tiers and levels of governance, namely federal and state governments, in hope of raising awareness on WF accounting among decision-makers, consequently ensuring better planning, management, and water allocation consumption in Malaysia.

5.2 Objectives of Sub-Sectoral Study

Although Malaysia is regarded as a water-abundant country, it is essential to inculcate awareness on the need to use water more efficiently by considering the direct and indirect water consumption and trade within and outside of the country. To achieve this aim, seven objectives have been devised, which are:

i) To identify the main players and potential international collaborators in VW and WF initiatives;
ii) To identify the economic sectors that will be the focal point of the VW and WF inventory study based on sets of criteria;
iii) To establish VW and WF inventory for selected case studies;
iv) To calculate and analyse the VW of the selected economic sectors utilising the collected secondary data;
v) To calculate and analyse WF inventory of selected industrial and tourism sector and agricultural crops;
vi) To review and suggest improvement the current policy, acts, enactments, and ordinances to incorporate elements of WF; and
vii) To prepare a roadmap for the National Agenda on Water Sector Transformation 2040 (WST 2040 Roadmap).

5.3 Report on Findings based on each Scope of the Sub-sectoral Study as specified by the Terms of Reference (TOR)

5.3.1 TOR Scope 1: (Current Policies Reviewed and Analysed)

In Malaysia, VW and WF knowledge is still a new venture, with the current work mainly focusing on developing scientific methodology and collecting data for detailed analysis. The fundamental objective of this research is, in this context, to suggest an alternate strategy for the sustainable evaluation process of the WF methodology. To this purpose, this Report offers an extensive review and suggestions to integrate WF in the present legislation. Table 3.1.5.1 shows that only 2 policies have relevance to VW&WF.

Table 3.1.5.1. Review of current policies

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
1	National Sustainable Consumption and Production (SCP) Blueprint 2016 – 2030, under pathway 9	2016	Economic Planning Unit	WF calculation for food and beverage	i) Provision of legal aspect before embarking on WF certification programme. ii) Positioning agricultural sector as the focus for the WF programme. iii) Allocating research funds for invention in WF technology. iv) Providing training needs for WF certification initiative iv) Suggestion for local authorities in Malaysia to play a major role in water administration through provisions to control water usage, water efficiency and water quality. vi) Empowering local authorities for implementing WF initiative with knowledge, workforce, and strengthening law enforcement capacity.
2	National Water Resource Policy (NWRP), under thrust number 2 and number 9	2012	Ministry of Energy and Natural Resources	▪ Thrust number 2 – water resources integrity ▪ Thrust number 9 – capacity building and awareness.	

5.3.2 TOR Scope 2 (Undertake Comparative Strategy Analysis/Business Models with other nations)

Research has been carried out extensively based on WF strategies and activities in many water-intensive sectors such as food, farming and manufacturing in many countries. Currently, most research-driven countries engage with local researchers and their respective government organisations to accurately estimate the VW and WF of various economic sectors. The sub-sector studied WF initiatives introduced by two countries; Germany and the United States.

Germany initiated the WF toolbox which consists of standards, databases, concepts, data sets, tools and impact assessment concerning the environmental impacts and sustainability performance, including WF.

Meanwhile, the United States initiated the WF calculator which explicates the impacts of water use on everyday actions, from washing dishes to watering the lawn to buying groceries.

5.3.3 TOR Scope 3:

To study the potential of the nation's water sector through taking into account the current global market to establish the water sector as a new dynamic economic sector and capable of driving the nation's GDP growth in future

The WES Sub-sector has provided a write up on this scope.

5.3.4 TOR Scope 4:

To prepare the framework for the implementation strategy and the water sector transformation initiative for the four phases, including proposing the implementing agencies, budget estimates and the main achievement targets based on analyses undertaken as well as expert reviews

The roadmap framework had been prepared by the study team and approved by the Technical Committee at its meeting on 28 October 2020 and by the Steering Committee at its meeting on on 19 November 2020.

5.3.5 TOR Scope 5:

To implement consultation sessions with stakeholders and experts with the aim of finalising the proposed framework for the implementation strategy and the water sector transformation initiative (include providing tabulated lists of stakeholders/experts engaged with and dates)

The VW & WF sub-sectors have carried out 13 engagements via physical and online meetings and email correspondence with 67 stakeholders to gather data and feedback in devising the National Agenda on Water Sector Transformation 2040 (WST 2040 roadmap) concerning VW and WF initiatives which are proposed to be implemented by different sectors and agencies. The roadmap has been deliberated with various stakeholders, including Ministries, Government Agencies, Non-Governmental Organisations (NGOs), industry players and academicians through online and physical engagements (Table 3.1.5.2).

Table 3.1.5.2. Stakeholder consultations

No.	Date	Stakeholders	Number of Participants	Platform/ Venue	Purpose of Engagement/Activity
1	10/08/2020	MPOB, MADA, MARDI, UM, LGM, INTEL, NREB, DOSM, MITI, MIDA, KASA, SIRIM	19	ASM	VW & WF Task Force Member Meeting
2	3/9/2020	MPOB, UM	9	Zoom	VW & WF Task Force Meeting (Definition & Concept)
3	3/11/2020	MPOB, MADA, MARDI, UM, LGM, INTEL, DOE, NREB, EPD Sabah, Top Glove	12	Zoom	VW & WF Task Force Member Meeting
4	26/1/2021	MADA, KADA, IADA, MARDI, DOE, BERNAS, Faiza Sdn. Bhd., NREB, EPD Sabah, MAFI	15	Zoom	FGD Paddy
5	22/2/2021	Hotel (Terengganu, JB, KL, Selangor, Pahang, Sabah, Sarawak), DOSM, MOT, MAFI, MAH, MOTAC	31	Zoom	FGD Tourism
6	1/3/2021	FELCRA, FELDA, LGM, LIGS, UM, NAFAS	14	Zoom	FGD Rubber
7	3/3/2021	Micron Semiconductor Sdn. Bhd.	10	Zoom	Meeting for Semiconductor Sector
8	6/4/2021	KASA, SPAN, LGM, IPASA, UTM, MOTAC, JPS, NAHRIM, FMM, LESTARI, UM, LUAS, EPU, DOE, Jabatan Standard Malaysia, SIRIM, BAKAJ	23	Bangi Resort Hotel	*Bengkel Cadangan Penambahbaikan Polisi & Akta untuk Menerapkan Konsep VW & WF*
9	7/4/2020	LGM, MOSTI, ASM, GEC, MoHE, MOE, MOF, KASA, JPS, UTM, UM, SIRIM	24	Bangi Resort Hotel	*Kajian Pembangunan Roadmap WST2040 bagi VW & WF*
10	3/5/2021	Jabatan Standard Malaysia	10	Zoom	Meeting on Roadmap

No.	Date	Stakeholders	Number of Participants	Platform/ Venue	Purpose of Engagement/Activity
11	6/5/2021	JPS Sabah, Jabatan Tanah & Ukur Sabah, Pertanian Sabah, Jabatan Perancangan Bandar & Wilayah Sabah, Pertanian Sarawak, Jabatan Tanah & Survei Sarawak, Perbadanan Pembangunan Ekonomi Sarawak, NREB, Lembaga Air Kuching	21	Zoom	*FGD Cadangan Penambahbaikan Polisi & Akta untuk Menerapkan Konsep VW & WF (Sabah & Sarawak)*
12	25/5/2021	KASA, JPS, DOE, Jabatan Standard Malaysia, MOTAC, LGM, BAKAJ, LUAS, LESTARI UKM, RISE UTM, UM, NAHRIM, SIRIM, SPAN, ASM, GEC, MoHE, MOE, MOF, MPOB, EPD Sabah, BPEN Kedah, UPEN Kelantan, UPEN Terengganu, Jabatan Bekalan Air Terengganu, LAUT	42	Zoom	*Mesyuarat Pemurnian Kajian Pembangunan Roadmap WST2040 bagi VW & WF*
13	2/9/2021	MITI	8	Zoom	*Mesyuarat Pemurnian Kajian Pembangunan Roadmap WST2040 bagi VW & WF*

5.3.6 TOR Scope 6:

To prepare the complete roadmap for the National Agenda on WST 2040 roadmap for the reference and guide of the various Ministries and Agencies to implement project/programmes and activities towards achieving the aim of transforming the water sector.

The VW&WF Roadmap is given in the Sub-sectoral Final Report.

In summary, the VW and WF Study proposes 14 strategies, 22 programmes/initiatives, and 45 activities concerning water as resources and as livelihood that fall under five focus areas (People, Governance, Information and Research, Development, Innovation and Commercialisation (RDIC), Finance and Infrastructure), which form the basis for developing the roadmap for the National Agenda on the WST 2040 to be considered for implementation through the 12th MP to 15th MP.

Table 3.1.5.4. Strategies, targets and KPIs for the 12th Malaysia Plan

12th Malaysia Plan				
Strategies	**Targets**	**KPIs**	**Lead Agency**	**Budget Estimated (RM million)**
Heightened VW&WF awareness among the public and industry	Conduction of awareness programme and knowledge dissemination for the public	1. Awareness programme for roadshow will start from 2022. 2. Article on WF to be published on popular media targeted for the general public. 3. WF element included in the programme to start in 2023. 4. WF related contents on social media updated on a daily basis starting from 2022. 5. New content created on weekly basis in a dedicated YouTube channel starting from 2022. 6. Biennial WF workshop organised beginning from 2023. 7. Awareness programme with members of parliament and state assemblymen conducted every two years starting from 2024. 8. List of alternative local food with low WF to replace imported food starting from 2023. 9. Online customised individual WF calculator is available for local use starting from 2023	• KASA • MOE • MoHE • State agencies e.g., Sarawak Natural Resources & Environmental Board (NREB), Sabah Natural Resource Office • WF Centre	1.3
	Conduction of awareness programme and knowledge dissemination for schools and universities	1. Incorporation of WF concept in the activities of school environmental club by 2025. 2. Content and materials for WF activities for school and university students developed by 2024. 3. WF-related content for school and university students on social media updated on a daily basis starting from 2022. 4. One WF competition programme per year. 5. Article on WF to be published on popular media targeted for the general public. 6. Educational Institutions have the allocation for water conservation efforts in their schools/institutions (compulsory) 7. Co-organise activity with GEC using the DrH2O kit (Water Saving kits, Checklist, water Audit), Water Conservation Module.	• KASA • MOE • MoHE • State agencies e.g., Sarawak Natural Resources & Environmental Board (NREB), Sabah Natural Resource Office • WF Centre	1.1
	Conduction of awareness programme and knowledge dissemination for industry	1. Database of industry and WF association established by 2023. 2. Economic module for economic return framework developed by 2025. 3. Element of WF to be included in Prime Minister Hibiscus Award by 2025.	• KASA • MOE • MoHE • State agencies e.g., Sarawak Natural Resources & Environmental Board (NREB), Sabah Natural Resource Office • WF Centre	0.6

12th Malaysia Plan				
Strategies	**Targets**	**KPIs**	**Lead Agency**	**Budget Estimated (RM million)**
Enhance WF competency	Development of training modules and attainment of recognition by Certification Bodies (Statutory/ Private)	1. Accredited WF assessment training modules for industry ready to be utilised by end of 2022. 2. Accredited WF auditing training modules for auditor by June 2023.	• KASA • NREB • EPD Sabah	0.3
	Conduction of competency training programme for water managers	1. WF competency programme ready to be implemented by 2023. 2. 100 trained water managers per year beginning from 2023.	• KASA • NREB • EPD Sabah	0.4
Enhancement of policy and law to support WF initiatives	Incorporating WF component in Dasar Air Negara (DAN)	Inclusion of VW&WF elements and requirements in the Dasar Air Negara (DAN) by the end of 2022	• KASA	-
Becoming global champion	Elevating Malaysia role as a major player in the global WF initiative	1. Increased number of publications in high impact journals (2022 - 2040). 2. Increased number of citations on VW&WF publication (2022 - 2040).	• MoHE • MOSTI	2.5
Establishing WF governance	Creation of task force and guidelines	1. WF task force established by 2022. 2. Guidelines on WF implementation completed by 2024.	• KASA	0.7
Strengthening Institutional set up	Setting up WF centre	National WF centre will be set up by 2023.	• KASA • MoHE	6.5
Enhanced R&D in WF	Implementation of WF R&D within river basin framework	1. Completion of WF studies for 24 river basins in Malaysia (as listed by DID) by 2040. 2. Guideline on the involvement of local authority in WF implementation drafted by 2026.	• DID	1.5
	Implementation of WF R&D for selected sectors	Completion of 20 WF studies of products and services (2023 – 2040).	• EPU	1.5
Mainstreaming WF in business	Establish requirement for water accounting report	1. Requirement for water accounting report by industry in 2030 2. WF elements are incorporated in water accounting reporting by 2030	• KASA • JSM • MITI • MPC • MAFI	1.0
	Promotion of WF labelling scheme among local producers	The WF labelling scheme will be available by 2024.	• SIRIM	2.0
	Development of WF calculator	1. WF calculator developed by June 2025. 2. Completion of WF database for 26 various products/services (2022 - 2040).	• KASA	1.0

In addition to fulifilling the Study Scope, the Sub-sectors were requested to provide listings on Immediately Implementable Projects, Targets and KPIs.

5.3.7 Immediately Implementable Projects

The strategies and initiatives to be immediately implemented are presented in Table 3.1.5.3.

Table 3.1.5.3. Immediately implementable projects for the 12th Malaysia Plan

Focus Area	Strategy	Initiative	Year Start
People	Heightened VW&WF awareness among the public and industry	Conduction of awareness programme and knowledge dissemination for the public, younger generations, and industry	2022–2040
	Enhance WF competency	Development of training modules and attainment of recognition by Certification Bodies (Statutory/Private)	2022 – 2023
Governance	Enhancement of policy and law to support WF initiatives	Incorporation of WF component in Dasar Air Negara (DAN)	2022
	Becoming global champion	Elevating Malaysia role as a major player in the global WF initiative	2022 – 2040
	Establishing WF governance	Creation of task force and guidelines	2022 – 2024
	Mainstreaming WF in business	Establish requirement for water accounting report	2022 – 2030
		Promotion of WF labelling scheme amongst local producers	2024
		Development of WF calculator	2025
	Enhance WF competency	Conduction of competency training programme for water managers	2023 – 2040
Information & RDCI	Enhanced R&D in WF	Implementation of WF R&D within river basin framework	2023 – 2040
		Implementation of WF R&D for selected sectors	
Infrastructure & Technology	Strengthening Institutional setup	Setting up WF centre	2023 – continuous

5.3.7 Strategies, targets, KPIs and timelines

Strategies, targets, KPIs and timelines to achieve these aims are shown in Table 3.1.5.4 to Table 3.1.5.7.

Table 3.1.5.5. Strategies, targets and KPIs for the 13th Malaysia Plan

13th Malaysia Plan				
Strategies	**Targets**	**KPIs**	**Lead Agency**	**Budget Estimated (RM million)**
Mainstreaming WF in business	Strengthening water accounting report	Water accounting report is fully implemented to major water user industries by 2040	• KASA • JSM • MITI • MPC • MAFI	0.3
	Incorporate WF components in ESG initiative	1. WF information under water provision in ESG by 2027. 2. Participation of the public listed companies in the new provision of ESG by 20% in 2040.	• Bursa Malaysia	0.5
Provision of financial rewards and incentives	Initiate tax incentives upon completion of water reporting	Tax incentive programme ready to be implemented by 2027.	• MOF • LHDN	0.5
Strengthening Institutional set up	Establishment of a model river basin to fully implement the WF concept	A Pilot Project on WF implementation at the river basin scale started in 2026 and must be in line with the River Basin Authority (RBA) initiative.	• DID • Water State Authorities	50.0
Continuation of initiatives from 12th MP				21.0

Table 3.1.5.6. Strategies, targets and KPIs for the 14th Malaysia Plan

14th Malaysia Plan				
Strategies	**Targets**	**KPIs**	**Lead Agency**	**Budget Estimated (RM million)**
Becoming global champion	Positioning Malaysian WF experts at the international platform	1. MoU on WF collaboration with China, the Netherlands, and Germany signed by 2033. 2. Framework for benchmarking with global best players developed by 2032.	• MITI • MOSTI	1.5
Enhancing global trade	White paper on VW for the purpose of international trade agreement	A white paper of VW will be presented in the Malaysian Parliament by 2035.	• MITI • EPU	0.2
	Optimising global water management through VW trade under several trade agreements	Trade agreement involving VW is signed with major trade partners under AFTA and TPP members, and other trade partners and economic blocks (e.g., EU, North American Free Trade Agreement, and Australia) by 2040.	• MITI • EPU • MFA	1.0
Enhanced R&D in WF	Enhancing global trade	Studies on global economic opportunities, drivers, and impacts of VW completed by 2035.	• MITI • EPU	0.2
Continuation of initiatives from 12th MP and 13th MP				39.7

Table 3.1.5.7. Strategies, targets and KPIs for the 15th Malaysia Plan

15th Malaysia Plan				
Strategies	**Targets**	**KPIs**	**Lead Agency**	**Budget Estimated (RM million)**
Becoming global champion	Exporting WF knowledge	1. Training module accepted and implemented in selected Asian countries, namely Indonesia, Vietnam, and the Philippines (2036 – 2040). 2. Two WF training conducted in selected Asian countries per year (2036 - 2040)	WF centre (MyWaFA)	2.5
Enhancing global trade	Inclusion of VW in the international trade agreement	1. VW caucus among member countries established by 2037. 2. Trade agreement incorporating VW signed by 2040.	• MITI • EPU	1.0
Continuation of initiatives from 12th, 13th, and 14th MP				21.2

VW & WF had identified **22 Targets** and **22 KPIs** for the four Malaysia Plans. The details are given in its Final Report (**Volume 6**).

5.3.9 Conclusion

This study has reviewed ten Federal Government acts and 21 enactments/ordinances for possible WF inclusion in this study. A total budget of RM160 million has been proposed to drive the VW and WF in Malaysia (RM20.4 million for 12th MP, RM72.3 million for 13th MP, RM42.6 million for 14th MP and RM24.7 million for 15th MP), with a readily implementable roadmap for the National Agenda on the WST for 2022 – 2040. A total of 14 strategies, 22 programmes/initiatives and 45 activities have been proposed to drive the water sector transformation, covering five key focus areas; People, Governance, Information and RDIC, Finance and Infrastructure with a total of 50 Key Performance Indicators (KPIs) set out to drive the VW and WF initiatives under the water sector transformation in Malaysia. This study has gathered essential information regarding Malaysia's VW and WF accounting in major economic sectors and addresses the importance of WF accounting among decision-makers that may lead to better water allocation and consumption decisions. Therefore, improving and expanding the VW & WF concept application in all sectors will positively impact the water sector in Malaysia to achieve the expected water transformation targets.

6.0 CLIMATE CHANGE IMPACT AND ADAPTATION (CCIA)

6.1 Introduction

The National Agenda for WST2040 aspires to transform the water sector to an economy that is dynamic, contributes more significantly to the country's Gross Domestic Product and enhances employment opportunities, while indirectly driving the development of the nation's science, technology and innovation. The WST2040 will commence with the 12th MP in 2021 (GoM, 2021). The Economic Planning Unit (EPU), Prime Minister's Department has appointed the Academy of Sciences Malaysia (ASM) as its strategic partner to undertake a study to further develop the WST2040.

The mainstreaming of climate change is reflected in national development policies and strategies. The current development narrative for Malaysia as embodied in the SPV 2030, has three objectives underpinned by 15 guiding principles and 8 enablers covering 7 strategic thrusts 15 key economic growth activities (Ministry of Economic Affairs Malaysia, 2019). Climate change comes under the Strategic Thrust on Social Capital. There are several key economic growth activities that are linked to climate change including renewable energy, green economy, logistic, transportation and sustainable mobility. A total of ten economic indicators and eight social indicators have been identified to measure progress and one of these is the environmental and climate change index. The Shared Prosperity Vision 2030 builds on existing climate change measures in the country.

The National Policy on Climate Change was formulated in 2009 to address the challenges of climate change in an effective and holistic manner and promote balanced adaptation and mitigation, including disaster risk reduction, to achieve climate resilient development (Government of Malaysia, 2010). Climate change mitigation is mainstreamed in the country with a national aspiration to reduce GHG emission intensity of Gross Domestic Product by up to 40 % of 2005 levels by 2020 with financial support (MESTECC, 2018). This pledge has been made more ambitious recently with an entirely voluntary reduction of GHG emission intensity of Gross Domestic Product by up to 45% in 2030 as compared to 2005 levels (KASA, 2021). The carbon intensity would be calculated based on emissions of seven greenhouse gases, which include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbon (PFCs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3) (KASA, 2021). Climate change adaptation is embedded in specific sectors through existing environmental management plans, national conservation strategies, disaster management plans as well as in programmes of other sectors such as agriculture, forestry, transportation and fisheries, amongst others. The 12th Malaysia Plan has outlined the integration of adaptation and disaster risk reduction as a national strategy.

Malaysia is actively addressing the challenges of climate change on various platforms. The country is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and has submitted the Third National Communication (NC3) in 2018, where the Ministry of Environment and Water (KASA) serves as the National Focal Point. Through the National Disaster Management Agency (NADMA) Malaysia, the country reports progress on the Sendai Framework for Disaster Risk Reduction to the United Nations Office for Disaster Risk Reduction. The Economic Planning Unit of the Prime Minister's Department leverages on both these processes to report on the country's progress towards Sustainable Development Goal (SDG) with respect to climate change mitigation, climate change adaptation and disaster risk reduction.

6.2 Objectives

The Task Force on Climate Change Impact and Adaptation (CCIA) will develop a strategic advisory report to provide inputs to the EPU Study and also frame a national strategy for climate change adaptation to enhance adaptive capacity and build resilience, with specific focus on the impacts of 1.5°C global warming in the country. The specific objectives are as follows:

- Taking stock of the expected impacts of 1.5°C global warming to prioritise key sectors and vulnerable populations as well as its linkages to water resources;
- Identifying key priority actions for strengthening climate change adaptation and enhancing integration with disaster risk reduction in Malaysia, using the best available science;
- Leveraging on IWRM, to identify potential innovation in water technology to integrate climate change adaptation and its co-benefits as well as disaster risk reduction.

6.3 Scope of Study

The scope of the Task Force is in line with the TOR for the EPU study. The Task Force is designed to ultimately result in a roadmap for 1.5oC Global Warming to 2040. All activities were completed and the deliverables from the six scopes have resulted in the roadmap. The specific deliverables are as follows:

- Review of Scientific Literature and National Policies (Scope 1): This deliverable is essentially a synthesis of the status of knowledge on climate change impacts and policy analysis, to delineate gaps and recommendations;
- Comparative Analysis (Scope 2): This deliverable document's climate change adaptation strategies and technology related to IWRM and water management in ASEAN, to provide insights on the country's competitive edge for making the country a regional water hub;
- Case study of Selangor River Basin (Scope 3): This deliverable delineates context and basin specific priority actions on climate actions for water security, focusing on surface and groundwater resources;
- Focus group discussions and survey (Scope 4): This deliverable captures a range of perspectives on priorities from multiple stakeholder groups such as experts, the private sector, youths and the community;
- Stakeholder engagement (Scope 5): This deliverable encompasses recommendations that are integrated from multiple sources including peer reviewed literature, national policies, reports and a variety of engagement sessions; organized according to five focus areas of (i) people, (ii) governance, (iii) information, research, development, innovation and commercialisation (RDIC), (iv) finance and (v) infrastructure and technology; and
- Integration of recommendation on climate action (Scope 6): This deliverable constitutes the Roadmap that comprises strategies, programmes and initiatives, activities, etc. for the immediate-term (12th MP), near-term (13th MP), medium-term (14th MP) and long-term (15th MP), which have been selected by the custodian Ministries and agencies.

6.4 Key Findings

The Task Force on Climate Change Impact and Adaptation (CCIA) met on a monthly basis to discuss the plan of work based on the scope of the study as specified in the Terms of Reference. They also reviewed preliminary findings to provide guidance to the researchers. A total of 18 Task Force meetings were held during the study. A peer-review community was also established comprising researchers who met between Task Force meetings, to review findings of the assessment of the scientific literature and policies as well as content analysis and survey results.

6.4.1 Review of Scientific Literature and Policies (Scope 1)

A peer-review community was established comprising researchers, who met between Task Force meetings, to review findings of the assessment of the scientific literature and policies as well as content analysis and survey results. A total of 36 informal peer-review sessions were held during the study. The assessment of the peer reviewed scientific literature was conducted to get an insight on the expected impacts of 1.5ºC global warming in Malaysia. The approach taken allows for better understanding of the causal factors that impact the water sector as well as the interactions of the sector to food security and agriculture, coastlines, forests and biodiversity, public health, and the built environment. In assessing the scientific literature, the focus has been to conduct a systematic analysis of observation and projection of impacts as well as selected adaptation options in key thematic areas. A total of 63 national policies, including action plans, master plans, blueprints and frameworks were reviewed, and of these, 43 were found to have measures related to climate change (Figure 3.1.6.1). The review of national policies was conducted to obtain an insight into actions taken to strengthen climate change adaptation in the country.

Policy	CCM	Climate Change Impacts and Adaptation											
		CM	DR	Sw	Gw	FS	Ag	CP	FB	If	Hw	SE	Gv
National Policy on Climate Change (KASA, 2009)	10	2	6	4	4	4	5	3	7	6	4	4	15
National Water Resources Policy (KASA, 2012)	-	-	16	2	2	-	-	-	-	1	-	4	23
National Green Technology Policy (KASA, 2009)	1	-	-	-	-	-	-	-	-	2	-	1	1
National Action Plan for Peatlands (KeTSA, 2011)	3	-	7	1	-	-	5	-	7	-	-	1	14
National Agrofood Policy (MAFI, 2011-2020)	-	-	-	-	1	7	7	-	1	-	-	-	-
Second National Policy on Urbanization (KPKT, 2016 – 2025)	11	-	5	-	-	-	-	-	-	7	1	-	3
National Policy on Rural Development (KPLB, 2030)	1	-	1	-	-	1	6	-	6	-	-	2	-
Green Technology Master Plan (KASA, 2017 – 2030)	3	-	3	2	2	1	5	-	2	1	1	1	3
National Policy on the Environment (KASA, 2002)	4	-	2	-	1	-	1	1	4	-	1	1	14
National Renewable Energy Policy & Action Plan (KASA, 2010)	5	-	-	-	-	-	-	-	-	-	-	-	-
National Energy Efficiency Action Plan (KASA, 2015)	5	-	-	-	-	-	-	-	-	1	-	-	-
National Transport Policy (MOT, 2019 – 2030)	3	-	-	-	-	-	-	-	-	-	-	-	-
National Policy on Science, Technology & Innovation (MOSTI, 2013 – 2020)	1	-	-	1	1	1	1	-	1	1	1	-	-
National Policy on Biological Diversity (KeTSA, 2016 – 2025)	5	-	1	-	-	-	7	-	5	-	-	-	23
National Ecotourism Plan (MOTAC, 2016 – 2025)	2	-	-	-	-	-	-	1	1	1	-	-	1
National Plan of Action for Nutrition of Malaysia III (MOH, 2016 – 2025)	-	-	1	-	-	-	-	-	-	-	-	1	-
Malaysian National Environmental Health Action Plan 2013 (MOH, 2013)	-	-	-	-	-	-	-	-	-	-	8	-	4
National Policy on Solid Waste Management (KPKT, 2016)	-	-	-	-	-	-	-	-	-	-	-	-	5
National Community Policy (KPKT, 2019)	-	-	-	-	-	-	-	-	-	-	1	-	-
Shared Prosperity Vision (MEA, 2030)	2	-	-	-	-	-	-	-	-	1	-	-	-
National Cleanliness Policy (KPKT, 2019)	-	-	-	-	-	-	-	-	-	-	1	-	13
Communications and Multimedia Blueprint (KKMM, 2018 – 2025)	-	-	1	-	-	1	1	-	-	1	1	-	-
Malaysia Shipping Master Plan (MOT, 2017 – 2022)	1	-	-	-	-	-	-	-	-	-	-	-	-
National Forestry Policy (JPSM, 1978) (Revised 1992)	-	-	1	-	-	-	-	-	11	-	-	-	-
Pelan Strategik Jabatan Hutan Sarawak (Forest Department Sarawak, 2015 – 2020)	-	-	-	-	-	-	-	-	5	-	-	-	-
Sabah Forestry Policy (Sabah Forestry Department, 2018)	-	-	-	-	-	-	-	-	14	-	-	-	2
National Education Policy (MOE, 2017)	-	-	7	-	-	-	-	-	-	-	-	-	-
The National Biofuel Policy (MPIC, 2006)	1	-	-	-	-	-	-	-	-	-	-	-	-
National Physical Plan-3 (KPKT, 2016)	10	1	7	6	1	2	5	2	3	9	-	-	-
The National Physical Plan for Coastal Zone Areas (KPKT, 2012)	1	-	2	-	-	-	1	5	1	-	-	-	-
Central Forest Spine (CFS): The Master Plan for Ecological Linkages (KPKT, 2010)	-	-	-	-	-	-	-	-	10	-	-	-	-
National Policy on Science, Technology and Innovation (MOSTI, 2021 – 2030)	1	-	-	-	-	-	1	-	-	-	2	-	-
National Timber Industry Policy (MPIC, 2009 – 2020)	1	-	-	-	-	-	-	-	2	-	-	-	1
National Biotechnology Policy (MOSTI, 2005)	-	-	-	-	-	-	1	-	-	-	-	-	-
National Space Policy (MOSTI, 2030)	-	-	3	-	-	-	1	-	-	-	-	-	-
National Automotive Policy (MITI, 2020)	1	-	-	-	-	-	-	-	-	-	-	-	-
Dasar Perhutanan Malaysia (KeTSA, 2021)	1	-	2	2	-	-	-	-	41	-	-	10	8
Malaysia Smart City Framework (KPKT, 2018)	14	-	7	2	2	3	3	-	-	-	-	-	2
National Standards for Drinking Water Quality (MOH, 2000) (Revised 2004)	-	-	-	4	-	-	-	-	-	-	4	-	6
Public Sector Open Data Initiative (MAMPU, 2014)	1	-	-	-	-	1	2	-	1	-	-	-	-
Low Carbon Cities Framework (KASA, 2011)	35	-	2	1	-	-	-	-	3	29	-	-	-
National Low Carbon Cities Masterplan (KASA, 2021)	23	-	-	-	-	-	1	-	1	4	-	-	19
National Security Policy (MKN, 2021-2025)	-	-	5	3	-	1	1	-	-	-	4	1	-

Number of Measures (Strategies, Actions and Initiatives) on climate change in National Policies:
CCM: Climate Change Mitigation; CM: Climate Modelling (Climate Factors/Projection); DR: Disaster Risk Reduction (Impact Drivers); Sw: Surface Water Security; Gw: Groundwater Security; FS: Food Security; Ag: Agriculture; CP: Coastal Protection; FB: Forests & Biodiversity; If: Infrastructure; Hw: Health & Wellbeing; SE: Socio-economic; and Gv: Governance

Very High Coverage, > 20 measures
High Coverage, 10-20 measures
Medium Coverage, 5-10 measures
Low Coverage, < 5 measures
No Coverage

Figure 3.1.6.1. An overview of coverage on climate actions in 43 national policies of Malaysia

Drawing from the review of scientific literature and policies to fulfil scope 1, an overall framework for climate change adaptation is required in the country, which could be developed in conjunction with local stakeholder inputs and scientists and practitioners from multiple disciplines and sectors. A step-wise adaptation approach could be implemented at the river basin and local scales, with IWRM as a vehicle to promote climate change adaptation. Measures need to be identified to strengthen disaster risk governance, upgrade disaster related decision-making systems, build capacity, promote strategic investment in climate proofing infrastructure and assets, mainstreaming groundwater usage and promote nature-based solutions, among others. In this regard, a National Policy on Disaster Risk Reduction that gives priority to preparing the country for the impacts 1.5°C global warming is critical. The National Policy should also take into account the impacts associated with all the probable range of global warming.

Whole lifecycle monitoring of pollutants is needed for more efficient management of industrial and municipal waste. The existing master plan for wastewater treatment plants and policies could be further improved for more sustainable water resource management. Proper and thorough clean-up of contaminated sites such as ex-mining areas and ageing landfill would be necessary to avert adverse effects in the future. The identification of emerging non-point sources of soil pollution such as agricultural land is also important. This is to prevent pollutant mobilisation by floodwaters due to climate extremes, contaminating surface water resources, and subsequently groundwater aquifers.

In addition to delineating climate resilient groundwater resources, a key solution to handle emerging issues is transitioning groundwater management to groundwater governance, which stresses the participation of multilevel stakeholders. Water resources governance involves coordination of a range of stakeholders including political, social, economic, environmental and institutional actors in managing surface water resources and aquifers for providing water supply and transboundary related issues. This approach

involves scientists, policy makers, industry players and end-users by considering each of their concerns on the freshwater supply. It contributes to alleviating the burden of responsibilities the government carries in ensuring the sustainability of groundwater resources.

Resilience has become a key challenge for cities, especially in the face of climate change. Resilient cities have the capacity to adapt and transform in the face of adversity. They can plan for the expected and the unexpected by involving and preparing communities to effectively prevent and respond to current and emerging hazards. The National Low Carbon Cities Master Plan (NLCCMP) should be reviewed to include the component of climate and disaster resilience. Furthermore, there is need for enhanced understanding on the subsurface condition of cities and emerging risks as development proceeds in a changing climate. Resilience building that draws on both surface and subsurface information will ensure that the efforts undertaken by cities to reduce their carbon footprint is complemented by reducing their exposure to disaster risks due to climate extremes.

6.4.2 Comparative Analysis (Scope 2)

The second scope involves content analysis of documents from multi-lateral regional agencies. Approximately 27 relevant sources, 53 potential documents and 82 emerging keywords were used to conduct the analysis. The final analysis relied primarily on documents from ASEAN to get a representative snapshot of the region.

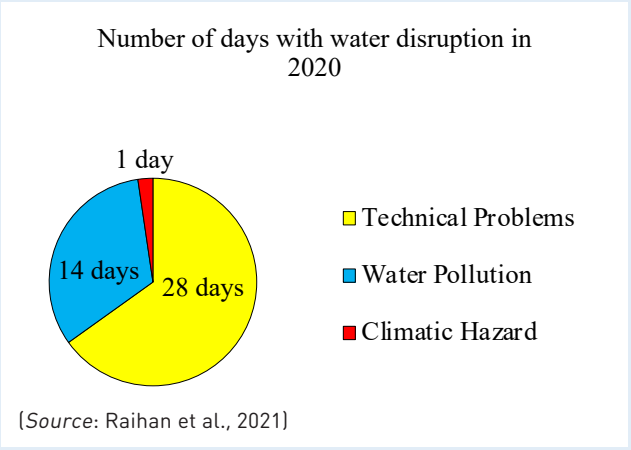
Malaysia appears to have the second highest level of implementing IWRM practices in the region, after Singapore. In terms of implementing water resource management strategies for strengthening disaster risk reduction, Malaysia is among the top three countries in ASEAN, after Singapore and Viet Nam. However, it appears that Malaysia is less advanced in implementing climate change adaptation strategies related to IWRM. The Philippines, Vietnam, Singapore, Thailand and Indonesia are relatively more advanced in this respect. The way forward for the country is to improve communication on existing IWRM practices including strategies and technology, and its linkages to disaster risk reduction. At the same time there is an opportunity to take proactive actions to strengthen climate change adaptation through IWRM by promoting a river basin approach to facilitate achievement of optimal implementation. In this regard, Malaysia could strengthen its participation at the various regional platforms of ASEAN and engage in more technical cooperation. Ministries and agencies that serve as national focal points have a critical role in this context. For example, experts from universities and the private sector could be included as part of the delegation for relevant sessions, to showcase Malaysian technology and sharing of experience.

6.4.4 River Basin Case Studies (Scope 3)

The third scope focuses on river basins to consider the nature of climate change adaptation, which is context and area specific. In order to leverage on the water sector as a potential new economic driver of growth, a river basin approach is required for site-specific prioritization of climate risks. The Selangor River Basin is the primary case study to identify the opportunities and challenges with focus on vulnerable populations, resources, innovative approaches, technology and knowledge gaps. The River Basin was selected because of its important role in supplying water to the Klang Valley, which is the most developed region and important income generator for the nation. Water disruption from the Selangor River is estimated to result in significant losses (Box 3.1.6.1). A cursory review of groundwater was also conducted on the Muda River Basin, given the importance of the area to ensure food security.

BOX 1: COST OF WATER DISRUPTION FROM THE SELANGOR RIVER

Water supply disruption is unsettling to communities and businesses. Based on the collation of reports in the media, the Klang Valley experienced a total of 465 events of water supply disruptions throughout the period of 2005-2020 (Raihan et al., 2021). The causes were due to technical problems, water pollution and small-scale climatic hazard events. The climatic hazards comprise rainfall-induced landslides, floods and dry spell. In 2020, the Klang Valley experienced a total of 43 days of water disruption (top right). The areas that experienced the disruption covered a total of 673 sq. km comprising eight districts. These include parts of Kuala Lumpur and the districts of Petaling, Klang, Hulu Langat, Gombak Kuala Langat, Kuala Selangor and Sepang.

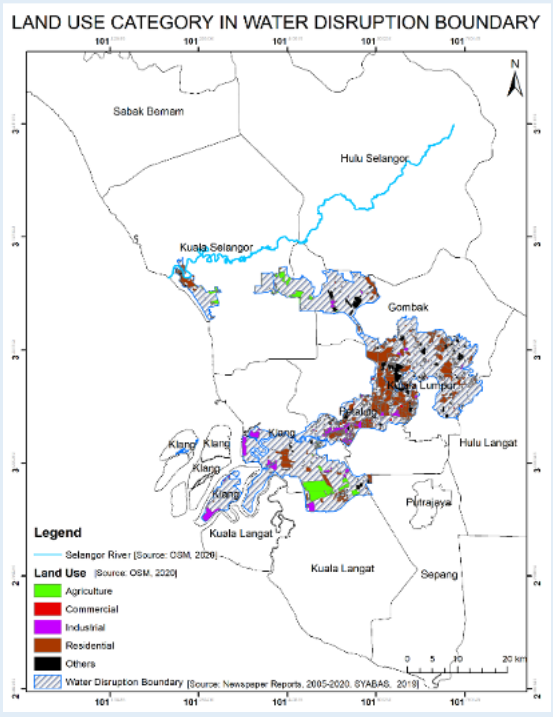


(*Source*: Raihan et al., 2021)

A recent investigation to assess the economic impacts of water supply disruption from Selangor River included evaluating property value at risk due to water disruption and estimating business loss. The property value at risk due to water disruption was based on the methodology from Gawande and Jenkins-Smith (2001). The number, price, and transaction of residential, commercial, and industrial property (stock) were obtained from National Property Information Centre (NAPIC). The business loss estimation was based on a survey conducted between May and June 2021 using the purposive random sampling method (Selelo et al. 2007). The survey involved 117 respondents from small and medium enterprises (SMEs) representing the manufacturing, construction and services sector.

The findings show that the total property value at risk due to water disruption in the Klang Valley is estimated at approximately RM 459,041 million (Raihan et al., 2021). This covers commercial property valued at RM 532 million, residential property valued at RM 414,328 million and industrial property valued RM 44,181 million (Raihan et al., 2021). Agriculture land was not included in the study as it does not receive treated water supply.

About 46% of the respondents involved in the survey reported business loss due to water disruption. In a scenario where all the SMEs were affected by the water disruption in 2020, the total business loss due to water disruption is estimated at about RM 4,464 million (Raihan et al., 2021). In comparison, if only 46% of the SMEs are affected, the loss is estimated at about RM 2,053 million in 2020 alone (Raihan et al., 2021). A major limitation of the survey is the small sample size and low response due to COVID pandemic. However, the investigation does provide some insights on the importance of ensuring undisrupted water supply from the Selangor River.



(*Source*: Raihan et al., 2021)

References:

Gawande, K., & Jenkins-Smith, H. (2001). Nuclear waste transport and residential property values: estimating the effects of perceived risks. Journal of Environmental Economics and Management, 42(2), 207-233.

Raihan, A., Begum, R. A., Pereira, J. J. & Rasiah, R. (2021). Economic impact of water supply disruption from Selangor River, Malaysia (in preparation).

Selelo, L. R., Madigele, P. K., Ntaka, P., & Moetedi, K. (2017). The effects of extended water supply disruptions on the operations of SMEs. Southern African Business Review, 21(1), 480-500.

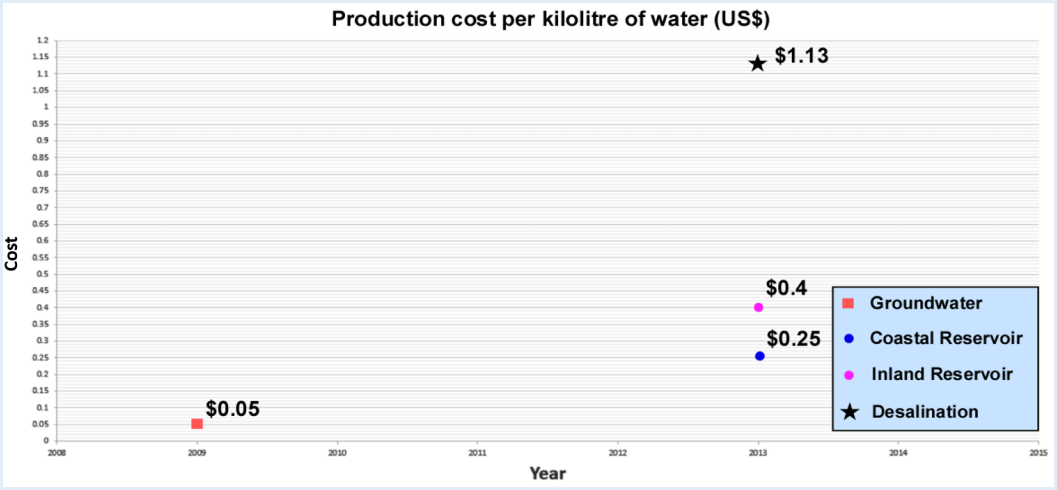
Box 3.1.6.1: Cost of Water Disruption From the Selangor River

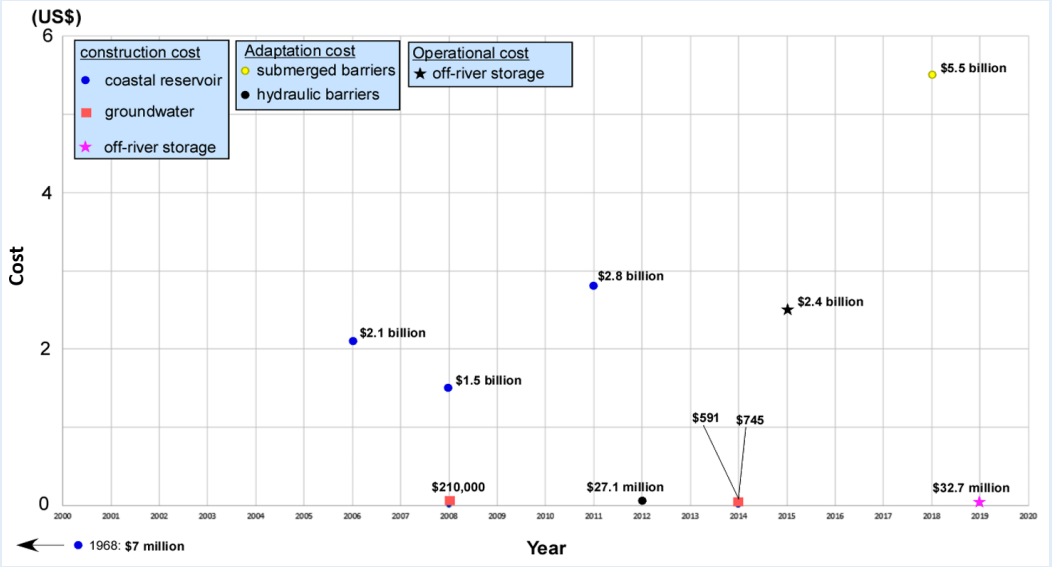
The feasibility of increased groundwater use, by itself or in conjunction with surface water resources needs to be explored. A review of costs associated with groundwater supply indicates that groundwater is by far the cheapest source of water compared to other options (Box 3.1.6.2). Groundwater is especially important within the Selangor River Basin since all available surface water has been fully investigated and utilised, largely for potable water supply. Forest reserves in the Selangor and Muda Rivers Basins must be protected as groundwater recharge zone areas. The impacts of extreme rainfall patterns and saline intrusion need to be identified. In addition, investment such as Managed Aquifer Recharge Storage (MARS) system is required to delineate climate resilient groundwater resources in both these river basins. Overall, groundwater management needs to be improved, including better planning and siting of monitoring wells.

Increasingly, non-conventional use of groundwater resources for climate change adaptation such as Aquifer Thermal storage for heating and cooling (ATES), renewable energy and water (RENEW), CO2 storage and managed artificial recharge and storage (MARS) programme are becoming common (Casanova et al. 2016). Such non-conventional offer climate change mitigation benefits and must be explored for urban water supply as well as in the agricultural, rural, tourism and industrial areas. In addition, a groundwater adaptation plan including critical water level (CWL) monitoring within unconfined aquifers should be developed for immediate implementation.

The investment for better adaptation technology in the country could start with more widespread implementation of a tertiary wastewater treatment plant that could further eliminate nutrient load from the wastewater before being released back to the river may (Muyibi et al., 2008). This should be expanded to address the aspect of contaminated soils to address the threat to future safety and quality of water resources. Technologies to effectively remediate contaminated soils have been widely explored the developed countries, including phytoremediation of soils contaminated with multiple pollutants (Tripathi et al., 2015). In order to perform a more effective appraisal of future risk to pollutant mobilization, more inclusive monitoring information on sources of pollutant is needed, both from the point sources and non-point sources. Such pollutant sources include agricultural inputs, wastewater and sewage and sediment loading to soils, as well as acidification inputs from greenhouse gases that needs further study.

BOX 2: COSTS OF GROUNDWATER SUPPLY COMPARED TO OTHER SOURCES





The cost of producing each kilolitre of water for a desalination plant is by far the highest when compared to an inland reservoir, a coastal reservoir, or groundwater resources (top chart). The cost of desalination is estimated as part of a comprehensive economic evaluation using data from Singapore, Australia, the United States of America, India, and Israel. Groundwater has the lowest production cost (USD0.05/kilolitre), making it nearly five times less expensive than water from a coastal reservoir.

The construction of coastal reservoirs requires a very high investment compared to off-river storage systems or groundwater development (bottom chart). Coastal reservoirs will require further protection from sea level rise which is an additional aspect to be considered. The cost of constructing 1 km of vertical seawall ranges from USD0.4 to USD27.5 million. The rising sea level urges for adaptation measures to combat coastal groundwater salinization, where the aquifers are exposed. The cost of adaptation measures such as submerged and hydraulic barriers to preserve coastal groundwater reservoirs ranges from USD27 million to USD5.5 billion.

Groundwater is the cheapest source of water supply. Climate-resilient groundwater aquifers provide long-term resource availability which are abundant in the tropics. Such groundwater resources must be investigated and further developed in Malaysia. Groundwater resources require financial investment for development, management, protection strategies, and monitoring networks to realise their full potential as a key cost-optimal adaptation option. Non-conventional groundwater extraction can also help to mitigate global climate change by providing clean renewable energy.

** Groundwater development and production inflation rate (2008: 1 USD ~ 3.33 MYR; 2010: 1 USD ~ 3.22 MYR; 2014: 1 USD ~ 60.994 INR). Off-river storage construction and operational cost inflation rate (2015: 1 USD ~ 6.45 CNY; 2019: 1 USD ~ 4.09 MYR). Adaptation cost inflation rate (2012; 1 USD ~ 0.85€)

Source: UK Environment Agency, 2007; Stek, 2008; Air Kelantan, 2009; Linham et al., 2010; Liu et al., 2013; Narayanamoorthy, 2014; Davidsen et al. 2015; Yang, 2018; Selangor Journal, 2019.

Box 3.1.6.2: Cost of Groundwater Supply as Compared to Other Sources

There is a need for improved downscaled climate change models to perform effective catchment projection, as the coupling of these models with hydrological model results in amplified uncertainties. Such coupled models should be used judiciously for decision-making at the river-basin level. Other approaches by using existing and expanded climate services should be explored, particularly for early warning. For example, susceptibility modelling should be further expanded to determine the spatial and temporal status of land, soil and water resources quality. This is critical for identifying risks associated with natural hazard triggered technological accidents (NATECH) involving the releases of hazardous materials. As flood events become more intense and the extent of flood-prone areas expands, there may be an increasing risk of NATECH events, especially in areas that have never been flooded before or when the flood level exceeds current protection. The consideration of climate change impacts of NATECH risk is important and should be taken into account in the integration of disaster risk reduction and climate change adaptation. Translational research projects drawing on a multi-disciplinary framework are imperative for this purpose.

6.4.4 Focus Group Discussions and Surveys (Scope 4)

A total of 9 focus group discussions have been conducted virtually from September 2020 to April 2021 to fulfil Scope 4. The focus group discussions covered stakeholder perspectives on climate actions, climate modelling, the status of the groundwater, ocean and marine biodiversity, emerging public health issues as well as low carbon and disaster resilient cities in Malaysia. The information from the focus group discussions was supplemented with key issues from 12 events organised by other parties, to delineate sector-based priorities with respect to climate change. The events covered were on broader themes such as disaster risks, adaptation planning, resilience building, financing climate action, insurance, health, nature-based solutions in urban planning and food security. While the survey of the private sector by Climate Governance Malaysia (CGM) and youths by the Malaysian Youth Delegation (MYD) provided empirical data on priorities for the water sector. Citizens Assembles were also convened in Langkawi, Sabah and Sarawak to get insights from the communities.

In many of these sessions, the issue of extreme weather was highlighted. Information on hazards and risks of extreme climate events has to be made available to the public. A one-stop open-source database is proposed to support the National Risk Register that is under the custodianship of NADMA. The information could encompass areas that are susceptible to flooding, landslides, coastal inundation, extreme weather events, air pollution levels, diseases, supply chain disruptions, deforestation, and biodiversity loss, amongst others.

Public awareness of IWRM and IRBM and their linkages must be enhanced. The importance of both IWRM and IRBM to address disaster risks and climate change impacts must be transmitted to all stakeholders. Additionally, technological innovation and good practices in climate change adaptation planning, nature-based solutions for coastal protection and water demand management must be disseminated within the country and to the region.

Governance mechanisms should be strengthened to bring the voices of the community to the attention of decision makers at all levels of government, from the district or city levels to state and federal levels. There are many community-specific challenges faced at the local level that is expected to worsen with climate change. Genuine engagement is the pathway to seek sustainable solutions. In this context, a river basin management approach may offer new entry-points for the engagement of multiple stakeholders, including agencies, the private sector, youths, civil society organisations and the community. These stakeholders must be linked to district offices, local authorities as well as state and federal agencies operating at the district level. A river basin platform would also serve to strengthen interagency collaboration, infuse a broader perspective and strengthen existing and proposed programmes to tackle disaster and climate risks and its impacts to the health and well-being of local communities.

6.4.5 Undertake Consultation with Stakeholders and Experts (Scope 5)

The fifth scope covers conducting strategic consultative workshops targeting key stakeholders from multiple levels and sectors with the aim of finalising the proposed strategies and initiatives of the nation's water sector transformation. Several ministries, agencies and civil society organisations (CSOs) were consulted via online sessions for this purpose (Table 3.1.6.1). All the sessions were convened by ASM in

collaboration with selected parties. The topics selected were guided by findings from the previous scopes, primarily the literature and policy review, case study and stakeholder perspectives.

Global warming of 1.5 oC and associated extreme events is expected to worsen water related disasters, including water stress in selected areas and contribute to increased water borne diseases. Transformative actions are required to diversify water supply sources, identify emerging disaster risks and enhance the adaptive capacity of all stakeholders. A preliminary set of key recommendations are grouped into five focus areas of (i) people, (ii) governance, (iii) information, research and development, (iv) finance, and (v) infrastructure and technology as listed below:

6.4.5.1 People

- Enhancing community engagement and capacity in disaster management.
- Empowering people for strengthening adaptive capacity to climate change.
- Strengthening technical capacity within operational agencies at the river basin level.

6.4.5.2 Governance

- Strengthening governance and partnerships at all levels.
- Adopting Integrated Approaches for Climate Adaptation and Disaster Risk Reduction.
- Strengthening regional linkages on disaster risks, climate change and IWRM.

6.4.5.3 Information, Research and Development

- Implementing Evidence-Based and Risk-Informed Actions.
- Enhancing capability for data driven decision-making.
- Assimilating knowledge to improve planning and implementation.

6.4.5.4 Finance

- Investing in disaster risk management.
- Strengthening financial capacity for climate resilience.

6.4.5.5 Infrastructure and Technology

- Enhancing early warning systems and disaster response.
- Developing sustainable infrastructure with cost effective technology.
- Enhancing Disaster Preparedness and Recovery
- Enhancing Conservation Measures as an Adaptation Option for Coastal and Marine Areas.

Table 3.1.6.1. List of participants in stakeholder consultations

Date	Key Agency	Participants & Affiliation
14 Dec 2020	Department of Minerals and Geosciences Malaysia (JMG)	**Strategic consultation on Climate Change and Groundwater** 1. Academician Datuk Fateh Chand FASc (ASM) 2. Mr. Loganathan Ponnambalam FASc (ASM) 3. Dato' Yunus Abd Razak (Past Chair, Board of Geologists) 4. Dato' Zakaria Mohamad (Chair, Board of Geologists) 5. Mr. Nizarulikram bin Abdul Rahim (JMG) 6. Mr. Alvyn Clancey Mickey (JMG) 7. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 8. Dr. Nurfashareena Muhamad (UKM) 9. Dr. Go Wen Ze (ASM) 10. Mr. Navakanesh (ASM) 11. 40 members of GSM and IGM
25 Feb 2021	National Disaster Management Agency (NADMA)	**Strategic consultation on Climate Change Adaptation and Disaster Risk Management** 1. Datuk Dr. Aminuddin bin Hassim (NADMA) 2. Dato' Ir. Sabri bin Abdul Mulok (NADMA) 3. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 4. Assoc. Prof. Dr. Arpah Abu Bakar (UUM) 5. Dr. Nurfashareena Muhamad (UKM) 6. Dr. Go Wen Ze (ASM) 7. Mr. Navakanesh (ASM) 8. 38 professionals working on disaster risk management
10 May 2021	Ministry of Health (MOH)	**Consultative Workshop on Mainstreaming Climate Change in Public Health** 1. Pn. Maniza Mahfuz (EPU) 2. Mr. Loganathan Ponnambalam FASc. (ASM) 3. Datuk Dr. Hishamshah bin Mohd Ibrahim (MOH) 4. Dr. Muna Zahira binti Mohd Yusoff (Planning Division, MOH) 5. Dr. Rohana binti Ismail (Family Health Development Division,MOH) 6. Dr. Roslan bin Mohamad (Engineering Service Division, MOH) 7. Mr. Norhafizan bin Daud (Engineering Service Division, MOH) 8. Puan Dalila Farhana Baharudin (Engineering Service Division, MOH) 9. Puan Bariah binti Bakri (Engineering Service Division, MOH) 10. Dr. Norlen bin Mohamed (Disease Control Division, MOH) 11. Dr. Anis Salwa binti Kamarudin (Disease Control Division, MOH) 12. Dr. Rafiza binti Shaharudin (EHRC, IMR) 13. Dr. Rohaida binti Ismail (EHRC, IMR) 14. Dr. Mohamad Iqbal bin Mazeli (EHRC, IMR) 15. Dr. Rohani Mat Bah (KPPK, KPAS Sarawak) 16. Dr. Sharul Rizan bin Ilias (KPPK, KPAS Perlis) 17. Dr. Rosidah binti Omar (KPPK, KPAS Kedah) 18. Dr. Adliah binti Mohamed Soid (KPPK, KPAS Perak) 19. Dr. Khairunnisa Kharimah bt Shafiee (MO, KPAS Perak) 20. Dr. Suriya Kumareswaran (KPPK, KPAS Johor) 21. Dr. Noor Azurah binti Wan Chik (KPPK, KPAS Pahang) 22. Dr. Norazah Ab Aziz (MO, KPAS Pahang) 23. Dr. Valentine Japule Gantul (KPPK, KPAS Sabah) 24. Dr. Rosnelizaide bin Ramely (KPPK, KPAS WPLabuan) 25. Dr. Gunenthira Rao (KPPK, KPAS Pulau Pinang) 26. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 27. Prof. Dr. Mazrura Sahani (UKM) 28. Assoc. Prof. Dr. Rozita Hod (UKM) 29. Dr. Nurfashareena Muhamad (UKM) 30. Dr. Kwan Soo Chen (UKM) 31. Prof. Dr. Hidayatulfathi Othman (UKM) 32. Assoc. Prof. Dr. Yanti Rosli (UKM) 33. Assoc. Prof. Dr. Norfazilah Ahmad (UKM) 34. Cik Norhafizah Karim (UKM) 35. Dr. Asif Raihan (UKM) 36. Dr. Go Wen Ze (ASM) 37. Mr. Navakanesh (ASM)

Date	Key Agency	Participants & Affiliation
17 May 2021	Department of Minerals and Geosciences Malaysia (JMG)	**Discussion on Groundwater Status for Selangor and Muda River Basins (Preparatory discussion for JMG/KeTSA consultation with ASM on 24 May 2021)** 1. Mr. Loganathan Ponnambalam FASc (ASM) 2. Mr. Alvyn Clancey Mickey (JMG) 3. Mr. Abd Rahim bin Harun (JMG) 4. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 5. Dr. Lim Choun Sian (UKM) 6. Dr. Norsyafina Roslan (UKM) 7. Dr. Go Wen Ze (ASM)
20 May 2021	Disease Control Division, Ministry of Health (MOH)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** 1. Dr. Norlen Mohamed (MOH) 2. Prof. Dr. Mazrura Sahani (UKM) 3. Assoc. Prof. Dr. Rozita Hod (UKM) 4. Dr. Kwan Soo Chen (UKM) 5. Dr. Go Wen Ze (ASM)
21 May 2021	Engineering Service Division, Ministry of Health (MOH)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** 1. Mr. Yahaya Saad (MOH) 2. Mr. Norhafizan Daud (MOH) 3. Dr. Roslan Mohamed (MOH) 4. Pn. Bariah Bakri (MOH) 5. Pn. Dalila Farhana (MOH) 6. Prof. Dr. Mazrura Sahani (UKM) 7. Assoc. Prof. Dr. Rozita Hod (UKM) 8. Dr. Kwan Soo Chen (UKM) 9. Dr. Go Wen Ze (ASM)
24 May 2021	Department of Minerals and Geosciences Malaysia (JMG) & Academy of Sciences (ASM)	**Groundwater Roadmap Consultation** 1. Pn. Maniza Mahfuz (EPU) 2. Mr. Abdul Hadi bin Omar (KASA) 3. Pn. Hanis Huzaira binti Abd Hanan (KASA) 4. Ir. Dr. Salmah Zakaria FASc (ASM) 5. Academician Datuk Fateh Chand FASc (ASM) 6. Mr. Loganathan Ponnambalam FASc (ASM) 7. Mr. Zamri bin Ramli (JMG) 8. Mr. Nizarulikram bin Abdul Rahim (JMG) 9. Pn.Hasnida Zabidi (JMG) 10. Pn. Mazatul Akmar Aros (JMG) 11. Mr. Abd Rahim Harun (JMG) 12. Pn. Asminah binti Rajuli (JMG) 13. Mr. Alvyn Clancey Mickey (JMG) 14. Mr. Roslan Rajali (JMG) 15. Mr. Japri Bujang (JMG) 16. Mr. Jaineh Linggi (JMG) 17. Dr. Roslan bin Mohamed (MOH) 18. Mr. Mohd Aizat bin Aziz (MOH) 19. Ir. Dr. Asmadi bin Ahmad @ Hasan (DID) 20. Mr. Adnan bin Ismail (MYSA) 21. Mr. Mohd Idham Mansor (MYSA) 22. Mr. Ismail bin Tawnie (NAHRIM) 23. Pn. Noor Adibah binti Mohd Dawi (MAFI) 24. Mr. Mohd Adnan Ahmad Fauzi (MAFI) 25. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 26. Dr. Lim Choun Sian (UKM) 27. Dr. Norsyafina Roslan (UKM) 28. Dr. Go Wen Ze (ASM) 29. Cik Nurul Rahimah Abu Bakar (ASM) 30. Mr. Hareehaaran Mathialagan (ASM)
31 May 2021	Planning Division, Ministry of Health (MOH)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** Provided feedback via email 1. Dr. Muna Zahira Mohd Yusoff (MOH) 2. Dr. Asma Ahmad Khalid (MOH)

Date	Key Agency	Participants & Affiliation
31 May 2021	Academy of Sciences Malaysia (ASM)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** 1. Prof. Datuk Dr. Lokman Hakim Sulaiman FASc (ASM) 2. Prof. Dr. Mazrura Sahani (UKM) 3. Assoc. Prof. Dr. Rozita Hod (UKM) 4. Dr. Kwan Soo Chen (UKM) 5. Dr. Go Wen Ze (ASM)
1 June 2021	Institute for Medical Research (IMR)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** 1. Dr. Haji Tahir bin Aris (IMR) 2. Prof. Dr. Mazrura Sahani (UKM) 3. Assoc. Prof. Dr. Rozita Hod (UKM) 4. Dr. Kwan Soo Chen (UKM) 5. Dr. Go Wen Ze (ASM)
10 June 2021	Universiti Kebangsaan Malaysia (UKM)	**Bilateral discussion for WST2040 Draft Roadmap on Climate Change and Public Health** 1. Prof. Dato' Dr. Syed Mohamed Aljunid (UKM) 2. Prof. Dr. Mazrura Sahani (UKM) 3. Assoc. Prof. Dr. Rozita Hod (UKM) 4. Dr. Kwan Soo Chen (UKM) 5. Dr. Go Wen Ze (ASM)
5 July 2021	Ministry of Environment and Water (KASA), Department of Fisheries (DOF), Non-Governmental Organisations (NGOs) and Local Universities	**Multilateral Stakeholder Engagement: Impact of Climate Change on Marine Biodiversity in Malaysia** 1. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 2. Prof. Dato' Dr. Azizan Abu Samah FASc (University of Malaya) 3. Pn. Siti Nooraznie Rahim (KASA) 4. Dr. Cheah Wee (University of Malaya) 5. Prof. Dato' Dr. Nor Aieni Haji Mokhtar (UMT) 6. Prof. Dr. Che Abdul Rahim (UKM) 7. Assoc. Prof. Dr. Lim Po Teen (University of Malaya) 8. Assoc. Prof. Dr. Liew Ju Neng (UKM) 9. Dr. Jilian Ooi Lean Sim (University of Malaya) 10. Dr. Zarinah Waheed (UMS) 11. Dr. Lee Jen Nie (UMT) 12. Dr. Lubna Alam (UKM) 13. Dr. Ahmad Aldrie Amir (UKM) 14. Dr. Abe Woo Sau Pinn (USM) 15. Cik Lim Ai Gaik (DOF) 16. Cik Hemalatha Raja Sekaran (DOF) 17. Mr. Affendi Yang Amri (MSMS) 18. Cik Choo Po Leem (WWF) 19. Cik Evelyn Teh (SAM) 20. Mr. Mohamad Zaid Hamzah (MNS) 21. Dr. Go Wen Ze (ASM) 22. Cik Anna Tutsilawati (University of Malaya)
7 July 20201	National Disaster Management Agency (NADMA)	**Bilateral agency meeting with NADMA** 1. Pn. Che Siti Noor Binti Koh Poh Lee @ Che Mamat (NADMA) 2. Pn. Siti Mariam Binti Abu (NADMA) 3. Pn. Hayatul Husna Binti Kamaruddin (NADMA) 4. Prof. Dr. Joy Jacqueline Pereira FASc 5. Dr. Lim Choun Sian 6. Dr. Nurfashareena Muhamad 7. Mr. Mohd Khairul Zain Bin Hj. Ismail 8. Dr. Go Wen Ze 9. Mr. Navakanesh M Batmanathan

Date	Key Agency	Participants & Affiliation
15 July 2021	National Disaster Management Agency (NADMA)	**Consultation Workshop with NADMA Officers on DRR Policy** 1. Tuan Jamil Derus Bin Ahmad (Timbalan Ketua Pengarah, NADMA) 2. Dato' Ir. Sabri Abdul Mulok (Pengarah Seksyen Mitigasi, NADMA) 3. Pn. Che Siti Noor Binti Koh Poh Lee @ Che Mamat (Ketua Penolong Pengarah Seksyen Mitigasi, NADMA) 4. Pn. Siti Mariam Binti Abu (Penolong Pengarah Kanan Seksyen Mitigasi, NADMA) 5. Pn. Hayatul Husna Binti Kamaruddin (Penolong Pengarah Seksyen Mitigasi, NADMA) 6. Prof. Dr. Joy Jacqueline Pereira FASc (SEADPRI-UKM) 7. Assoc. Prof. Dr. Arpah Abu Bakar (UUM) 8. Dr. Lim Choun Sian (SEADPRI-UKM) 9. Dr. Nurfashareena Muhamad (SEADPRI-UKM) 10. Mr. Mohd Khairul Zain Bin Hj. Ismail (SEADPRI-UKM) 11. Dr. Tariqur Rahman Bhuiyan (SEADPRI-UKM) 12. Cik Nurul Syazwani Yahaya (SEADPRI-UKM) 13. Cik Husna Shaidin (SEADPRI-UKM) 14. Dr. Go Wen Ze (ASM) 15. Mr. Navakanesh M Batmanathan (ASM) 16. Mr. Ahmad Rajiun bin Abu Bakar (Dasar, NADMA) 17. Mr. Adiratna Wira bin Adnan (Teknikal & Infrastruktur, NADMA) 18. Mr. Mohd Abdul Halim bin Sulaiman (BKP-ICT, NADMA) 19. Pn. Munirah binti Zulkaple (Logistik, NADMA) 20. Supt. Amran bin Dolah (Pelaksanan Operasi, NADMA) 21. Pn. Norbazliah Binti Ibrahim (NDCC, NADMA) 22. Datin Nur Daliza binti Dohat (UKK, NADMA) 23. Mr. Muhammad Fauzie bin Ismail (Pembangunan & Komuniti Sosial, NADMA) 24. Kapt. Mohd Izzuddin (SMART) 25. Pn. Murni binti Mat Amin (Penyelarasan Operasi, NADMA) 26. Mr. Mohd Khairi bin Abd. Ghani (Pembangunan & Komuniti Sosial, NADMA) 27. Mejar Shahrul Nizam Jaafar (SMART) 28. Mr. Wan Mohd Fadli bin Ab. Rahman (Dasar, NADMA) 29. Cik Nurul Ain Nabilah binti Azmal (Dasar, NADMA) 30. Mr. Asa'ari bin Zainudin (Teknikal & Infrastruktur, NADMA) 31. Mr. Aiman (BKP-Khidmat Pengurusan, NADMA)
19 July 2021	Department of Minerals and Geosciences Malaysia (JMG)	**CCIA Draft Final Report and Groundwater Roadmap Consultation** 1. Tuan Zamri bin Ramli (JMG) 2. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 3. Pn. Hasnida Zabidi (JMG) 4. Pn. Mazatul Akmar Aros (JMG) 5. Mr. Abd Rahim Harun (JMG) 6. Pn. Asminah binti Rajuli (JMG) 7. Mr. Alvyn Clancey Mickey (JMG) 8. Mr. Ahmad Zamani (JMG) 9. Mr. Wan Neqhaikal Wan Abdul Karim (JMG) 10. Mr. Mohamed Fadzli Rahman (JMG) 11. Mr. Roslan Rajali (JMG) 12. Mr. Japri Bujang (JMG) 13. Mr. Jaineh Linggi (JMG) 14. Dr. Lim Choun Sian (UKM) 15. Dr. Go Wen Ze (ASM) 16. Mr. Navakanesh M Bathmanathan (ASM)
23 July 2021	Academy of Sciences Malaysia (ASM) and Ministry of Energy and Natural Resources (KeTSA)	**Meeting with Dato' Yap and Dr. Elizabeth on CCIA's Draft Final Report (DFR)** 1. Prof. Dr. Joy Jacqueline Pereira FASc (SEADPRI-UKM) 2. Dato' Yap Kok Seng FASc 3. Dr. Elizabeth Philip (KeTSA) 4. Dr. Go Wen Ze (ASM)

Date	Key Agency	Participants & Affiliation
12 August 2021	National Disaster Management Agency (NADMA)	**Bengkel Brainstorming Penyediaan Dasar Pengurangan Risiko Bencana Negara (Dasar DRR) (Federal Level)** 1. Tuan Jamil Derus Bin Ahmad (Timbalan Ketua Pengarah, NADMA) 2. Dato' Ir. Sabri Abdul Mulok (Pengarah Seksyen Mitigasi, NADMA) 3. Pn. Che Siti Noor Binti Koh Poh Lee @ Che Mamat (Ketua Penolong Pengarah Seksyen Mitigasi, NADMA) 4. Pn. Siti Mariam Binti Abu (Penolong Pengarah Kanan Seksyen Mitigasi, NADMA) 5. Pn. Hayatul Husna Binti Kamaruddin (Penolong Pengarah Seksyen Mitigasi, NADMA) 6. Prof. Dr. Joy Jacqueline Pereira FASc (SEADPRI-UKM) 7. Dr. Lim Choun Sian (SEADPRI-UKM) 8. Dr. Nurfashareena Muhamad (SEADPRI-UKM) 9. Mr. Mohd Khairul Zain Bin Hj. Ismail (SEADPRI-UKM) 10. Cik Nurul Syazwani Yahaya (SEADPRI-UKM) 11. Dr. Go Wen Ze (ASM) 12. Mr. Navakanesh M Batmanathan (ASM) 13. Pn. Siti Khadijah Satari (SEADPRI-UKM) 14. Mr. Mohd Khairi bin Abd Ghani (NADMA) 15. Pn. Munirah binti Zulkaple (NADMA) 16. Dr. Adiratna Wira bin Adnan (NADMA) 17. Pn. Murni binti Mat Amin (NADMA) 18. Mr. Asaari bin Zainuddin (NADMA) 19. More than 80 representatives from other agencies, i.e: MOE, MOH, DID, APAM, MGTC, EPU, KASA, NAHRIM, MetMalaysia, JMG, MITI, PLANMalaysia, KPKT, JBPM, SMART, JUPEM, JKP, KeTSA, MOSTI, JKR, RELA, KPDNHEP, DOSH, KPT, Jabatan Kebajikan Masyarakat, Kementerian Dalam Negeri, Kementerian Pertahanan Malaysia, Kementerian Sumber Manusia, Kementerian Luar Negeri dan Tenaga Nasional Berhad.
16 and 19 August 2021	Ministry of Environment and Water (KASA)	**Preparatory Discussion with KASA on the Stakeholder Engagement for WST2040 roadmap** 1. Mr. Ahmad Farid bin Mohamed (KASA) 2. Pn. Siti Nooraznie Rahim (KASA) 3. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 4. Pn. Nor Hidayah Mohammad (KASA) 5. Cik Ezza Sabrina Azmi (KASA) 6. Dr. Go Wen Ze (ASM)
20 August 2021	Malaysian Green Technology and Climate Change Centre (MGTC)	**Follow-up meeting on Low Carbon Cities and Disaster Resilient Cities in Malaysia** 1. Dr. Gary Theseira (MGTC) 2. Mr. Wan Faizal Mohd Anwar (MGTC) 3. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 4. Pn. Komathi Mariyappan (MGTC) 5. Pn. Norhasliza (MGTC) 6. Mr. Raja Aiman (MGTC) 7. Pn. Kiranjeet Kaur (MGTC) 8. Cik Aimi Ayuni Mohamad Sapia (MGTC) 9. Dr. Go Wen Ze (ASM)

Date	Key Agency	Participants & Affiliation
24 August 2021	Ministry of Environment and Water (KASA)	**Bengkel Penetapan Perancangan Bagi Tindakan Adaptasi Perubahan Iklim Bagi 12th MP Hingga 15th MP** 1. Mr. Ahmad Farid bin Mohammed (KASA) 2. Pn. Siti Nooraznie Rahim (KASA) 3. Ir. Dr. Salmah Zakaria FASc (ASM) 4. Prof. Dr. Joy Jacqueline Pereira FASc (UKM/ASM) 5. Mr. Loganathan Ponnambalam FASc (ASM) 6. Datuk Ir. Mohd Adnan Mohd Nor FASc (ASM) 7. Datuk Ir. Abdul Kadir Mohd Din FASc (ASM) 8. Prof. Dr. Mahendhiran Nair FASc (ASM) 9. Pn. Nor Hidayah Mohammad (KASA) 10. Cik Ezza Sabrina Azmi (KASA) 11. Mr. Ahmad Farhan (KASA) 12. Dr. Lim Choun Sian (UKM) 13. Dr. Nurfashareena Muhamad (UKM) 14. Dr. Go Wen Ze (ASM) 15. Mr. Navakanesh M. Bathmanathan (ASM) 16. Mr. Mohd Shahairudin Hairi (ASM) 17. Cik Nurul Rahimah Abu Bakar (ASM) 18. Mr. Hareehaaran Mathialagan (ASM) 19. Mr. Ahmad Ashrin Abdul Jalil (ASM) 20. Cik Siti Nurhayati Kamaruddin (ASM) 21. 80 representatives from other agencies, i.e: DID, RECODA, NAHRIM, CIDB, FRIM, IRDA, DBKL, LGM, JKR, MOE, MPIC, MOH, MPOB, MOSTI, MPB, JMG, JKM, EPU, SEDA, MOTAC, MGTC, KeTSA, KPLB, ECERDC, KPKT, KKR, MOT, MOHE, JAKOA, MARDI, DOF, MYSA, NCER, MIGHT, MetMalaysia, Malaysian Cocoa Board and Jabatan Laut Malaysia.
1 September 2021	National Disaster Management Agency (NADMA)	**Bengkel Penyediaan Dasar Pengurangan Risiko Bencana Negara (Dasar DRR) (State Level)** 1. Tuan Jamil Derus Bin Ahmad (Timbalan Ketua Pengarah, NADMA) 2. Dato' Ir. Sabri Abdul Mulok (Pengarah Seksyen Mitigasi, NADMA) 3. Pn. Che Siti Noor Binti Koh Poh Lee @ Che Mamat (Ketua Penolong Pengarah Seksyen Mitigasi, NADMA) 4. Pn. Siti Mariam Binti Abu (Penolong Pengarah Kanan Seksyen Mitigasi, NADMA) 5. Mr. Ahmad Rajiun bin Abu Bakar (NADMA) 6. Cik Nurul Ain Nabilah binti Azmal (Dasar, NADMA) 7. Prof. Dr. Joy Jacqueline Pereira FASc (SEADPRI-UKM) 8. Dr. Lim Choun Sian (SEADPRI-UKM) 9. Mr. Mohd Khairul Zain Bin Hj. Ismail (SEADPRI-UKM) 10. Pn. Siti Khadijah Satari (SEADPRI-UKM) 11. Cik Nurul Syazwani Yahaya (SEADPRI-UKM) 12. Cik Husna Aini Binti Shaidin (SEADPRI-UKM) 13. Dr. Go Wen Ze (ASM) 14. Mr. Navakanesh M Batmanathan (ASM) 15. Mr. Sandy bin Muhammad Affandi (ECERDC) 16. Pn. Ernnie Syafika binti Omar (SUK Perlis) 17. Pn. Nurul Intan Suraya binti Aminuddin (SUK Pahang) 18. Pn. Shahrinaz Maamor (IRDA) 19. Mr. Abdul Khaliq bin Abdul Hamid (NCIA) 20. Mr. Akmal Farid Rizal bin Noordin (SUK Negeri Sembilan) 21. Mr. Mohd Roshdi Ismail (Kelantan) 22. Mr. Mohd. Firdaus bin Abdul Halim (NCIA) 23. TPr. Saifuddin bin Abdul Karim (Jabatan Ketua Menteri Melaka) 24. Mr. Faisal Rizal bin Hj Mohmmad (BPEN Kedah) 25. Mr. Mohd Azmi Mustafa (SUK Terengganu) 26. Lt Kol (PA) Kamarulsyah bin Muslim (APM Johor) 27. Mr. Mohamad Zahri bin Samingon (SUK Selangor) 28. Mr. Rasis bin Rustam (SUK Johor) 29. Mr. Muhamad Shah Osmin Shah (SUK Selangor) 30. Mr. Noor Azam bin Johari (APM Perak) 31. Mr. Wan Fahazil bin Wan Mohamad Jaffar (UPEN Kelantan) 32. Datu IK Pahon Joyik (Jabatan Ketua Menteri Sarawak) 33. Mr. Mohd Ikram Rahimi (Selangor) 34. Mr. Mohamad Zahri Bin Samingon (TSUK Selangor) 35. Mr. Johan (UP JKM) 36. Pn. Raihani binti Che Mamat (JKT) 37. BKP SUK Melaka

Date	Key Agency	Participants & Affiliation
10 September 2021	Malaysia Meteorology Department (MetMalaysia) and National Water Research Institute of Malaysia (NAHRIM) and Local Universities	**Strategic Consultation Workshop: The State of Knowledge on Climate Modelling** 1. Prof. Joy Jacqueline Pereira FASc (UKM) 2. Dr. Sheeba Nettukandy Chenoli (University of Malaya) 3. Dr. Mohd Fadzil Firdzaus Mohd Nor (University of Malaya) 4. Dr. Go Wen Ze (ASM) 5. Mr. Navakanesh M. Batmanathan (ASM) 6. Puan Siti Khadijah (SEADPRI-UKM) 7. Emeritus Prof. Johnny C. L. Chan (City University of Hong Kong) 8. Prof. Dato' Azizan Abu Samah (University of Malaya) 9. Assoc. Prof. Dr. Liew Ju Neng (UKM) 10. Dr. Tan Mou Leong (USM) 11. Dr. Elizabeth Philip (KeTSA) 12. Dato' Yap Kok Seng (ASM fellow) 13. Mr. Muhammad Firdaus Ammar Abdullah (MetMalaysia) 14. Mr. Hamray Muhammad Yazit (MetMalaysia) 15. Dr. Ahmad Fairudz Jamaluddin (MetMalaysia) 16. Mr. Ambun Dinding (MetMalaysia) 17. Ir. Azman Mat Jusoh (NAHRIM) 18. Mr. Noor Hisham Ab Ghani (NAHRIM) 19. Dr. Tariqur Rahman Bhuiyan (UKM) 20. Dr. Md Azizul Bari (UKM)
17 September 2021	Department of Minerals and Geosciences Malaysia (JMG)	**Discussion on Groundwater Costing and WST2040 roadmap Consultation** 1. Mr. Loganathan Ponnambalam FASc (ASM) 2. Mr. Abd Rahim Harun (JMG) 3. Pn. Asminah binti Rajuli (JMG) 4. Mr. Alvyn Clancey Mickey (JMG) 5. Mr. Ahmad Zamani (JMG) 6. Mr. Mohamed Fadzli Rahman (JMG) 7. Mr. Roslan Rajali (JMG) 8. Mr. Japri Bujang (JMG) 9. Mr. Jaineh Linggi (JMG) 10. Dr. Ferdaus Ahmad (JMG) 11. Dr. Norsyafina Roslan (UKM) 12. Dr. Lim Choun Sian (UKM) 13. Dr. Go Wen Ze (ASM) 14. Mr. Navakanesh M Bathmanathan (ASM)
22 September 2021	Federal Department of Town & Country Planning	**Bilateral discussion with PLANMalaysia for WST2040 roadmap** 1. Prof. Joy Jacqueline Pereira FASc (UKM) 2. Datin Paduka Dr. Halimaton Saadiah Hashim (UKM) 3. TPr. Dr. Chee Ping Ngang (PLANMalaysia) 4. Pn. Nor Zaliza binti Mohd Puzi (PLANMalaysia) 5. Dr. Go Wen Ze (ASM)
23 September 2021	Ministry of Environment and Water (KASA), Department of Irrigation and Drainage (DID) and National Water Research Institute of Malaysia (NAHRIM)	**Bilateral discussion with DID and NAHRIM for WST2040 roadmap** 1. Mr. Ahmad Farid bin Mohammed (KASA) 2. Prof. Dr. Joy Jacqueline Pereira FASc (UKM) 3. Pn. Nor Hidayah Mohammad (KASA) 4. Dr. Go Wen Ze (ASM) 5. Ir. Dr. Asmadi bin Ahmad @ Hasan (DID) 6. Mr. Wan Marhafidz Shah bin Wan Mohd. Omar (DID) 7. Mr. Mohammad Hakim bin Hasnul (DID) 8. Ir. Azman Mat Jusoh (NAHRIM) 9. Ts. Saiful Bahri Hamzah (NAHRIM) 10. Mr. Noor Hisham Ab Ghani (NAHRIM) 11. Dunstan Anthony Pereira (NAHRIM)

6.4.5 Prepare a Roadmap for WST2040 (Scope 6)

The sixth scope is to prepare a complete roadmap for the National Agenda on the WST2040for key ministries and agencies to consider climate change impacts and strengthen adaptation for the water sector. The roadmap was populated according to the five focus areas drawing on findings of the study. Inputs from the assessment of literature and review of policies (Scope 1), regional assessment (Scope 2), case studies (Scope 3) as well as multiple engagement sessions and elicitation techniques (Scope 4) have been integrated, and in consultation with stakeholders (Scope 5), these are expressed as key recommendations. The recommendations served as inputs to strengthen existing programs and identify new initiatives for the immediate-term (12th MP), near-term (13th MP), medium-term (14th MP) and long-term (15th MP). Further consultations were held for this purpose with KASA, NADMA, MOH and JMG/KeTSA, among others.

6.4.6 Immediately Implementable Projects for 12th Malaysia Plan

The immediately implementable projects for 12th Malaysia Plan are presented in Table 3.1.6.2.

Table 3.1.6.2. Immediately implementable projects for 12th Malaysia Plan

Focus Area	Programme/Initiative
People	• Community-based activities, including drills to engage stakeholders in disaster-prone areas across all phases of disaster management. • Capacity building for disaster managers in local authorities and operational agencies for area-specific risk and simulation exercises with multiple partners. • Awareness training and community-based adaptation efforts to engage local communities in vulnerable areas to build climate resilience. • Technical capacity building across relevant sectoral ministries and agencies at all levels for adaptation planning, implementation and reporting. • Competency training and certification for environmental professionals with knowledge of climate and disaster risks. • Community-based adaptation for the water sector in river basins to promote engagement of multiple stakeholders. • Technical capacity building for health professionals on management of climate sensitive diseases and outbreaks during disasters. • Capacity building of trainers and teachers on climate change and sustainable water resources management. • Capacity building for urban planners, supporting staff and related professional bodies in spatial integration of DRR and CCA.
Governance	• National policy on disaster risk management, multi-level disaster resilience plans and legislation on DRR. • Adaptation actions, implementation, monitoring and reporting of climate change adaptation progress at all levels. • CCA centre to strengthen cross-sectoral collaboration between government agencies and all other stakeholders for informed decision-making at all levels. • Land use and spatial planning governance at all levels for integrating climate adaptation and disaster risks. • Guidelines for disaster resilient cities to address climate extremes and integration of low carbon cities, sponge city and smart city for nation-wide adoption. • Smart partnerships and coordination platforms to strengthen the health, disaster and climate nexus. • Partnerships, coordination platforms and framework for integrating climate and disaster risks.
Information & RDIC	• Multi-hazard risk management and vulnerability assessment for extreme events and cascading hazards, high-risk and sensitive areas and communities. • Establish a multi-hazard data centre and risk register platform for efficient information sharing and risk communication through use of ICT. • Streamline land use planning for river basins and administrative boundaries. • Monitoring and assessment of emerging groundwater hazards to improve groundwater management and disaster preparedness. • Weather, climate and geophysical information services for water related hazards such as flood, drought and tsunami. • Climate science and modelling for planning and implementation to support decision-making at the river-basin level. • Climate change impacts on water resources and supply at the river basin scale. • Smart technology for irrigation systems and crop production. • Public health emergency preparedness, climate-disease surveillance and coordination of environmental health data. • Vulnerability, hazards and emerging issues to address the impact of climate change and disasters. • Strategic and emerging issues across terrestrial margins and oceans.

Focus Area	Programme/Initiative
Finance	• Disaster risk financing and social protection. • Mainstreaming disaster risk management in public investment. • Climate resilient and environment-friendly financing and alternative sources of income.
Infrastructure & Technology	• Framework for subsurface geological hazards and early warning for better preparedness of at-risk communities. • Infrastructure and technology for flood and coastal protection. • Health, water, food and energy nexus at the river basin level. • IoT for agriculture and forest sectors to build climate resilience. • Risk reduction and adaption for strategic infrastructure. • Resilient construction guidelines and standards for retrofitting and reconstruction of damaged buildings and infrastructure.

6.4.7 Strategies, targets, KPIs and proposed budgets for 12th MP–15th MP

The strategies, targets, KPIs and proposed budgets for 12th–MP 15th MP are depicted in Table 3.1.6.3 to Table 3.1.6.5.

Table 3.1.6.3. Strategies, targets and KPIs for 12th Malaysia Plan

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
People	Enhancing Community Engagement and Capacity in Disaster Management	Community-based activities including drills to engage stakeholders in disaster-prone areas across all phases of disaster management.	Number of activities including drills conducted.	NADMA	9.00
		Capacity building for disaster managers in local authorities and operational agencies for area-specific risk and simulation exercises with multiple partners.	Number of officers trained.	NADMA	6.00
	Empowering People to Strengthen Adaptive Capacity to Climate Change	Awareness training and community-based adaptation efforts to engage local communities in vulnerable areas to build climate resilience.	Number of CEPA activities being conducted.	KASA	3.00
		Technical capacity building across relevant sectoral Ministries and agencies at all levels for adaptation planning, implementation and reporting.	Number of officers trained.	KASA	3.00
		Competency training and certification for environmental professionals with knowledge of climate and disaster risks.	Achieving and sustaining accreditation of MS ISO/IEC 17025 by 2022.	KASA/MITI	0.37
		Community-based adaptation for the water sector in river basins to promote engagement of multiple stakeholders.	Number of river basin.	KASA	50.00
		Technical capacity building for health professionals on management of climate sensitive diseases and outbreaks during disasters.	Number of officers trained.	MOH	0.21
		Capacity building of trainers and teachers on climate change and sustainable water resources management.	Number of trainers, teachers trained; number of webinars conducted; 100% polytechnic community colleges curriculum embedded green element; Graduate Employability and Employer Satisfaction Index.	MOE/MOHE/ MOSTI/MOHR/ KASA	112.40
	Strengthening Capacity of Operational Agencies at the River Basin Level	Capacity building for urban planners, supporting staff and related professional bodies in spatial integration of DRR and CCA.	Annual training of 10 urban planners from PLANMalaysia; 14 urban planners from PLANMalaysia at State (including Sabah & Sarawak); 10 urban planners form local authorities; 10 urban planners from Malaysian Institute of Planners; and 10 Institute of engineers, institute of landscape architects, institute of surveyors.	PLANMalaysia/ NADMA	4.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Governance	Strengthening Governance and Partnerships at All Levels	National policy on disaster risk management, multi-level disaster resilience plans and legislation on DRR.	Number of policy/plans/legislations.	NADMA	1.00
		Adaptation actions, implementation, monitoring and reporting of climate change adaptation progress at all levels.	NAP and Implementation Plan.	KASA	3.50
		CCA centre to strengthen cross-sectoral collaboration between government agencies and all other stakeholders for informed decision-making at all levels.	One coordinating centre with staff.	KASA	2.00
	Adopting Integrated Approaches for Climate Change Adaptation and Disaster Risk Reduction	Land use and spatial planning governance at all levels for integrating climate adaptation and disaster risks.	One study on governing and financing mechanism.	PLANMalaysia/ NADMA	1.00
		Guidelines for disaster resilient cities to address climate extremes and integration of low carbon cities, sponge city and smart city for nation-wide adoption.	Guidelines, integrated plans; two pilots and five cities and townships per year.	NADMA/KASA/ KPKT	5.00
		Smart partnerships and coordination platforms to strengthen the health, disaster and climate nexus.	Coordination platform for environmental health; DWQA gazetted and enforced.	MOH/KASA	80.47

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Information & RDIC	Implementing Evidence-Based and Risk-Informed Actions	Multi-hazard risk management and vulnerability assessment for extreme events and cascading hazards, high-risk and sensitive areas and communities.	Tsunami risk assessment, NRR for man-made and rapid & slow on-set risk assessments.	NADMA/MOSTI/ KASA/KeTSA	4.50
		Establish a multi-hazard data centre and risk register platform for efficient information sharing and risk communication through use of ICT.	Feasibility and upgrading of NDCC.	NADMA	62.00
		Streamline land use planning for river basins and administrative boundaries.	Two River Basin Land Use Planning and Management Plan; one Coastal Land Use Planning and Management Plan; Land Use Scenario Planning Model and decision support system able to be replicated to other areas with similar characteristics; one local plan in an urban setting; 1 local plan in a rural setting; 1 special area plan in the coastal area; and 1 special area plan in high-density city; 1 special area plan for hilly terrain area.	PLANMalaysia/ NADMA	15.00
		Monitoring and assessment of emerging groundwater hazards to improve groundwater management and disaster preparedness.	National Groundwater Information System (NaGWiS)	NADMA/KeTSA	3.50
	Enhancing Capability for Data Driven Decision-making	Weather, climate and geophysical information services for water related hazards such as flood, drought and tsunami.	Two radar stations for each MP; implementation of cloud computing technology and fulfill the requirements of green technology in ICT.	KASA/NADMA	147.50
		Climate science and modelling for planning and implementation to support decision-making at the river-basin level.	Multiscale global model specifically focusing on the tropics and a semi-hemispheric global model.	KASA/NADMA	62.29
		Climate change impacts on water resources and supply at the river basin scale.	Number of river basin.	KASA/KeTSA/ MAFI/NADMA	120.00
		Smart technology for irrigation systems and crop production.	IoT technology in pepper farming throughout Malaysia; water footprint for 1kg of natural rubber produced.	MPIC/KASA	1.65
		Public health emergency preparedness, climate-disease surveillance and coordination of environmental health data.	New emerging pollutants; DWQI reporting; Environmental Health Information System.	MOH/KASA/ NADMA	17.80
	Assimilating Knowledge to Improve Planning and Implementation	Vulnerability, hazards and emerging issues to address the impact of climate change and disasters.	Five parameters of hydroclimate dataset output; three system/tools output; five technical assessment reports on vulnerability, impact & adaptation assessment (VIA); produced detailed local SLR, coastal sediment transport inundation and flood prone potential across 14 states in Malaysia; numerical modelling assessment on selected coastal and river mouth nationwide; 151 projects approved in Malaysia Grand Challenge (MGC).	KASA/NADMA/ MOH/MOSTI	531.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Finance	Investing in Disaster Risk Management	Disaster risk financing and social protection.	Framework	NADMA	3.00
		Mainstreaming disaster risk management in public investment.	One competition per year; 5 development grant per year; one seminar per year; 10 research grant per year, one joint colloquium per year; one compilation of research per year.	PLANMalaysia/ NADMA/KASA	13.30
	Strengthening Financial Capacity for Climate Resilience	Climate resilient and environment-friendly financing and alternative sources of income.	Feasibility study	KASA	3.00
Infrastructure & Technology	Enhancing Early Warning Systems and Disaster Response	Framework for subsurface geological hazards and early warning for better preparedness of at-risk communities.	Subsurface geology model and inventory; Subsurface DRM Plan and Early Warning System; and Regulations for Subsurface Development for Greater Kuala Lumpur.	NADMA/KeTSA	10.00
	Developing Sustainable Infrastructure with Cost Effective Technology	Infrastructure and technology for flood and coastal protection.	Number of river basin; best solution for flood door; identify national shoreline changes.	KASA/NADMA/ KeTSA/MAFI/ MOSTI	424.00
		Health, water, food and energy nexus at the river basin level.	Coverage of clean water supply for rural area with water treatment system.	MOH/KASA	89.44
		IoT for agriculture and forest sectors to build climate resilience.	Fertigation system; water recycle system; wastewater treatment system; scientific journal and Best Management Practices (BMP) of oil palm on peatland.	MPIC/MOSTI/ KASA	274.00
	Enhancing Disaster Preparedness and Recovery	Resilient construction guidelines and standards for retrofitting and reconstruction of damaged buildings and infrastructure.	MS EN 1998-2, Design of Structure for earthquake resistance.	NADMA	0.35

Table 3.1.6.4. Strategies, targets and KPIs for 13th Malaysia Plan

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
People	Enhancing Community Engagement and Capacity in Disaster Management	Community-based activities including drills to engage stakeholders in disaster-prone areas across all phases of disaster management.	Number of activities including drills conducted.	NADMA	9.00
		Capacity building for disaster managers in local authorities and operational agencies for area-specific risk and simulation exercises with multiple partners.	Number of officers trained.	NADMA	6.00
	Empowering People to Strengthen Adaptive Capacity to Climate Change	Awareness training and community-based adaptation efforts to engage local communities in vulnerable areas to build climate resilience.	Number of CEPA activities conducted.	KASA	5.00
		Technical capacity building across relevant sectoral Ministries and agencies at all levels for adaptation planning, implementation and reporting.	Number of officers trained.	KASA	5.00
		Community-based adaptation for the water sector in river basins to promote engagement of multiple stakeholders.	Number of river basin.	KASA	50.00
		Technical capacity building for health professionals on management of climate sensitive diseases and outbreaks during disasters.	Number of officers trained.	MOH	0.10
		Capacity building of trainers and teachers on climate change and sustainable water resources management.	Number of trainers, teachers trained; number of webinars conducted; one blueprint.	MOE/MOHE/ MOSTI/MOHR/ KASA	8.02
	Strengthening Capacity of Operational Agencies at the River Basin Level	Capacity building for urban planners, supporting staff and related professional bodies in spatial integration of DRR and CCA.	Annual training of 10 urban planners from PLANMalaysia; 14 urban planners from PLANMalaysia at State (including Sabah & Sarawak); 10 urban planners form local authorities; 10 urban planners from Malaysian Institute of Planners; and 10 Institute of engineers, institute of landscape architects, institute of surveyors.	PLANMalaysia/ NADMA	5.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Governance	Strengthening Governance and Partnerships at All Levels	National policy on disaster risk management, multi-level disaster resilience plans and legislation on DRR.	Number of policy/plans/legislations	NADMA	5.00
		Human capital for state and local levels, to further improve the efficiency of disaster response measures.	Number of offices in every state.	NADMA	50.00
		Adaptation actions, implementation, monitoring and reporting of climate change adaptation progress at all levels.	NAP and Implementation Plan.	KASA	10.00
		CCA centre to strengthen cross-sectoral collaboration between government agencies and all other stakeholders for informed decision-making at all levels.	One coordinating centre with staff.	KASA	20.00
	Adopting Integrated Approaches for Climate Change Adaptation and Disaster Risk Reduction	Guidelines for disaster resilient cities to address climate extremes and integration of low carbon cities, sponge city and smart city for nationwide adoption.	Guidelines, integrated plans; two pilots and five cities and townships per year.	NADMA/KASA/ KPKT	10.00
		Smart partnerships and coordination platforms to strengthen the health, disaster and climate nexus.	Coordination platform for environmental health; DWQA gazetted and enforced.	MOH/KASA	77.10
	Strengthening Regional Linkages on Disaster Risks, Climate Change and IWRM	International linkages on disaster management for joint technical programs and simulation exercises.	1 international program per year.	NADMA	2.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Information & RDIC	Implementing Evidence-Based and Risk-Informed Actions	Multi-hazard risk management and vulnerability assessment for extreme events and cascading hazards, high-risk and sensitive areas and communities.	Expansion to local level scale and coverage of more hazards (natural & man-made) for selected pilots.	NADMA/MOSTI/ KASA/KeTSA	15.00
		Establish a multi-hazard data centre and risk register platform for efficient information sharing and risk communication through use of ICT.	Centralised disaster information platform.	NADMA	150.00
		Streamline land use planning for river basins and administrative boundaries.	One local plan in an urban setting; one local plan in a rural setting; one special area plan in the coastal area; and one special area plan in high-density city; one special area plan for hilly terrain area.	PLANMalaysia/ NADMA	2.50
		Monitoring and assessment of emerging groundwater hazards to improve groundwater management and disaster preparedness.	National Groundwater Information System (NaGWiS); National Groundwater Monitoring System (NaGMiS) for groundwater hazards	NADMA/KeTSA	65.00
	Enhancing Capability for Data Driven Decision-making	Weather, climate and geophysical information services for water related hazards such as flood, drought and tsunami.	Two radar stations for each MP; implementation of cloud computing technology and fulfill the requirements of green technology in ICT.	KASA/NADMA	108.00
		Climate science and modelling for planning and implementation to support decision-making at the river-basin level.	Multiscale global model specifically focusing on the tropics and a semi-hemispheric global model.	KASA/NADMA	175.00
		Climate change impacts on water resources and supply at the river basin scale.	Number of river basin.	KASA/KeTSA/ MAFI/NADMA	120.00
		Smart technology for irrigation systems and crop production.	Water footprint for 1kg of natural rubber produced; workshop to introduce new technology packages to pepper growers.	MPIC/KASA	0.17
		Public health emergency preparedness, climate-disease surveillance and coordination of environmental health data.	New emerging pollutants.	MOH/KASA/ NADMA	4.00
	Assimilating Knowledge to Improve Planning and Implementation	Vulnerability, hazards and emerging issues to address the impact of climate change and disasters.	Equipped Malaysian Waters with Physical Oceanographic Sensors; five guidelines, procedures and technical documents; two Subject Matter Expert (SME) in Hydroclimate & two pilot site of nature based solution (NBS) adaptation projects; five technical reports including CCA-DRR frameworks for water related disaster; one Subject Matter Expert (SME) in Hydrodynamic & one SME in Green Technology & Ecosystem-based Approach (EbA); five parameters of hydroclimate dataset output; three system/tools output; five technical assessment reports on vulnerability, impact & adaptation assessment (VIA); produced detailed local SLR, coastal sediment transport inundation and flood prone potential across 14 states in Malaysia; numerical modelling assessment on selected coastal and river mouth nationwide.	KASA/NADMA/ MOH	57.70

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Finance	Investing in Disaster Risk Management	Mainstreaming disaster risk management in public investment.	One competition per year; five development grant per year; one seminar per year; 10 research grant per year, one joint colloquium per year; one compilation of research per year; sufficient fund to rural stakeholders for adoption and implementation of new technologies.	PLANMalaysia/ NADMA/KASA/ MPIC	30.50
Infrastructure & Technology	Enhancing Early Warning Systems and Disaster Response	Framework for subsurface geological hazards and early warning for better preparedness of at-risk communities.	Subsurface geology model and inventory; Subsurface DRM Plan and Early Warning System; and Regulations for Subsurface Development for Greater Kuala Lumpur, Ipoh, Johor Bahru, Penang, Kuching, Kota Kinabalu and all other states capital.	NADMA/KeTSA	35.00
	Developing Sustainable Infrastructure with Cost Effective Technology	Infrastructure and technology for flood and coastal protection.	Number of river basin.	KASA/NADMA/ KeTSA/MAFI	110.00
		Health, water, food and energy nexus at the river basin level.	Coverage of clean water supply for rural area with water treatment system.	MOH/KASA	110.53
		IoT for agriculture and forest sectors to build climate resilience.	Approx. 50 nurseries house at MCB Bagan Datuk, Perak; water recycle system; IoT application on white pepper production in Sarawak (first phase) and Peninsular Malaysia (second phase)	MPIC/KASA	8.20

Table 3.1.6.5. Strategies, Targets and KPIs for 14th Malaysia Plan

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
People	Enhancing Community Engagement and Capacity in Disaster Management	Community-based activities including drills to engage stakeholders in disaster-prone areas across all phases of disaster management.	Number of activities including drills conducted.	NADMA	9.00
		Capacity building for disaster managers in local authorities and operational agencies for area-specific risk and simulation exercises with multiple partners.	Number of officers trained.	NADMA	6.00
	Empowering People to Strengthen Adaptive Capacity to Climate Change	Awareness training and community-based adaptation efforts to engage local communities in vulnerable areas to build climate resilience.	Number of CEPA activities conducted.	KASA	5.00
		Technical capacity building across relevant sectoral Ministries and agencies at all levels for adaptation planning, implementation and reporting.	Number of officers trained.	KASA	5.00
		Community-based adaptation for the water sector in river basins to promote engagement of multiple stakeholders.	Number of river basin.	KASA	50.00
		Capacity building of trainers and teachers on climate change and sustainable water resources management.	Number of trainers, teachers trained; number of webinars conducted.	MOE/MOHE/ MOSTI/MOHR/ KASA	11.08
	Strengthening Capacity of Operational Agencies at the River Basin Level	Capacity building for urban planners, supporting staff and related professional bodies in spatial integration of DRR and CCA.	Annual training of 10 urban planners from PLANMalaysia; 14 urban planners from PLANMalaysia at State (including Sabah & Sarawak); 10 urban planners form local authorities; 10 urban planners from Malaysian Institute of Planners; and 10 Institute of engineers, institute of landscape architects, institute of surveyors.	PLANMalaysia/ NADMA	5.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Governance	Strengthening Governance and Partnerships at All Levels	National policy on disaster risk management, multi-level disaster resilience plans and legislation on DRR.	Number of policy/plans/legislations	NADMA	5.00
		Human capital for state and local levels, to further improve the efficiency of disaster response measures.	Number of offices in every state.	NADMA	100.00
		Adaptation actions, implementation, monitoring and reporting of climate change adaptation progress at all levels.	NAP and Implementation Plan.	KASA	10.00
		CCA centre to strengthen cross-sectoral collaboration between government agencies and all other stakeholders for informed decision-making at all levels.	One coordinating centre with staff.	KASA	10.00
	Adopting Integrated Approaches for Climate Change Adaptation and Disaster Risk Reduction	Guidelines for disaster resilient cities to address climate extremes and integration of low carbon cities, sponge city and smart city for nation-wide adoption.	Guidelines, integrated plans; two pilots and 5 cities and townships per year.	NADMA/KASA/ KPKT	10.00
		Smart partnerships and coordination platforms to strengthen the health, disaster and climate nexus.	Coordination platform for environmental health; DWQA gazetted and enforced.	MOH/KASA	77.00
	Strengthening Regional Linkages on Disaster Risks, Climate Change and IWRM	International linkages on disaster management for joint technical programs and simulation exercises.	One international program per year.	NADMA	2.00

Focus Area	Strategy	Programmes/Initiatives	Targets/KPIs	Lead Authority	Proposed Budget (RM '000,000)
Information & RDIC	Implementing Evidence-Based and Risk-Informed Actions	Multi-hazard risk management and vulnerability assessment for extreme events and cascading hazards, high risk and sensitive areas and communities.	Expansion to local level scale and coverage of more hazards (natural & man-made).	NADMA/MOSTI/ KASA/KeTSA	20.00
		Establish a multi-hazard data centre and risk register platform for efficient information sharing and risk communication through use of ICT.	Maintenance and expansion to state level.	NADMA	50.00
		Monitoring and assessment of emerging groundwater hazards to improve groundwater management and disaster preparedness.	National Groundwater Information System (NaGWiS); National Groundwater Monitoring System (NaGMiS) for groundwater hazards	NADMA/KeTSA	75.00
	Enhancing Capability for Data Driven Decision-making	Weather, climate and geophysical information services for water related hazards such as flood, drought and tsunami.	Two radar stations for each MP; implementation of cloud computing technology and fulfill the requirements of green technology in ICT.	KASA/NADMA	118.00
		Climate change impacts on water resources and supply at the river basin scale.	Number of river basin.	KASA/KeTSA/ MAFI/NADMA	120.00
		Smart technology for irrigation systems and crop production.	Workshop to introduce new technology packages to pepper growers.	MPIC/KASA	0.10
		Public health emergency preparedness, climate-disease surveillance and coordination of environmental health data.	New emerging pollutants.	MOH/KASA/ NADMA	2.00
	Assimilating Knowledge to Improve Planning and Implementation	Vulnerability, hazards and emerging issues to address the impact of climate change and disasters.	Equipped Malaysian Waters with Physical Oceanographic Sensors; five guidelines, procedures and technical documents; two Subject Matter Expert (SME) in Hydroclimate & two pilot site of nature based solution (NBS) adaptation projects; 5 technical reports including CCA-DRR frameworks for water related disaster; one Subject Matter Expert (SME) in Hydrodynamic & one SME in Green Technology & Ecosystem-based Approach (EbA); five parameters of hydroclimate dataset output; three system/tools output; 5 technical assessment reports on vulnerability, impact & adaptation assessment (VIA); produced detailed local SLR, coastal sediment transport inundation and flood prone potential across 14 states in Malaysia; numerical modelling assessment on selected coastal and river mouth nationwide.	KASA/NADMA/ MOH	56.00

CCIA had identified **214 Targets** and **214 KPIs** for the four Malaysia Plans. The details are given in its Final Report (Volume 7).

7.0 ALTERNATIVE WATER FINANCING (AWF)

7.1 Background/Introduction of Sub-Sectoral Study

Malaysia utilises both public and private funding to carry out various water infrastructure projects, including water resources, water supply services, sewerage services and water related risk mitigation. However, various economic sectors are competing for the limited government fund. As a result, it has constrained the planning of water projects, impeded coverage and quality of services.

Water resources and risk mitigation is not an income generation by nature of the project. Besides, water supply and sewerage services are perceived as not bankable as there are inadequate revenue streams to pay back the investment. There is also a mismatch in funding extended life span water infrastructure with short-term borrowing, especially from the private sector.

Toward sustainable future of the whole value chain of water sector, Malaysia must explore opportunity in alternative water financing and creating conducive ecosystem to support alternative water financing agenda.

This study examines the existing funding mechanism across all aspects of the water sector and proposes viable and practical alternative financing mechanisms for its long-term sustainability.

7.2 Objectives of Sub-Sectoral Study

The proposed mechanism covers the whole value chain in the water sector: domestic water supply, (paddy) irrigation, flood mitigation, rural water supply, sewerage and environment (greywater).

The objectives of the study include, but are not limited to, the following:

i) Undertake a comparative study on the funding mechanism in other countries.
ii) Revisit current private financing requirement schemes by various funding agencies locally and internationally.
iii) Assess the challenges/shortcomings of the existing funding mechanism.
iv) Propose an alternative funding mechanism for long-term sustainability.
v) Propose the roadmap for implementation.
vi) Propose the flexibility/amendment to the existing laws/regulations to promote greater private participation in the water sector.

7.3 Study Terms of Reference (TOR)

7.31 TOR Scope 1 (Current Policies Reviewed and Analysed)

The list of of Policies reviewed and with proposals for improvement are shown in Table 3.1.7.1.

Table 3.1.7.1. Policies reviewed

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
1	Water restructuring policy for the water services industry	2007	KASA (SPAN and PAAB)	The restructuring of the water services industry is a public policy intervention from the Federal Government to ensure sustainability in the water supply industry. It began with the amendment to the Federal Constitution in 2005 to place water services – water supply and sewerage services - under the Concurrent List. The policy is currently under the purview of the Ministry of Environment and Water (KASA). The National Water Services Commission (SPAN) was set up in 2007 to regulate the water services industry through a licencing regime. SPAN also developed the Tariff Setting Mechanism (TSM), a tool to standardise the tariff rates fixing with four key components: operating expenditure (OPEX), capital expenditure (CAPEX), regulated profit and environmental levy. Pengurusan Aset Air Bhd (PAAB), a special purpose vehicle, was set up to handle the migration of the State water operators' assets and take over the loan provided by the Federal Government to the States. At the same time, it offers low-cost loans for the operators CAPEX. As of March 2021, ten states have completed the restructuring process. However, most operators are loss-making, and the industry suffers from a high rate of water loss. More importantly, the water tariff is unsustainable for the operators to cover OPEX and CAPEX.	• Promoting alternative financing within migration framework • Implement water and sewerage tariff review to ensure financial sustainability of water industry
2	Suruhanjaya Perkhidmatan Air Negara (SPAN) Act 2006 - Act 654 Water Services Industry Act (WSIA) - Act 655 Water Services Industry Act and Regulations	1 February 2007 1 January 2008 2007	KASA (SPAN)	In 2006, the Federal Government enacted the Water Services Industry Act (Act 655) to regulate the water industry. Among others, the Act spells out the license requirements, the establishment of the Water Industry Fund for water resource conservation and the Sewerage Capital Contribution Funds to implement sewerage projects. It also empowers SPAN to carry out enforcement on offences related to water theft and pollution. Over the years, the law's shortcomings have emerged and required amendments to increase the penalty and strengthen SPAN's role in implementing new policies such as water reclamation and treated effluents and made desludging individual septic tanks every year mandatory.	• Water Services Industry Act (Licensing) (Amendment) 2007 Regulations extends the current license period of three years to a bankable license period up to 10 years. • Water operators can access CAPEX funding resources other than PAAB to develop water supply infrastructure

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
3	PAAB financing under migration framework	The Water Services Industry Act (WSIA 2006) was enacted, and water services industry restructuring took effect with the formation of SPAN and PAAB	KASA (PAAB)	PAAB raises funds from the capital market through the issuance of Government Guaranteed Sukuk to finance water infrastructure for the migrated states. PAAB works based on the 'lease and builds' mechanism – which free water operators from raising funding and lease water infrastructure from PAAB. However, PAAB's readiness to lend, to some extent, has been determined by the ability of water operators to pay lease rentals. The financial condition of most water operators is severely impacted by a low tariff, which in return affects their ability to secure financing from PAAB. Market-based financing has its limitation in providing good support to the industry and is no longer sustainable if the cost of borrowing is determined by the perception of risks and price discovery been dictated by investors. In some cases, inadequate responses from investors could result in Sukuk issuance under subscription.	• Set up a dedicated Water Bank to complement PAAB's role in providing financing for water projects. • Review current procurement policy to allow greater involvement of water operators in project implementation • Migrating PAAB's role from Water Asset Management Company (WAMCo) to Water Holding Company (WAHco)) • Review PAAB's role to include financing for the sewerage sector.
4	Privatisation policy	1985 - Government issued a Guideline on Privatisation 1991 – The government released a Master Plan on Privatisation to clarify the privatisation policy and strategy during the 6th Malaysia Plan	UKAS, EPU and private sector company	Malaysia began to implement a privatisation policy by issuing a Guideline on Privatisation in 1985, which outlined the policy's aim, method of privatisation, and implementation process. In 1991, it released a Master Plan on Privatisation to clarify the privatisation policy and strategy. It launched the Private Finance Initiative (PFI) approach as an alternative procurement tool for the public sector to construct and maintain infrastructures and other facilities under the Ninth Malaysia Plan. The policy is handled by the Public-Private Partnership Unit (UKAS) at the Prime Minister's Department. However, the privatisation record in Malaysia shows that its intended objectives, which were to raise efficiency and improve service, had not been met. Amongst the contributing factors included ineffective regulatory oversight, political interference in the decision-making, conflict of interest arising from the involvement of the government in business etc. The government must reform the institutional framework that emphasised efficiency, transparency and good governance.	• Privatisation plan in water projects ensures greater private sector involvement and minimises the government's risk of crowding out industries whereby the private sector can thrive. • There is a need for greater transparency for land swap projects through the request for proposal (RFP) and open tender to get the best deal • Conduct policy research, including ones that look at the costs and benefits of policy actions to ensure that factual claims and statistical proof back up the government's desired policies. • Develop a straightforward plan to privatise public companies and properties to ensure an increase in private sector involvement and a decrease in the risk of government crowding out of industries where the private sector can thrive. • Provide a platform for complaints. The organisation must have the authority to perform impartial investigations over allegations of impropriety. • The organisation can educate and disseminate information to the general public on project cost feasibility and community benefits. Simultaneously, the general public could provide feedback and input. It will serve as a check and balance mechanism.

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
4	Privatisation policy				• Take steps to improve the government-community relationship. The organisation must meet the broader needs of the economy, and that expressing intentions and objections is an essential part of that mechanism. • Develop guidelines to evaluate all proposals submitted, include: a) credentials and experiences; b) incentives based on agreed KPIs; c) entire risks tied up to the agreed KPIs; d) skilled and experienced workforce in the proposer and they must stay with the proposer for the first five years. • Set clear direction to achieve the intended objectives. Currently, the policy is perceived as to benefit the concessionaires regarding conditions on automatic tariff revision and guaranteed compensation.
5	National Water Resources Policy	Endorsed by Govt on 22 February 2012 and launched in March 2012	KASA (JPS)	The National Water Resources Policy was launched in 2012 to hasten integrated water resources management (IWRM) in Malaysia. It paved the way for federal and state agencies to resolve policy and jurisdictive disparities and update existing water laws, whereby their provisions have become obsolete. The policy does not mention the financing aspect of water resources management. It assumed that the government would finance any project or programme under the NWRP. The policy also provides for the setting up of the National Water Council and the drafting of the Water Resources Bill to harmonise State enactment with the IWRM concept. The Bill serves as the model law to assist state governments in uniforming water resources regulations at the state level. However, the said Bill failed to get the required supports from the State Governments. With the formation of the Ministry of Water, Land and Natural Resources (KATS) in 2018, the existing NWRP was revisited to include water supply and sewerage services covering the whole value chain of water management. The Ministry of Environment and Water (KASA) will continue to formulate the NWRP (now is known as Dasar Air Negara - DAN), and the study is expected to be concluded in 2022	• KASA should present the NWRP as an essential tool in water security and obtain an endorsement from the Council of Rulers on the argument that water, like land, is the state's constitutional right. • KASA to expedite the enactment of a comprehensive DAN that promotes the whole water value chain management covering water source, water supply and sewerage services.

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
6	National Policy on Environment and Environmental Quality Act 1974 (Act 127)	1975	KASA (DOE)	The Environmental Quality Act is enacted in 1974 to protect the natural environment and control various pollution. It also forms the fundamental mechanism to attain the objectives of the environmental policy. The Act is updated constantly to meet the present and future challenges of environmental protection, especially in pollution control. In 2002, the government adopted a National Policy on Environment (NPE) to include a policy structure for promoting a coordinated ecological management strategy.	• Act 127 is constantly reviewed and adaptive to tackle the current and future environmental protection challenges • There are proposals to amend the law for a stricter penalty on polluters and meeting future challenges to be carried out in two phases: Phase 1 – amendments focusing on compound elements, penalties and standards; Phase 2 – substantive amendments to deal with emerging issues in environmental governance. • Integration of sustainable development elements through financial instruments and environmental impact assessment via awareness initiatives • Amendment to EQA to enhance the function of the Department of Environment to combat environmental crime such as pollution. It includes the establishment of the Environment Commission to regulate the environmental sector effectively. • Financial instruments have a more prominent role in promoting sustainable development, including incorporating the polluters pay principle, user fees, and economic evaluation techniques.
7	Green Technology Master Plan (GTMP) 2017-2030	Govt introduced National Green Technology Policy (NGTP) in 2009. GTMP was introduced in Oct 2017	KeTSA	The government introduced the National Green Technology Policy (NGTP) in 2009 to promote green technology to accelerate the national economy and promote sustainable development. It consisted of energy, environment, economy, and social pillars. The policy is implemented by the Malaysian Green Technology and Climate Change Centre (MGTC). The policy outlines strategies and goals for the water sector, but there is still a lot to be done. Subsequently, the government launched the Green Technology Master Plan 2017–2030 (GTMP), which outlines the strategic plans for green technology development to create a low-carbon and resource-efficient economy. GTMP covered five sectors – water, waste, transport, building and energy. Primary water sector-related targets included increasing freshwater abstraction rate from 15% in 2025 to 20% by 2030; reducing NRW from 25% in 2025to 20% in 2030. But the significance of GTMP in driving green growth has not been given actual emphasis post-14th General Election. The Green Technology Financing Scheme (GTFS) offers low-cost financing for green technology projects. The GTFS provides a government guarantee of 60% of the financed amount and a 2% rebate on the interest/profit rate charged by financial institutions annually. Therefore, the sub-sector proposes a water sector-specific GTMP to spur the development of green technology in the sector.	• Review the GTMP & NGTP in line with SDG, Shared Prosperity Vision & WST. • Implement a water-sector specific GTMP to broaden the initiatives on the water sector holistically from source to source by examining the demand and supply chain of the water cycle loop that cuts across the various sectors. • The government to relax conditions to facilitate better and easy access to the GTFS by water sectors. In addition, the size of the GTFS fund is to be increased to provide broader coverage.

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
8	Eleventh Malaysia Plan	2016–2020	Fed Govt, State Govts	The Eleventh Malaysia Plan outlines the water-related strategies and initiatives to improve continuous water supply, expand sewerage services coverage, enhance disaster resilience, etc. The initiatives are ongoing, such as Non-Revenue Water Reduction Programme and water supply coverage expansion. Like in the previous Malaysia Plan, the Federal Government's responsibility is to provide funding to develop water infrastructure. The funding comes in the form of interest-free loans or grants to state governments.	• Continue to implement water-related strategies and initiatives to improve continuous water supply, expand sewerage services coverage, enhance disaster resilience and layer a conducive environment for WST2040 to take place. • The initiatives on NRW reduction and water supply coverage continued. The fragmented governance causing inefficiency in delivery must be streamlined.
9	Regulatory Framework for Cash Waqf Sukuk Issuance i) Capital Markets and Services Act 2007 (Act 671) ii) Guidelines on Sukuk issued by Securities Commission Malaysia iii) Guidelines on Issuance of Corporate Bonds and Sukuk to Retail Investors iv) Guidelines on Unlisted Capital Market Products under the Lodge and Launch Framework	i) 2007, revised in 2012 ii) 2014 iii) 2015 iv) (5th revision, 2019) 2017 (7th revision, 2020)	Securities Commission	The existing Capital Market and Services Act and the relevant *Sukuk* Guidelines outlined the regulatory framework for Sukuk issuance in Malaysia. The possible regulatory challenge to issue Cash Waqf *Sukuk* is that the element of Waqf is not mentioned in the definition of "issuer". And the term "Corporation" that act as issuer must be a commercial entity, but Waqf entity is not established for commercial purposes.	• The existing Capital Market and Services Act 2007 and relevant guidelines on *Sukuk* issuance are sufficient to implement Cash Waqf *Sukuk*. • Act 671 did not factor in the non-profit Waqf entity as the issuer for Sukuk. Nevertheless, the Waqf entity's operation resembles normal commercial corporate whereby it aims to make a profit. The only difference is that the profit is distributed to beneficiaries. • There is a need to have further discussion with the Securities Commission for clarification. Or the Cash Waqf *Sukuk* could be issued by a commercial entity set up expressly to be the issuer.

No.	Policies Reviewed	Effective Date	Ministry Involved	Features	Proposals for Improvement
10	Ecological Fiscal Transfer (EFT)	Introduced in 2019 with an allocation of RM60 million to encourage the State Governments to gazette protected areas as a water catchment area and wildlife protection essential for ecosystem services	Fed Govt (KeTSA) & State Govts	The Federal Government transfers its taxes to the State Governments to encourage the latter to conserve the forest as part of climate change mitigation. It launched the Ecological Fiscal Transfer for Biodiversity Conservation (EFT) in 2019 with an allocation of RM60 million to encourage the State Government to gazette protected areas as a water catchment area and wildlife protection essential for ecosystem services. However, it is unclear what type of financing model would fund the EFT apart from the public fund.	• There is no formal policy to support EFT practice in Malaysia. • KeTSA needs to establish a policy on EFT and develop a workable model to calculate the opportunity cost of conserving the forest and make payment accordingly. In return, the State Governments must implement specific measures to preserve their forests and water catchment areas and allow the Federal Government to monitor their progress. • The Federal Government could develop a financing mechanism to fund the EFT sustainably. • The private sector is also encouraged to play a more significant role in providing funds for forest conservation.

7.3.2 TOR Scope 2 (Comparative strategy analysis/business models with other nations)

The AWF sub-sector studied five countries: Singapore, India, Japan, England and the Netherlands on the financing models used for water projects.

Singapore used public-private partnerships to develop water projects, mainly for knowledge and technology transfers. The Public Utilities Board (PUB) under the Ministry of Sustainability and the Environment (MSE) is responsible for the water supply, water catchment, used water in an integrated way. It uses both internal funding, private investment and government funding for developing water infrastructures. Big and capital extensive infrastructure such as Deep Tunnel Sewerage System (DTSS) was implemented via state-funded financial assistance.

India uses a novel financing model – a hybrid annuity model to develop wastewater projects under the National Mission for Clean Ganga programme.

Japan primarily uses government funding on water projects and the development of innovative technology for the international market.

England and Wales adopt a privatisation model for the water supply and wastewater sectors, with regulation from the economic regulator, the Water Services Regulation Authority (OFWAT), that also conduct price review every five years. Meanwhile, the Department for Environment, Food and Rural Affairs (DEFRA) regulates matters relating to the environment, and the Drinking Water Inspectorate ensures the quality of drinking water.

The Netherlands established a government-owned Water Bank to lend to water projects, and it has **currently** expanded to other sectors.

7.3.3 Scope 3: Study Potential of the Nation's Water Sector Industry

The Water as an Economic Sub-Sectorial Study has completed the write-up on this Scope.

7.3.4 Scope 4: To prepare the framework for the implementation strategy and the water sector transformation initiative for the four phases including proposing the implementing agencies, budget estimates and the main achievement targets based on analyses undertaken as well as expert reviews

The roadmap framework had been prepared by the study team and approved by the Technical Committee at its meeting on 28 October 2020 and by the Steering Committee at its meeting on on 19 November 2020.

7.3.5 TOR Scope 5: (Consultation sessions with stakeholders and experts)

The AWF Sub-Sector had carried out 12 online engagements via online meetings and email correspondences with 26 stakeholders to gather data on water sector financing and accumulate inputs on the proposed alternative water financing mechanisms (Table 3.1.7.2).

Table 3.1.7.2. List of Stakeholders Consulted

Date	Stakeholders	Platform	Purpose of Engagement
11/2/2021	HSBC	Virtually via Google Meet	AWF meeting on alternative financing models in the water sector in Malaysia
09/03/ 2021	• Jabatan Kemajuan Orang Asli Malaysia (JAKOA) • Kementerian Pertanian dan Industri Makanan (MAFI) • Kementerian Tenaga dan Sumber Asli (KeTSA) • Malaysian Water Association (MWA) • Indah Water Konsortium (IWK) • Jabatan Pengairan dan Saliran Malaysia (JPS) • Malaysian Palm Oil Board (MPOB) • Malaysian Palm Oil Association (MPOA) • Kementerian Perusahaan Perladangan dan Komoditi (MPIC) • Muda Agricultural Development Authority (MADA) • Federal Land Development Authority (FELDA) • Jabatan Mineral dan Geosains Malaysia (JMG) • Unit Perancang Ekonomi Negeri (UPEN) Negeri Sembilan • UPEN Melaka • UPEN Sabah • UPEN Sarawak • UPEN Pahang • UPEN Perlis • UPEN Kedah • UPEN Selangor • UPEN Pulau Pinang • UPEN Terengganu • UPEN Perak • UPEN Kelantan • UPEN Johor • DBKL	Google Forms	To obtain data related to water sector financing from the stakeholders
12/3/2021	Bank Negara Malaysia	Virtually via Microsoft Teams	Meeting on WST 2040 AWF study, Cash Waqf Sukuk model and Water Bank.
10/5/2021	Securities Commission	Virtually via Google Meet	To deliberate on the proposed Cash Waqf Sukuk
18/5/2021	• UKAS • MOF • SID • EPU • KPLB • MPIC • KETSA • MAFI • DOA • DOF	Virtually via Google Meet	AWF meeting with Federal Government agencies to get input on financing in the respective agency
3/6/2021	• Bank Pembangunan • KWAP • TH • MARC • PAAB • Air Selangor	Virtually via Zooms	Webinar on Alternative Water Financing
16/8/2021	Unit Kerjasama Awam Swasta (UKAS)	Virtually via Microsoft Teams	Meeting on Alternative Water Financing
22/7/2021	• Bank Pembangunan • PAAB Note: SME1 was the moderator for webinar.	Virtually via Zoom	Webinar on Financing Solutions for Water Infrastructure Projects in Malaysia organised by the Malaysian Water Association (MWA)

Date	Stakeholders	Platform	Purpose of Engagement
23/8/2021	• Agrobank • RHB Investment Berhad	Virtually via Microsoft Teams	Meeting on Alternative Water Financing
Q1 – Q3 2021	• Kementerian Alam Sekitar dan Air (KASA) • Jabatan Pengairan dan Saliran (JPS) • Pengurusan Aset Air Berhad (PAAB) • Indah Water Konsortium (IWK) • Suruhanjaya Perkhidmatan Air Negara (SPAN) • The International Shari'ah Research Academy for Islamic Finance (ISRA)	Via email correspondence	Data collection from agencies

7.3.6 TOR Scope 6: To prepare the complete Roadmap for the National Agenda on Water Sector Transformation 2040 (WST2040 roadmap) for the reference and guide of the various Ministries and Agencies to implement project/programmes and activities towards achieving the aim of transforming the water sector

The roadmap will be included in the AWF Final Report.
In addition to fulifiling the study scope, the sub-sectors were requested to provide listings on immediately implementable projects, targets and KPIs.

7.3.7 Tabulated list of Immediately Implementable Projects for 12th Malaysia Plan

The AWF Study focused on developing and implementing the alternative water financing models in meeting the funding requirements of the water infrastructures across the supply chain. A list of immediately implementable financing models (Table 3.1.7.3) and a timeline to realise the financing models (Table 3.1.7.4) as shown below.

Table 3.1.7.3. Immediately implementable alternative water financing models for 12th Malaysia Plan

Alternative Water Financing Model	Remarks
Wakaf Air	Wakaf Air is launched in December 2020 to fund small scale (below RM50,000) rural water supply and sewerage services projects. Wakaf Air raised contributions from individuals and organisations. As of September 2021, seven projects were implemented with RM266,486 which benefitted at least 2,880 people in six states.
Public Private Partnership: land swap	The Federal Government uses land in exchange for a project. Currently, it is being used in three ongoing wastewater treatment plant upgrading projects.
Performance-Based Contract (PBC)	PBC would be used for NRW reduction projects that can be used with the National NRW Reduction Programme.
Private Financing Initiative (PFI) (BOT/BOOT/Concession)	The improved PFI financing model under SPAN's regulation would be used for water supply, wastewater treatment, and water reclamation projects. It requires an amendment to the Act 654, Act655 and Regulations to extend the licencing period and expand the regulator's purview to reclaimed water.
Public Private Partnership: Hybrid Annuity Model (PPP: HAM)	The PPP: HAM model is a performance-based deferred payment model that could be used for wastewater projects and could be implemented immediately.
Green Climate Fund (GCF)	GCF finances adaptation projects and could be utilised to implement IWRM projects, climate-resilient water, sanitation and hygiene, integrated drought management and integrated flood management projects. KASA is the national designated authority (NDA) to apply for the fund.

Table 3.1.7.4. Roadmap to Implement Alternative Water Financing Models

	12th MP	13th MP	14th MP	15th MP
Alternative Water Financing Models in placed	• Wakaf Air • PPP: land swap	• Wakaf Air • PPP: land swap • PFI: BOT/BOOT/ Concession • PPP: HAM • PBC • GCF	• Wakaf Air • PPP: land swap • PFI: BOT/BOOT/ Concession • PPP: HAM • PBC • GCF • Minimum exposure policy (through education)	• Wakaf Air • PPP: land swap • PFI: BOT/BOOT/ Concession • PPP: HAM • PBC • GCF • Minimum exposure policy (through education) • Cash Waqf Sukuk
Alternative Water Financing Models to be introduced	• PFI (BOT/BOOT • PPP: HAM • PBC • GCF	Minimum exposure policy (through education)	Cash Waqf Sukuk	DFI Water/ Water Bank

7.3.8 Strategies, Targets and KPIs for the Four MPs

Table 3.1.7.3, Table 3.1.7.4, Table 3.1.7.5 and Table 3.1.7.6 show the Strategies, {Proposed KPIs and estimated budgets for the 12th MP – 15th MP.

Table 3.1.7.3. Strategies, proposed KPIs and estimated budget for 12th Malaysia Plan

Main strategy	Initiative	Proposed KPIs	Lead Agency	Budget Estimated (RM billion)
Laying foundation for implementation of Alternative Water Financing • Review of the Current Water Services Industry Reform Initiatives • Strengthening Financial Sustainability of Water Services Providers • Enhancing Innovative Financing for Water Sector • Promoting Disaster Risk Financing	• Implementation of TSM for Water & Sewerage service • Development of new policy on holistic water financing covering public & alternative financing • Amendment of related regulations in Act 655 and other legal, procedural instruments, • Implementation of Wakaf Air, PBC and DFI Financing (NRW), Eco-payment • Disaster risk financing, including utilising Green Climate Fund • New facility license for sewerage • Establish raw water price mechanism	**OPEX Recovery** IWK 90% 7/12 water operators 100% OPEX recovery **Financing Mix** AWF to fund 10% of the total investment required for the 12th MP	KASA, SPAN, UKAS, KPLB, MAFI, MPIC	Total funding RM63.35bil • Public funding RM57.01bil • Alternative financing RM6.34 bil

Table 3.1.7.4. Strategies, proposed KPIs and estimated budget for 13th Malaysia Plan

Main strategy	Initiative	Proposed KPIs	Lead Agency	Budget Estimated (RM billion)
Improving financial capability of the industry and increase access to alternative water financing	Second cycle review of water and sewerage services tariff to support financial capability of operators	**OPEX Recovery** IWK 100% 10/12 water operators 100% **Financing Mix** AWF to fund 20% of the total investment required for the 13th MP	KASA, SPAN, UKAS	**Total funding RM81.66** • Public funding RM65.33 • Alternative financing RM16.33
	Intensify public-private financing project		KASA, UKAS	
	Formation of Water Financing Coordination Taskforce to coordinate the establishment of Cash Waqf *Sukuk*, DFI Water & Water Bank		KASA, PAAB, MOF, Securities Commission (SC), EPU	
	Development concept and implementation roadmap for Cash Waqf *Sukuk*		KASA, PAAB, SC	
	Development of a one-stop platform for facilitating water financing		UKAS, KASA	
	Stakeholder engagement for Cash Waqf *Sukuk*		KASA, PAAB	

Table 3.1.7.5. Strategies, proposed KPIs and estimated budget for 14th Malaysia Plan

Main strategy	Initiative	Proposed KPIs	Lead Agency	Budget Estimated (RM billion)
Widening access and scope of alternative water financing in the water sector	Third cycle review of water and sewerage services tariff to support financial capability of operators	**OPEX Recovery + Full Cost Recovery** IWK 25% Full Cost Recovery 4 water operators 25% Full Cost Recovery eight water operators 100% OPEX Recovery **Financing Mix** AWF to fund 30% of the total investment required for 14th MP	SPAN	**Total funding RM107.73** • Public funding RM75.41 • Alternative financing RM32.32
	Launching of Cash Waqf *Sukuk* to fund 3% water project (RM 3.01 billion)		KASA, PAAB	
	RM27.13 billion from the other alternative financing		KASA	
	Stakeholder buy-in for DFI Water & Water Bank		KASA, PAAB	
	Enhancing implementation of public-private financing project		KASA, UKAS	
	Development concept and implementation roadmap for DFI Water & Water Bank		KASA, PAAB	

Table 3.1.7.6. Strategies, proposed KPIs and estimated budget for 15th Malaysia Plan

Main strategy	Initiative	Proposed KPIs	Lead Agency	Budget Estimated (RM billion)
Strengthening the role of alternative water financing to ensure the sustainability of the water sector	Fourth cycle review of water and sewerage services tariff to support financial capability of operators	**Sewerage industry** IWK achieve 35% Full Cost Recovery (FCR) **Water Industry** Four water operators achieve 35% FCR Three water operators 25% FCR Five water operators 10% FCR **Financing Mix** AWF to fund 40% of the total investment required for the 15th MP	KASA, SPAN	**Total funding RM158.93** • Public funding RM95.36 • Alternative financing RM63.57
	Intensifying Cash Waqf *Sukuk* to Fund 8% water project (RM 12.07 billion)		KASA, PAAB, SC	
	Launching of Water Bank/DFI Water to fund 10% of water projects (RM15.08 billion)		KASA, PAAB	
	RM33.18 billion from other alternative financing models		KASA, PAAB	
	Water Financing Coordination Taskforce monitors the performance of water financing		KASA, SPAN, PAAB, UKAS	

AWF had identified **68 Targets** and **68 KPIs** for the four Malaysia Plans. The details are given in its Final Report (Volume 8).

7.3.9 Conclusion

The Study had reviewed ten policies and drawn lessons from five countries on the financing mechanisms to fund the infrastructures to ensure water security. The Sub-Sector proposed seven financing mechanisms to realise the country's aspiration to transform the water sector into a vibrant economic sector. A mixture of public and private financings and co-operations from the financial institutions are needed to meet the funding requirements of RM411.66 billion over 20 years. A progressive target of increasing the financing from alternative financing at 10% in 2025 to 40% in 2040 could ensure concerted efforts are in place to achieve it. To ensure a full-cost recovery industry, the operators' financial strength will be enhanced from time to time through the implementation of fair, systematic and transparent tariff setting mechanisms for water supply and sewerage services.

8.0 WATER AS AN ECONOMIC SECTOR (WES)

8.1 Introduction

Water is an important commodity for sustaining life and economies across the globe. Emerging water shortages and access to quality water supplies are a major concern for policymakers across the globe. While Malaysia gets abundant rainfall, the water sources are vulnerable to increasingly erratic weather patterns. Coupled with an aged water infrastructure and under-resourced water management system, there has been an increasing trend of water supply shortages and disruptions. These problems of the country's water system have major implications on the health and well-being of citizens and the economic development of local industries. Hence, better management of the water sources of the country will go a long way to ensure water security and economic security of the nation. Importantly, good management of the water supply is critical to ensure the development of a vibrant water industry that becomes a major revenue earner for the nation and a key enabler for ensuring the competitiveness of other sectors of the economy where water is an important input.

8.2 Objectives

This sub-sector study, Water as an Economic Sector (WES), is aimed at transforming the Malaysian water sector into a competitive economic sector with significant contribution to the National GDP and at the same time meeting the needs of the current and future generations. The specific objectives of this study are as follows:

- To examine the economic value of water as a new source of growth for the Malaysian economy.

In this context, we will estimate the economic value of this vital resource as a final product for the domestic and international markets; input for production processes for key economic sectors; and as a source of employment.

- To examine key challenges of transforming the water resources of the nation into a vibrant and valued-adding economic driver for the Malaysian economy.
- To examine key strategies and policies that will transform the water sector into an important source of economic growth as a key revenue generator and enabler for other sectors to move up the global economic value chain (improve productivity and efficiency).

Here, the study will examine global best practices and case studies that will provide valuable insights into the formulation of a vibrant and competitive water sector.

8.3 Report on Findings based on each Scope of the Sub-sectoral Study as required by the (TOR)

8.3.1 TOR Scope 1 - Review of Scientific Literature and Policies[1]

In this section, a detailed review of the current plans and policies (Table 3.1.8.1) of transforming the water sector into a vibrant ecosystem, contributing to the wealth of the country is undertaken. Figure 3.1.8.1 highlights the key policies in these reports that are grouped according to the eight enablers of the 8i water ecosystem framework.

The Malaysian Government recognises the importance of the water industry not only to meet the basic needs of people, but also its' potential role as a major contributor to the economic development of the nation. While the broad goals are mentioned in the NIWRM plan, a clear framework and hard targets and timelines to achieve the objective of transforming the water sector into a vibrant economic sector was not clearly articulated. Comparison of policies against global benchmarks makes it clear that a holistic multisectoral approach with strong stakeholder collaboration is vital for the success of NIWRM and water-related initiatives. In Singapore, water and environmental policy and institutional review is done in tandem due to the intertwined nature of the two resources. Efforts will need to be synchronous, not just across these two aspects, but also in adjacent sectors that both rely on and affect water resources and services. This is the case in Netherlands, whereby water-related policies are reviewed together with a broad range of

1 Please refer to Volume 9 Water as an Economic Sector Sub-Sectoral Final Report for the full list of references

sectors, including energy, agriculture, housing, shipping, nature, and recreation in conjunction with water tasking.

8.3.2 TOR Scope 2 - Comparative Analysis

Figure 3.1.8.2 and Table 3.1.8.2 show the components of a dynamic water ecosystem from benchmark countries. Comparing to that of Malaysia, there is a stronger focus on ensuring the water ecosystem is future ready. This includes continuous infrastructure upgrades and alternative investments to fund these upgrades to prevent a systemic failure of the water supply systems due to long-term neglect. There is also a commitment to thought-leadership and cutting-edge research into water and water-related knowledge, which is then leveraged into market pacesetters and expansions.

Table 3.1.8.1. Review of current policies and proposed improvements

No.	Gaps Identified	Policies Reviewed	Ministry Involved	Effective Date	Elaboration	Proposed Improvements
1	Lack in specialized skills and career pathway progression for professions within the water sector.	National Water Resources Policy National Policy on Environment Green Technology Master Plan 2017-2030	Ministry of Natural Resources and Environment Ministry of Science, Technology, and the Environment Ministry of Energy, Green Technology and Water	March 2012 October 2002 October 2017	Under the Economic Transformation Program (ETP), it is projected that Malaysia will require 2.5 times increase in TVET enrolment by 2025. However, the National Education Blueprint 2015 – 2025 highlights an undersupply of TVET workers in 10 of the 12 National Key Economic Area (NKEA) sectors. This is because TVET is perceived as a less attractive pathway than university education, therefore limiting the number of students who enrol in such programs, especially high performing students. To increase the attractiveness of water and wastewater-related professions, one of the crucial steps is to provide an appealing and defined skill and career pathway progression. In the National Water Resource Policy, PTS65 (p. 47) states the importance of formulating education, training, and research program with local institutions of higher learning, training, and NGOs. However, while the aforementioned strategy emphasizes on defining skills progression in water-related courses, establishing a clear career pathway will better help define the necessary skills at each career node.	Perform a technology scanning of global water technologies to identify the current and future skills needs of the water sector workforce. Establish clear and attractive skills progression and career pathways for the water sector. These pathways should be deliberated and designed in collaboration between stakeholders (i.e., public, private, industry association, academia, society) to ensure they meet the needs of the industry and are recognized for tertiary education progression.
2	Water education and awareness programs have been centred on the adult population. There is little emphasis on nurturing sustainability, environmental protection, and water awareness in early education.	Malaysian Education Blueprint 2013 – 2025 National Water Resources Policy	Ministry of Education Ministry of Natural Resources and Environment	2013 March 2012	The Malaysian Education Blueprint 2013–2025 are on the right track in emphasizing the importance of strengthening STEM education (Thrust) and imparting important values in the current curriculum. Similarly, the National Water Resources Policy highlights the need to improve understanding and awareness of water security and sustainability. However, upon careful examination of the current curriculum, the values highlighted do not include sustainability, environmental protection, and water awareness. Further, awareness building described in the National Water Resources Policy is focused on the adult population and not on creating a water-sensitive younger generation. Coupling the two strategies while simultaneously including sustainability into formal curricular would greatly improve water awareness and appreciation among the younger generation on the value of water resources in the country.	• Formalizing water, sustainability, and environmental protection, as well as the incorporation of the Circular Economy Framework that embeds the 8Rs of water philosophy (Respect water; Rethink the value of water; Reduce wastage; Re-Use used water; Recharge ground water (rain harvesting); Recycle wastewater, Repurpose water for higher value use; and Regenerate water) at all levels of education (i.e., primary through tertiary). Collaboration with water and wastewater sector players in designing fun and attractive education and "citizen science" programs to increase the interest among the younger generation in STEM and the water sector.

3	IWRM remains specific to water-related sectors and policies, and not cross-cutting economic sectors that rely and affect water resources.	National Timber Industry Policy National Biofuel Policy 2006 National Tourism Policy 2020 - 2030 National Agro Food Policy	Ministry of Plantation Industries and Commodities Ministry of Plantation Industries and Commodities Ministry of Tourism, Arts and Culture Ministry of Agriculture and Food Industries	February 2009 March 2006 December 2020 September 2011	Water's ubiquity in all economic sectors makes it imperative that water resources are not viewed in isolation, but rather in tandem and consideration of both economic growth and environmental protection. Based on this notion, water-related policies, especially the National Integrated Water Resources Management Plan and IWRM Framework should be integrated in policy design across all ministries and portfolios. However, water resources management is rarely discussed or defined in economic sector policies, especially sectors closely intertwined with water, such as the National Timber Industry Policy, National Biofuel Policy 2006, National Tourism Policy 2020 – 2030, and National Argo Food Policy.	Use a Whole-of-Government approach to integrate IWRM and environmental management in policies, state/federal planning, and national plans. This ensures water resource management is a facet of all forms of future development. Specific attention should be given to strengthening the water-energy-food nexus to ensure water and economic security. A stronger nexus will create economic multiplier effect, thus increasing demand for higher quality water services.
4	There is no formal platform for "collaborative governance" that allows multi-stakeholder participation and consultation on policy design and decision making.	National Water Resources Policy National Policy on Environment	Ministry of Natural Resources and Environment Ministry of Science, Technology, and the Environment	March 2012 October 2002	As mentioned in the National Resources Water Policy, a collaborative governance (i.e., stakeholder inclusiveness and collaboration) enables the capitalisation of expertise of different stakeholders. This is especially crucial on a resource as important as water. Even though both policies have highlighted different aspects for the inclusion of multi-stakeholder collaboration and possible channels of communication, it would be beneficial to clearly define the platforms and the rules of engagement and the extent of academia, industry and society's role and level of participation in not just the implementation of policy decisions; but also, the design and decision-making process. Water resources and the environment are nuanced areas that affect different stakeholders differently;hence, gathering multi-stakeholder perspective and input in government decisions will help create both a holistic policy as well as gain the Rakyat's trust, acceptance, and participation.	Establish a formal platform that allows "collaborative governance" between multiple jurisdiction and stakeholders (federal, state, and local government). This "collaborative governance" should also include "citizen participation" - input of all stakeholders to create business and consumer friendly water and environmental policies, legislation, and regulations (top-down and bottom-up approach).

5	Strategies and implementing bodies are described but there is no designated central entity or agency tasked with monitoring, implementation, and high-level coordination between stakeholders.	National Water Resources Policy National Policy on Climate Change	Ministry of Natural Resources and Environment Ministry of Natural Resources and Environment	March 2012 November 2009	In the National Water Resources Policy (p. 44), strategy 23 elucidated the need to identify stakeholders and clarify roles, as well as respective responsibilities, and PTS51 detailed the importance of identifying and profiling roles for shared responsibilities and collaborations. This strategy provides a good starting point in effort to monitor and coordinate water initiatives between the different stakeholders. Similarly, in the National Policy on climate change (p. 7), ST8-P4 stated the need to improve collaboration through efficient communication and coordination amongst all stakeholders for effective implementation of climate change responses, and KA24-ST6 (p. 15) discussed the importance of stocktaking of current measures. Both these policies have discussed the importance of collaboration, shared responsibilities, and coordination. However, these policies do not clearly articulate effect coordination and implementation of the policies. This leads to overlapping responsibilities, duplication of resources and increase bureaucratic processes. All of which results in the IWRM being not effectively implemented.	Establish the National Water Sector Transformation Task Force, tasked with the monitoring and coordination of agencies and stakeholders in the effective implementation of water resources management strategies.
6	Authority and regulation exist only at the higher level (i.e., federal, state). However, water basins may span across state borders, with overlapping and conflicting resource sharing and regulation.	National Water Resources Policy National Physical Plan	Ministry of Natural Resources and Environment Ministry of Housing and Local Government	March 2012 April 2005	Water resources in the country falls under state jurisdiction. However, river basins often exist across multiple state borders, and oftentimes results in disputes over water resources and regulation (e.g., the ongoing water dispute between Kedah and Penang since 2002). The National Water Resources Policy made important emphasis on the need to promote shared responsibility, to cooperate and resolve conflict (p. 45): PTS55 stated the need to identify processes and procedures that can be integrated to ensure shared governance of water resources, and PTS61 highlighted the need to identify platforms for resolution of conflicts and competing interests. In a similar vein, the National Physical Plan have also stated the importance of addressing anticipated water shortage and uneven water distribution through inter-basin and interstate water transfer. These strategies addressed the need to ensure shared governance of water resources. However, they are, arguably, ineffective in addressing issues or conflict arising in relation to water resource allocation and governance between states.	Establish river basin organisation and/or independent regulators whose boundaries are tied to key larger water basins and not to state borders or the Federal Government.

7	Lack of clear accountability and transparency mechanisms for operators and service providers within the water sector related to service quality targets, environmental and sustainability targets, and innovation targets.	National Water Resources Policy National Policy on Environment Green Technology Master Plan 2017 - 2030 National Policy on Climate Change	Ministry of Natural Resources and Environment Ministry of Science, Technology, and the Environment Ministry of Energy, Green Tech and Water Ministry of Natural Resources and Environment	March 2012 October 2002 October 2017 November 2009	There is a lack of discussion on accountable and transparent mechanisms for operators and service providers in water-related policies, such as the National Policy on Environment, the Green Technology Master Plan 2017 –2030, and the National Policy on Climate Change. This is related to having clear guidelines, standards and targets related to service quality, environmental and sustainability, and innovation. In the National Water Resource Policy (p. 28), Strategy 6 outlined the importance of improving and developing measures to determine threshold and yield of water resources and integrity of water resource agencies. To do so, specific action plans were created: PTS10 stated the need to profile methods and measures used to determine threshold and yield, and PTS11 stated the need to develop a system to consolidate information to create national standards and parameters for setting threshold and yield levels for different water resource types and waterbodies. Similarly, PTS12 stated the need to review, revise, and reconcile the present standards to determine integrity and health of water resources. These steps are useful and important as they are the foundational measures towards ensuring accountability (i.e., establishing measuring standards). However, the policy can benefit from more specified procedures or measures to inspect and monitor if the relevant stakeholders adhere to the quality standards and targets sets.	Establish accountability and transparency mechanisms within the water sector, as well as promote the use of smart technologies (greater digital platform adoption with integration of ledger systems e.g., blockchain) for traceability and monitoring. Water operators making publicly accessible financial reports, annual/5-year business plans, service quality targets, environmental and sustainability targets, and innovation targets. Water operators measured based on service quality, environmental targets, national initiative targets, and should be held accountable when targets aren't met. Accountability mechanisms should be made applicable to all relevant stakeholders (contractors, service providers, material suppliers, etc). This ensures that the entire supply chain is transparent to ensure continuous improvement cycles and efficiency and building trust among the end-users. The latter is critical for ensuring sustainable water demand and willingness to pay higher premium for quality water services.
8	There is a lack of formal data sharing, e-governance, and open-data in national policies to enable data-driven water solutions and transparency.	National Water Resources Policy	Ministry of Natural Resources and Environment	March 2012	E-governance and data sharing are mentioned in the National Water Resources Policy: on page 26, PTS7 which stated the need to develop a profile of stakeholders and existing information database. The PTS8 stated the importance of providing mechanisms for sharing of information and access between stakeholders. While these policies are a step in the right direction, effective implementation of these policies will require formal procedures and implementation strategies to facilitate seamless data sharing amongst the multiple stakeholders in the water industry.	Reviewing laws/ legislation on data sharing among government agencies (Official Secrets ACT) and designing policies for greater adoption of the use of smart technologies (digital platforms for delivering government services and e-governance); greater coordination between agencies in data collection and sharing; and open-source government data.

9	Tariff review mechanism is not described in the policies that captures the full cost for providing water services (operations, infrastructure, talent building and innovation).	National Water Resource Policy	Ministry of Natural Resources and Environment	March 2012	Revenue from water charges is important not only to cover operation and maintenance costs, but also to enable continuous investment in advanced water infrastructure to meet the needs of the industry and society. In addition, water pricing is a vital instrument for improving water use efficiency. Therefore, it is important to establish a well-planned water tariff system - one that properly and adequately reflects the costs of infrastructure, human capital, innovation etc. The water tariff review mechanism was not described in the National Water Resources Policy to reflect the full cost of water pricing. PTS39 (p. 40) stated the importance of identifying best practices in the valuation of water resources pricing and cost recovery. However, a comprehensive water tariff mechanism is not in place to accurately capture the full cost of water services across all regions in the country. A lack of a comprehensive water tariff has adversely impacted the quantum and quality of water supply across the country.	Incorporating a tariff review mechanism which includes KPIs that are tied to service quality, customer satisfaction, environmental goals, national target alignment, etc. Optimal tariff rates to ensure financial sustainability and KPI targets incentivize water operators to continuously improve services. In addition, the optimal tariff rates also serve as a demand management strategy for more efficient water consumption and conservation practices. Optimal tariff rates are critical to ensure sustainable supply and demand side management of water resources. Effective management of supply side and demand side of water resources are important drivers for ensuring affordable and competitive water rates, resulting in a profitable water sector.

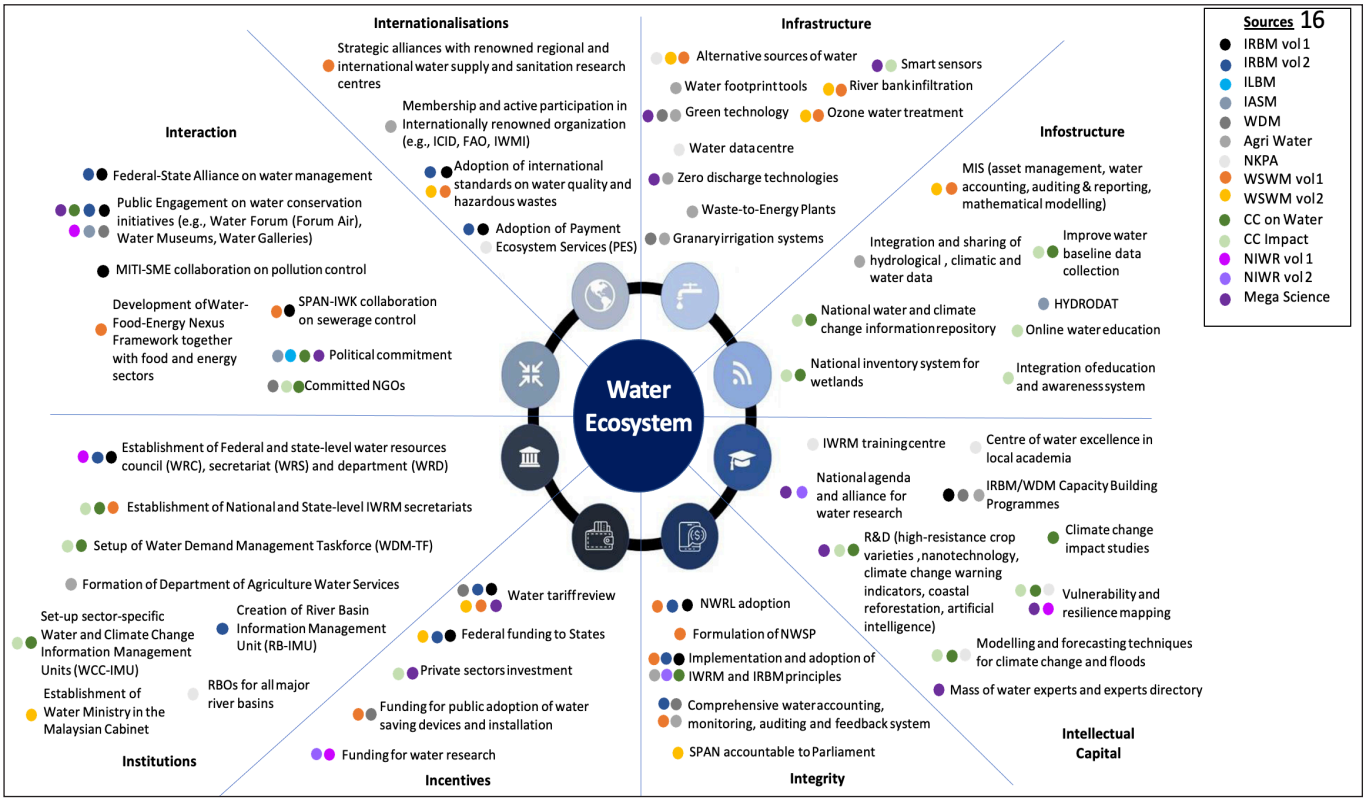


Figure 3.1.8.1. Policy review of the integrated river basin studies and water-related studies in Malaysia

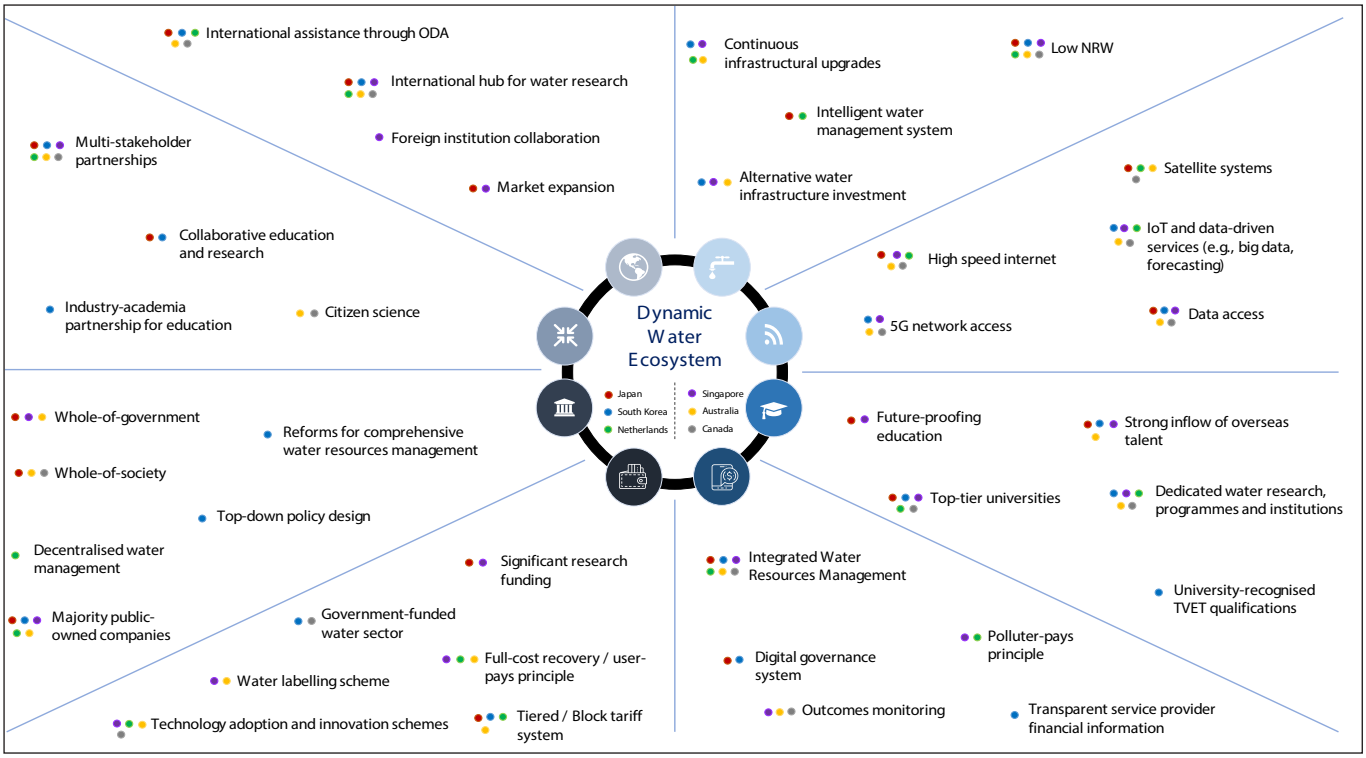


Figure 3.1.8.2. Policy review of benchmark countries' dynamic water ecosystems

Table 3.1.8.2. Policy strategies comparison between Malaysia and benchmark countries[2]

Country	People	Governance	Finance	Information and RDCI	Infrastructure and Technology	Economic Impact
Malaysia	• Weak knowledge sharing culture. • TVET enhancement roles divided among institutions but poor coordination has created silos (Beschel et al., 2018). • Lack of awareness on the 8R water philosophy • Lack of next generation talent in specialized areas with inter- and multi-disciplinary skills set to foster strong nexus between the water sector and other sectors.	• Weak implementation of IWRM due to lack of a strong "Champion with Clout" and low usage of digital governance systems. • Poor cohesion in government policy and weak, patchy and territorial water governance (Lee, 2005). • Institutions operate in silos due to poor coordination. Lack of effective stakeholder involvement in water resource management. • Use of traditional water management systems that is inadequate in addressing water resources in multiple jurisdictions/ states and ensuring seamless flow of information for strategic decision-making.	• Low investment in R&D for water industry. • Tariff rates have not been reviewed regularly incorporating the current costing structures • The current tariff rates are inadequate to cover operational and capital expenditure to meet the increasing needs of society and industry(SPAN, 2017). • Water service provision primarily government funded. Low private sector and FDIs into the water sector.	• Low ICT literacy. • Low adoption of advanced ICT systems in the water industry (Ali, 2019). • Low impact research resulting from high quantity but low impact publications and low technology transfer rate (World Bank, 2020).	• Water infrastructure does not utilise advance technology and cost-effective nature-based technology. • Lack of basic water infrastructure in several rural and island communities. • High NRW due to aging infrastructure and primary use of mild steel (29.1%), asbestos-cement (27.1%) and polyethylene pipes (19.0%) (Jones et al., 2021; MWA, 2018; Rishyakaran, 2016).	• Gaps and weaknesses in the enablers in the ecosystem (in the five focus areas) has resulted in disruptions in the quantum and quality of the water supply. This has had a significant impact on the water and other economic sectors and quality of life. • Inadequate investment in the five enablers to stimulate strong demand side water management (water conservation effort and higher value-added use of water). • Strong government participation leading to 'crowd-out' private sector participation and local innovation in the water sector. • Limited global reach and mostly operating at the low end of the global value chain.

2 Please refer to Volume 9 Water as an Economic Sector Sub-Sectoral Final Report for the full list of references

Country	People	Governance	Finance	Information and RDCI	Infrastructure and Technology	Economic Impact
Japan	Significant investment in next generation talent for the industry.	• Adopts a "Whole-of-Government" and "Whole-of-Society" approach (EPD, 2007). • Incorporated IWRM and **strong digital governance system** (MLIT, n.d.). • Strong internationalisation strategy, dispatching water experts through official development assistance (ODA) (MOFA, 2014) and overseas capacity building (Forbes, 2020). • Government-driven structured **multi-stakeholder partnership** to encourage MNC leadership in R&D (Government of Japan, n.d.; JST, n.d.; Tomas, 2021).	• **Tiered tariff** system at **competitive** rates (JICA, 2017). Balanced mix of GOVERD, BERD and HERD (OECD, 2021), with BERD emphasis on **experimental research**.	• **Smart water management system** enabled by high-speed Internet, satellite systems, and 5G deployment (5G Observatory, 2020; Clark, 2012; Galvin, 2017). • **Competitive national universities** (The Japan Times, 2021). • **MNCs in areas of ICT**, electronics and energy amongst others developing water technologies (e.g., NTT, Hitachi, Fujitsu, Sony) (Fujitsu, 2012; Hitachi, 2021; NTT Communications, 2016; Sony, 2020).	Intelligent water management system and fully upgraded pipes bringing NRW to 10% (Macharia et al., 2021)namely, Current State Extends (CSE.	Japanese companies' market value of water-related fields (i.e., supply, sewage, desalination) at USD2.6 billion (Matsutani, 2018). Collective market value of drinking water systems, drinking water treatment, and sewage treatment at USD12.9 billion (United Nations, 2016).
South Korea	• Policies encouraging STEAM education (Mani & Trines, 2018). • Dedicated water academy and TVET education developed with industry for local and global training programmes (Mani & Trines, 2018). • World-class tertiary institutions and World Class University Project to increase talent inflow (OECD, 2020b; Woolston, 2020).	• IWRM integrated into existing and future Smart City development (i.e., **Smart Water City** project). • Publicly-owned water supply operators and largely private sector wastewater providers (I.-C. Choi et al., 2017; Korea Water and Wastewater Association, 2012). • Government-driven private sector development and participation in research, innovation, and commercialisation of water technologies (Ministry of Environment, 2017). • Stakeholder engagement groups and alliances for research and smart city development (Yi et al., 2018). • International collaboration and provide water expertise through ODA to emerging economies (Ministry of Environment, 2017).	• Government-led and funded large scale water management projects. • Significant GERD by percentage GDP, largely contributed by BERD (OECD, 2021) with emphasis on experimental research. • Block tariff system with moderate rates and primarily government funded financing structure. Use of price signals to adjust consumption behaviour (Danilenko & Bahuguna, 2016; OECD, 2018). • **Polluter-pays** principle.	• Water resource management using smart water network and digital twin simulations (K-Water, 2021; Yi et al., 2018). • 5G coverage and dedicated networks for IoT deployment. • MNCs are leaders in ICT technologies and innovations (e.g., Samsung, LG, SK Group).	Major investments upstream and downstream to **modernise water infrastructure** and systems (i.e., smart water meters, pipe upgrades, automating processes) to achieve NRW of 10.6% (Cheol, 2019; Y. J. Choi et al., 2014; K-Water, 2021; Trade, 2019; Yi et al., 2018).	As of 2018, South Korea's water management industry was worth EUR20.75 billion – of the country's EUR79.76 billion environmental market. Doosan Heavy Industries and Construction holds the largest market share in seawater desalination, at 40% in the USD26.81 billion market (EU Gateway, 2020).

Country	People	Governance	Finance	Information and RDCI	Infrastructure and Technology	Economic Impact
Singapore	• People-private-public approach in public education and community relations (IWA, n.d.). • Water education formalised at all levels education and online professional skills training platforms. • Policies emphasising STEM education and continuous investments in research and innovation (Y. P. Ho et al., 2009; Koh, 2006; Quah, 2018)	• Highly coordinated self-regulated proactive public water agency with extensive portfolio allowing it to tackle water security with a 'whole-system' approach (Jensen & Nair, 2019). • IWRM through holistic cross-sectoral policy framework development and **high-level coordination** between agencies (e.g., land, housing, health) and integration of water security goals in broader range of policies (Tortajada et al., 2013). • Collaboration with foreign firms and universities to establish research centres and accelerator programmes within Singapore (PUB, 2018a). • Government-driven public-private partnerships.	• **Full-cost recovery block** tariff system (PUB, 2017)with polluter-pays principle (PUB, 2018b, 2018c). • Fiscal and non-fiscal incentives and support to drive local and foreign direct investment in research and innovation, as well as support local SMEs' globalisation efforts (PUB, 2018a). • Fiscal and non-fiscal safety nets to encourage private participation in water PPPs (S. Ho, 2015; Jensen, 2017).	• Digitalisation of water resources management and strong public investment in emerging digital technologies (PUB, 2020). • Top universities regionally and globally with water expertise (Dhalla, 2017; Times Higher Education, 2021).	• Continuous upstream and downstream improvements to digitalising water management and infrastructure for disaster management and alternative water sources (i.e., Four National Taps) (PUB, 2016). • 5G deployment and nationwide access to high-speed broadband network.	Water industry employing 14,400 and generating SGD2.5 billion in annual value-add (PUB, 2018a). There are over 200 water-related companies and 25 research centres (PUB, 2018a).
Netherlands	Expansion of water research and capabilities building by renowned universities and leading water education and research institutions (IHE Delft, n.d.; KWR Water Research Institute, 2021; Studyportals Masters, 2021b, 2021a).	• Highly coordinated water governance system with decentralised water agencies whose boundaries are determined by catchment and basins (Havekes et al., 2017; Vollebergh & Dijk, 2017). • WRM through contemporary legislation and proactive governance, enforcement and implementation to ensure transparency and overcome corruption (IRC, 2016; Mostert, 2009; Studyportals Masters, 2021a). • Global water hub offering international development projects, ODA, and multidisciplinary water expertise (i.e., Amsterdam Utility Agreement and Netherlands Water Partnership) (Amsterdam International Water Web, 2021; Kingdom of the Netherlands, 2017; NWP, n.d.).	• Two-part tariff system and user-pays principle enablers of financially independent water authorities (European Environment Agency, 2013; Havekes et al., 2017; Vollebergh & Dijk, 2017). • Fiscal incentives strong driver of investment into innovative products (Government of the Netherlands, n.d.-a; OECD, 2020a).	• Government push for open data and leader in providing open access geo-data (Hisham, 2015; Overheid.nl, 2021). • Strong indigenous firms in space, geo-data, and environmental technologies (Government of the Netherlands, 2021). • Commercialisation of smart water solutions through collaborations between water authorities, space and geo-data agencies (Kingdom of the Netherlands, 2017).	• Large-scale and long-term investments into comprehensive water infrastructure and digitalisation (e.g., Delta Works programme for flood mitigation and land reclamation) helped achieve an NRW of 5% (Havekes et al., 2017; Hisham, 2015; Kingdom of the Netherlands, 2017; Macharia et al., 2021) • High speed internet and 5G deployment (Government of the Netherlands, n.d.-b).	Water tax revenue amounting to EUR2.7 billion (Havekes et al., 2017). Water supply and waste management worth EUR3 billion (18%) value add in the EUR16.7 billion environmental goods and services sector (CBS, 2015).

Country	People	Governance	Finance	Information and RDCI	Infrastructure and Technology	Economic Impact
Australia	• **Citizen science** approach to promote public collaboration and capacity building (ACSA, 2021a, 2021b). • **'Brain gain**' driven by strong tertiary education sector, tailored visa programmes, water education institutions (e.g., TVET, Australian Water School, Water Training Australia) (ARC, 2021; Department of Home Affairs, 2021; Times Higher Education, 2021).	• **"Whole-of-Government"** approach in water reform efforts for IWRM and development of water markets (Infrastructure Australia, 2019). • Regulatory instruments ensuring water efficient products, services, and buildings (e.g., WELS scheme, BASIX). • Government-driven government-university-industry partnerships (NWGA, 2020; PMC, 2016; Productivity Commission, 2011).	• **Two-part tariff** system with user-pays principle. Urban and irrigation service providers generate sufficient revenue and operate **without government subsidy.** • Service providers regulated by **independent economic regulators** incentivised to meet key license targets to achieve cost-reflective pricing structure. • **Co-investment schemes** to encourage state/local government adoption of water solutions and infrastructure.	• Government-led commitment to data access. • Strong public research institution investment into emerging digital and data-driven water technologies. • High-speed internet and 5G networks (Speedtest, 2021a, 2021b).	Government-driven investment into water infrastructure (i.e., **National Water Initiative** and **National Water Grid**) and addressing system leaks, achieving NRW of 10% (Harris, 2017).	Water sector employs 27,000 and adds AUD18.9 billion to the Australian economy (Infrastructure Australia, 2019). Trade in water allocations and entitlements annually ranging between AUD1-7 billion (Bureau of Meteorology, 2021).
Canada	• **Citizen science** and engaging the public in water monitoring initiatives (Cliche & Freeman, 2016; Sandford et al., 2018). • Talent building through dedicated water research institutes and training centres and world class universities offering water-related education (Sandford et al., 2018; Times Higher Education, 2021; Walkerton Clean Water Center, n.d.).	• IWRM through "**Whole-of-Society**" water governance. • Government vertical and lateral coordination via collaborative institutions (Sandford et al., 2018). • Continuous outcomes monitoring of policies and initiatives (Shrubsole et al., 2016). • Government-driven government-university-industry partnerships in data sharing, innovation and research (Alberta Innovates, 2014; Canadian Water Network, 2018; Living Lakes Canada, 2021).	Fiscal incentives to drive R&D in water technologies (Canadian Water Network, 2018; Natural Sciences and Engineering Research Council of Canada, 2019).	• **IoT and satellite remote sensing** enablers of digital and data-driven water systems (Government of Canada, 2017, 2020; Roper, 2020). • Government-driven commitment to **data access** (Government of Canada, 2021a, 2021b).	Investment into physical and digital infrastructure (i.e., **Clean Water and Wastewater Fund**) with maintenance and upgrades to pipelines to achieve NRW of 13% (Renzetti & Dupont, 2013; Statistics Canada, 2020).	Water treatment market worth CAD2.5 billion (Water Canada, 2017).

8.3.3 TOR Scope 3 - Water Sector as a Dynamic New Economic Sector Capable of Driving the Nation's GDP Growth in the Future

Figure 3.1.8.3 and Table 3.1.8.4 show the strategies required to the strategies required to strengthen the water ecosystem in Malaysia into a dynamic one, like selected benchmark countries (South Korea, Japan and Singapore). If the enablers of the water ecosystem were strengthened by implementation of strategic programs towards positioning the water sector as a new national economic sector, there is much potential in turning the water sector into a dynamic economic sector. In 2019, the water sector had a value-add of RM 4.5B[3] which represents a 0.32% contribution to Malaysia's national GDP. By accelerating the growth of a skilled labour force, the right investments, and the digital transformation of the water sector, it is possible for the sector to achieve a much higher value-add amount to the economy. If the water sector can achieve the Japan growth scenario in Figure 3.1.8.3, implementing the appropriate reforms to the water sector and water ecosystem can lead to a value-add of RM13.3B by 2040, contributing 0.46% to the national GDP. The reforms include transforming the Malaysian water ecosystem to be knowledge-intensive and technology-driven. A developed water ecosystem will ensure sustainable supply of quantum and quality of water to meet the need of society and key economic sectors of the economy. A sound water ecosystem will also ensure appropriate strategies are in place that will ensure effective management of the demand of water by society. This include greater effort is in place to reduce water wastage, thus ensuring domestic water consumption reducing from 245 litres per capita per day in 2020 to a target of 160 litres per capita per day. Sound supply and demand of water will lead to strong private sector and foreign direct investment into the water sector spawning local water/aqua tech industries. All of which will nurture a strong local water supply chain with extensive regional footprint.

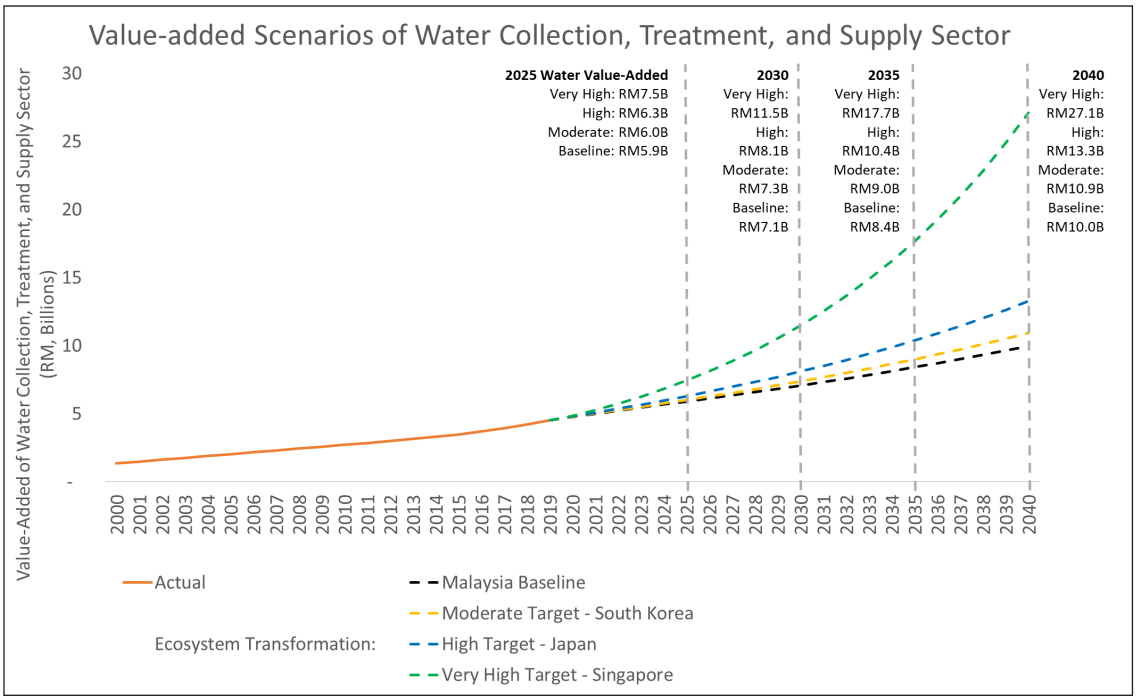


Figure 3.1.8.3. Value-added growth scenarios of water collection, treatment and supply sub-sector

Source: Department of Statistics, Malaysia

Note: Economic data for the water collection, treatment, and supply sector was only available for 2010, 2015, 2017, and 2019. Missing data between years were interpolated and back casted. Analytics by Sunway Institute for Global Strategy and Competitiveness.

3 Source: Department of Statistics, Malaysia

Table 3.1.8.4. Policy strategies to target the five focus areas of the water ecosystem

WES				
Implementation of a strategic programme towards positioning the water sector as a new national economic sector (WES)				
People	**Governance**	**Finance**	**Information and RDCI**	**Infrastructure and Technology**
• Adequate talent with specialized knowledge, technical, entrepreneurial and leadership skills. • Continuous upgrading and reskilling in place. • Strong awareness and acculturation of care for water basins and civic consciousness on the value of the natural water resources. • Incorporate the **8Rs of water philosophy** • Strong training centres in the water areas that meet the talent needs of the industry and provide training to other countries.	• Adopt a **"Whole-of- Government and Whole-of-Society"** Approach to operationalize Integrated Water Resource Management (IWRM) model. • Continuous improvement of institutions in place – adoption the new technology, knowledge systems and capability development. • A strong **"Champion with Clout"** (Federal Government) orchestrating the development of the water ecosystem – a good **'Conductor.'** • Level and quality of cooperation among all stakeholders good – ability to harness **economic multiplier & spill over effects.** • Ensure green rating for buildings and halal certification includes good and sustainable water management practices saving practices. • Strong International cooperation that fosters two-way technology and knowledge transfer – continuously moving up the global value chain. • Strong adherence to global best practices; in some cases, setting new standards.	• Competitive fiscal incentives to encourage continuous modernization of the water sector via the adoption of new technology, innovation, and systems to enhance the competitiveness and the sustainability of the water resources and industry. • Strong incentives for fundamental & translational R&D and commercialisation of R&D in the water sector. • **Tariff rates are competitive** to attract private sector participation in the water sector. • Attractive economic incentives schemes, financial instruments, and support systems to encourage **private sector participation** in the water sector. • Strong fiscal and non-fiscal incentives to encourage **foreign direct investments** (FDIs) into the water sector.	• Extensive use of digital infrastructure, blockchain, big data, data analytic tools to seamlessly integrate multiple information and data system in the water sector. • Strong use of digital governance systems to enhance stakeholder relationsand effective management of the water ecosystems, including prevention of rent-seeking and moral hazard behaviour. • Digital technology is used to monitor water quality, water supply and potential risks of climate change and other natural disasters on the water basins. • Digital technology enables the gathering of market intelligence (water usage & demand conditions). • Intensify research and development for a Circular Economy in the water sector aligned to the 10-10 *My*STIE framework. • Increase research and development investments to nurture a strong local **water-tech/aqua-tech industry and supply chain**.	• The upstream and downstream water system incorporate intelligent water management system, which enable **traceability** (ability to trace the source of water and contaminants), **harmony** (balanced use among householders, industry, and the environment), **sustainability** (safe and reliable water services) and **self-reliance** (energy-efficient systems). • Continuous upgrading of the infrastructure to reduce the Non-Revenue Water (NRW), increase reserve margin rate, quantity & quality of water and contribution to GDP. • High water by using sectors such as agriculture to use smart technology to improve the water distribution network, reduce wastage, and enhance efficiency and productivity.

8.3.4 TOR Scope 4 - Transformation Strategy and Initiative Implementation Framework

The roadmap framework had been prepared by the study team and approved by the Technical Committee at its meeting on 28 October 2020 and by the Steering Committee at its meeting on on 19 November 2020.

8.3.5 TOR Scope 5 - Stakeholders and Experts Consultation

A total of 73 stakeholders were consulted (Table 3.1.8.5). All stakeholder sessions were conducted via online sessions.

8.3.6 TOR Scope 6 –WST2040 Roadmap[4]

Figure 3.1.8.4 shows a summary of the strategies and key activities proposed by WES to be implemented across the four phases of the water sector transformation. It highlights some of the key milestones that need to be achieved in the 12th MP that will enable the continued transformation of the water sector in the subsequent 13th MP to 15th MPs. This systemic transformation is crucial in ensuring a holistic approach in setting up institutional frameworks, foundational conditions, and ownerships that will address the current fragmentation of the water sector ecosystem.

4 Please refer to Volume 9 Water as an Economic Sector (WES) Sub-Sectoral Final Report for the complete Roadmap for the National Agenda on Water Sector Transformation 2040 (Roadmap WST 2040). The roadmap provides a reference and guide of the various Ministries and Agencies to implement project/programmes and activities towards achieving the aim of transforming the water sector.

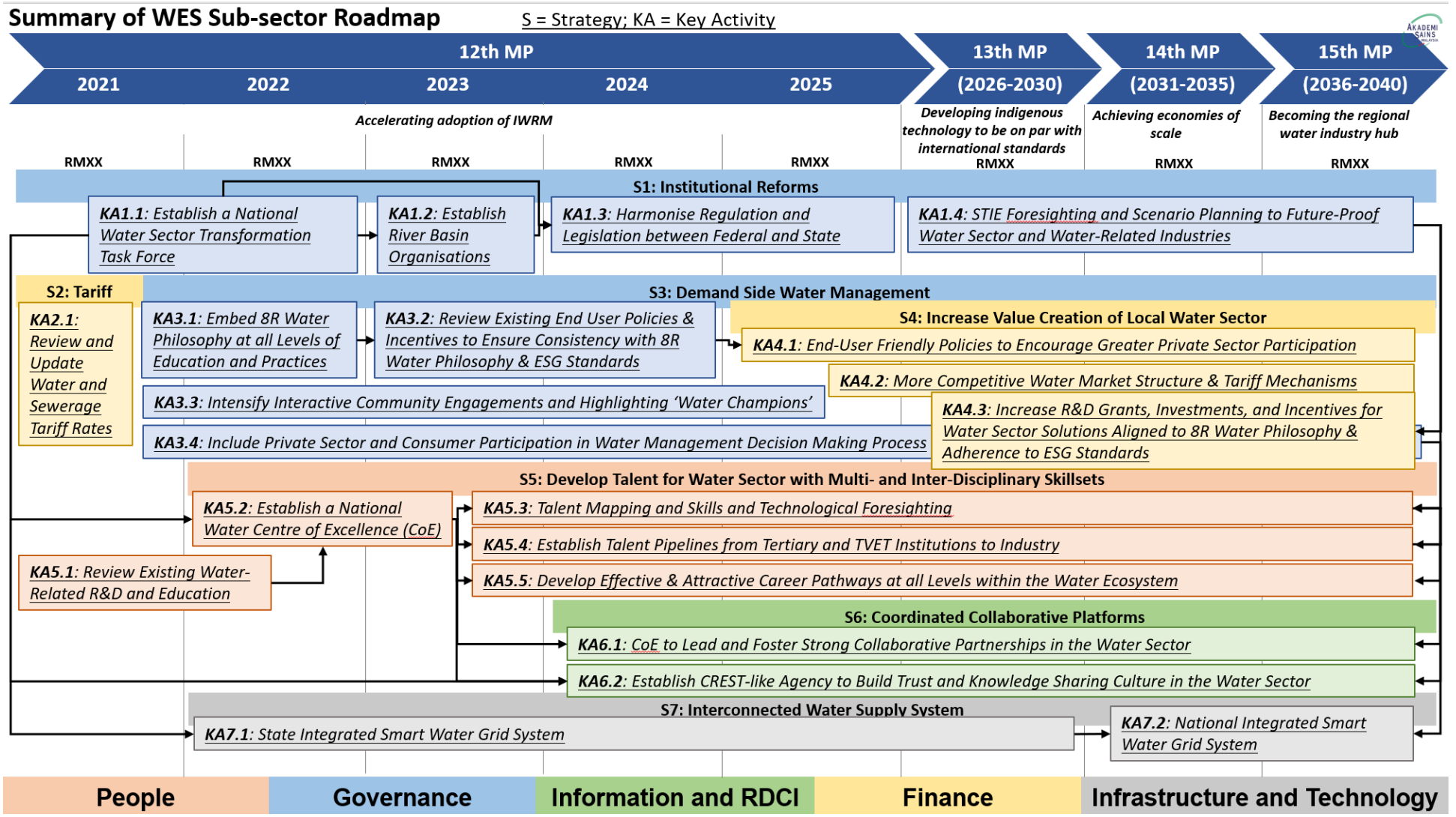
Table 3.1.8.5. List of stakeholders and experts consultation

ministry/ state governments/ organisations	category (federal government / state government / glc/ university/ private/ ngos/ sabah/ sarawak)	date conducted	participants (total)
Focus Group Conducted			
Suruhanjaya Perkhidmatan Air Negara (SPAN)	Government (Federal)	28 May, 2021	8
Jabatan Pengairan dan Saliran (JPS)		11 May, 2021	1
National Disaster Management Agency (NADMA)		2 June, 2021	2
SME Corp		11 June, 2021	1
Indah Water Konsortium (IWK)	Government (State)	31 May, 2021	8
Lembaga Urus Air Selangor (LUAS)		27 May, 2021	1
Ministry of Utilities Sarawak (MOU Sarawak)	Sarawak	8 June, 2021	6
Jabatan Pengairan dan Saliran Sarawak (JPS Sarawak)		6 May, 2021	1
Institut Penyelidikan Air Kebangsaan Malaysia (NAHRIM)	Research Institute	10 May, 2021	2
Malaysian Association of Hotels (MAH)	Private Sector	23 June, 2021	1
Federation of Malaysian Manufacturers Institute (FMM Institute)		22 July, 2021	2
Federation of Malaysian Manufacturers (FMM)		**9 July, 2021**	**6**
ROCKWOOL Malaysia Sdn. Bhd.			1
Top Glove Corporation Berhad			2
Showa Denko Carbon Malaysia Sdn. Bhd.			1
Mega Fortris (M) Sdn. Bhd.			1
FMM Secretariat			1
Federation of Malaysian Manufacturers Malaysian Food Manufacturing Group (FMM MAFMAG)		**22 July, 2021**	**3**
Etika Holdings			1
Nestle Malaysia			1
FMM Secretariat			1
Malaysia Shopping Mall Association (PPK Malaysia)		**5 July, 2021**	**3**
See Hoy Chan Holdings Group			1
Hektar Real Estate Investment Trust			1
PPK Malaysia Secretariat			1
Malaysian Plastics Manufacturers Association (MPMA)		**2 July, 2021**	**1**
Piping Technology Sdn. Bhd.			1

ministry/ state governments/ organisations	category (federal government / state government / glc/ university/ private/ ngos/ sabah/ sarawak)	date conducted	participants (total)
Federation of Malaysian Consumers Associations (FOMCA)	NGO	28 May, 2021	1
Extracted from Third Party Discussions[5]			
Pengurusan Aset Air Berhad (PAAB)	Government (Federal)	3 July, 2021	1
Kementerian Alam Sekitar dan Air (KASA)		3 July, 2021	1
Ministry of Transport (MOT)		8 June, 2021	1
Ministry of Plantation Industries and Commodities (MPIC)		8 June, 2021	1
Ministry of Education (MOE)		8 June, 2021	1
Jabatan Kimia Malaysia (KIMIA Malaysia)		8 June, 2021	1
Air Selangor	Government (State)	8 June, 2021	1
PricewaterhouseCoopers (PwC)	Private Sector	28 September, 2020	1
Wildlife Conservation Society (WCS)	NGO	8 June, 2021	1
Sustainable Development Network Malaysia (SUSDEN)		8 June, 2021	1
Malaysian Water Association (MWA)		8 June, 2021	2
Parti Sosialis Malaysia (PSM)	Other	8 June, 2021	1

5 Qualitative analysis of external webinars/forum/panel discussions

Table 3.1.8.5. List of stakeholders and experts consultation



Ministry/ State Governments/ Organisations	Category (Federal Government / State Government / GLC/ University/ Private/ NGOs/ Sabah/ Sarawak)	Date Conducted	Participants (Total)
Focus Group Conducted			
Suruhanjaya Perkhidmatan Air Negara (SPAN)	Government (Federal)	28 May, 2021	8
Jabatan Pengairan dan Saliran (JPS)		11 May, 2021	1
National Disaster Management Agency (NADMA)		2 June, 2021	2
SME Corp		11 June, 2021	1
Indah Water Konsortium (IWK)	Government (State)	31 May, 2021	8
Lembaga Urus Air Selangor (LUAS)		27 May, 2021	1
Ministry of Utilities Sarawak (MOU Sarawak)	Sarawak	8 June, 2021	6
Jabatan Pengairan dan Saliran Sarawak (JPS Sarawak)		6 May, 2021	1
Institut Penyelidikan Air Kebangsaan Malaysia (NAHRIM)	Research Institute	10 May, 2021	2
Malaysian Association of Hotels (MAH)	Private Sector	23 June, 2021	1
Federation of Malaysian Manufacturers Institute (FMM Institute)		22 July, 2021	2
Federation of Malaysian Manufacturers (FMM)		**9 July, 2021**	**6**
ROCKWOOL Malaysia Sdn. Bhd.			1
Top Glove Corporation Berhad			2
Showa Denko Carbon Malaysia Sdn. Bhd.			1
Mega Fortris (M) Sdn. Bhd.			1
FMM Secretariat			1
Federation of Malaysian Manufacturers Malaysian Food Manufacturing Group (FMM MAFMAG)		**22 July, 2021**	**3**
Etika Holdings			1
Nestle Malaysia			1
FMM Secretariat			1
Malaysia Shopping Mall Association (PPK Malaysia)		**5 July, 2021**	**3**
See Hoy Chan Holdings Group			1
Hektar Real Estate Investment Trust			1
PPK Malaysia Secretariat			1
Malaysian Plastics Manufacturers Association (MPMA)		**2 July, 2021**	**1**
Piping Technology Sdn. Bhd.			1
Federation of Malaysian Consumers Associations (FOMCA)	NGO	28 May, 2021	1

Ministry/ State Governments/ Organisations	Category (Federal Government / State Government / GLC/ University/ Private/ NGOs/ Sabah/ Sarawak)	Date Conducted	Participants (Total)
Extracted from Third Party Discussions[6]			
Pengurusan Aset Air Berhad (PAAB)	Government (Federal)	3 July, 2021	1
Kementerian Alam Sekitar dan Air (KASA)		3 July, 2021	1
Ministry of Transport (MOT)		8 June, 2021	1
Ministry of Plantation Industries and Commodities (MPIC)		8 June, 2021	1
Ministry of Education (MOE)		8 June, 2021	1
Jabatan Kimia Malaysia (KIMIA Malaysia)		8 June, 2021	1
Air Selangor	Government (State)	8 June, 2021	1
PricewaterhouseCoopers (PwC)	Private Sector	28 September, 2020	1
Wildlife Conservation Society (WCS)	NGO	8 June, 2021	1
Sustainable Development Network Malaysia (SUSDEN)		8 June, 2021	1
Malaysian Water Association (MWA)		8 June, 2021	2
Parti Sosialis Malaysia (PSM)	Other	8 June, 2021	1

6 Qualitative analysis of external webinars/forum/panel discussions

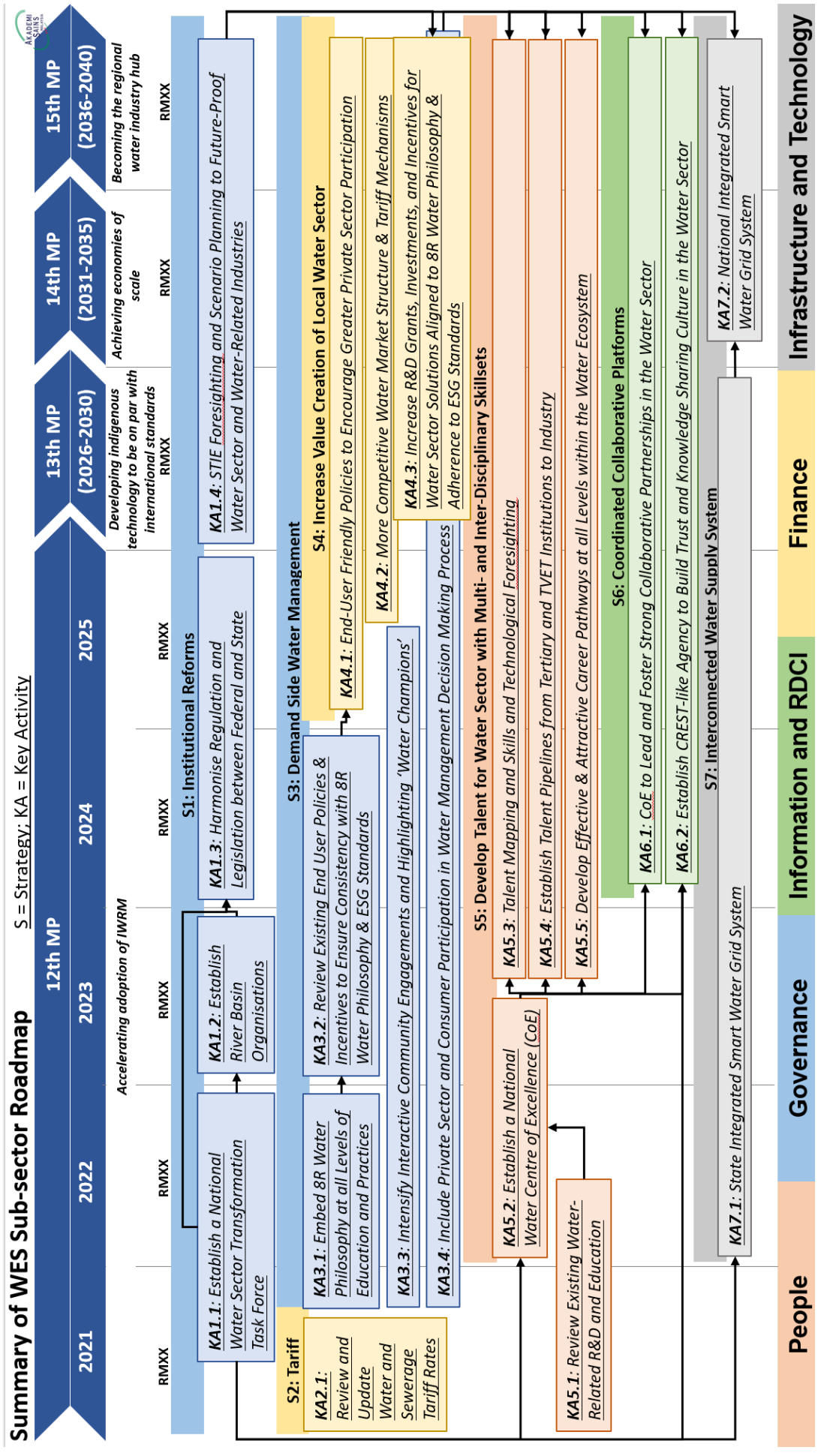


Figure 3.1.8.4. Summary of WES sub-sector roadmap

For example, KA1.1 (Key Activity 1.1): *Establishing a National Water Sector Transformation Task Force* is a key first step in the transformation process. This advisory body will guide and coordinate the water sector transformation that cuts across the other focus areas:

- Combining KA1.1 *Establishing a National Water Sector Transformation Task Force* and KA5.1 *Review Existing Water-Related R&D and Education* will then provide the foundational conditions needed to successfully implement KA5.2 *Establish a National Water Centre of Excellence (COE)*;
- KA5.2 coupled with KA1.1 will lead into KA6.1 *CoE to Lead and Foster Strong Collaborative Partnerships in the Water Sector* and KA6.2 *Establish CREST-like Agency to Build Trust and Knowledge Sharing Culture in the Water Sector*;
- The continued review process of KA6.1 and 6.2 will then be informed by KA1.4 *STIE Foresighting and Scenario Planning to Future-Proof Water Sector Water-Related Industries.*

Similar pathways for the WES roadmap to transform the water sector into a dynamic economic sector are mapped out in Figure 3.1.8.4. Without the series of progressions and dependencies on outcomes from previous strategies and key activities, implementation efforts will be hindered by a piecemeal approach. Therefore, a list of immediately implementable projects for the 12th MP has been proposed in Table 3.1.8.6 to kick-off the water sector transformation. Following the progressions proposed in Figure 3.1.8.4, Table 3.1.8.7 to Table 3.1.8.10 show some of the proposed targets for their respective strategies and MPs.

In addition to fulifilling the study scope, the sub-sectors were requested to provide listings on immediately implementable projects, targets and KPIs.

8.3.7 Immediately Implementable Projects

Table 3.1.8.6 shows the proposed list of Immediately Implementable Projects for the 12th MP.

Table 3.1.8.6. Proposed immediately implementable projects for 12th MP

Projects	Lead Authority	Implementing Authority	Remarks
Review current curriculum for water sector training and embedding water education that incorporates the 8Rs of water philosophy in school curriculums, general public, and industrial practices.	MOE/MOHE	MOE/MOHE, Ministry of Entrepreneurship Development and Cooperatives	Consolidate existing water education and awareness materials and supplement them with the 8Rs.
Review existing business/ consumer-friendly policies/ practices to ensure that they are consistent and aligned with 8Rs of water philosophy.	Ministry of Entrepreneurship Development and Cooperative	Ministry of Entrepreneurship Development and Cooperative, FOMCA	From the Focus Group discussion analysis, there are contradicting policies/practices that disincentivises businesses from adopting sustainable practices. One of reasons cited is the lack of guidelines from local council on establishing water storage systems. Businesses that have developed their own water storage systems were penalized for erecting their own storage systems in their premises. While industry and consumers are already embarking on recycling initiatives, there is a lack of guidelines and fiscal incentives for them to pursue these practices.
Intensify interactive community engagements (i.e., River of Life project in Klang/Gombak River).	KASA	State Governments; Department of Irrigation and Drainage	Embark on more flagship projects to increase engagement and appreciation of water-related activities.
Review and update water tariff rates to increase self-sustainability of water suppliers.	KASA	KASA	Low tariff rates in the water sector are one of the key factors that hinders the sustainability of water suppliers and disincentives private sector investments into the water sector.
Identifying industry and community water champions/ role-models/influencers/ ambassadors that showcase best practices for a circular economy.	KASA	Malaysia Water Association, NGOs (e.g., WWF), Ministry of Primary Industries, Ministry of Rural Development, Ministry of Agriculture, Industry Associations, Chambers of Commerce.	Engage existing leading water influencers and champions of circular economy to build the culture of water sustainability and transform the water into a dynamic economic sector.
Include private sector and consumer participation in the water management decision making process.	KASA, Sabah/ Sarawak	FOMCA, Ministry of Entrepreneurship Development and Cooperatives, other Industry Associations (e.g., FMM)	Many stakeholders are already eager to participate in the decision-making process. The water transformation process needs to start from a Whole-of-Government and Whole-of-Society approach. A strong stakeholder participation will encourage private sector investment into the water sector.
Undertake STIE fore sighting and scenario planning to future-proof water sector and water-related industries.	KASA	MIGHT, state water authorities and government, river basin organisations, industry associations, community organisations	Align water STIE plan with 10-10 *My*STIE framework and continuously update the STIE trends to future-proof the water sector.
National Water Sector Transformation Task Force (strengthen Federal-State cooperation and collaboration)	KASA	KASA, State water authorities and government, river basin authorities, industry associations, community organisations	Implement Whole-of-Government, Whole-of-Society approach.
Operators within the water-value chain need to provide five-year business plans with annual audited reporting against established targets	KASA	State authorities, river basin organisations	Standardised templates for tracking and reporting of targets and milestones across national, states, and river basins.

8.3.8 Strategies and Proposed Targets

The Strategies and Proposed Targets for the 12th MP, 13th MP, 14th MP and 15th MP are shown in Table 3.1.8.7, Table 3.1.8.8, Table 3.1.8.9 and Table 3.1.8.10

Table 3.1.8.7. Strategies and proposed targets for 12th Malaysia Plan

Strategies	Initiatives	Proposed Targets
Develop talent for water sector with multi/ inter-disciplinary skillsets	Review existing water-related research and development, research-inspired educational programs, training, and micro credentials in all educational institutions	Establish a National Water Centre of Excellence (CoE) that will futureproof water-related research and development, research-inspired educational programs, training, and micro credentials that meets the need of the water sector.
	Upgrade existing talent with key competencies across all key activity areas	• Skilled: Unskilled labour ratio – 1:4 • Number of employed persons growth of 5% per year
Demand Side Water Management	Ensuring appropriate education, incentives, and policies are in place to encourage stronger water conservation practices	Water consumption per capita: 215L/Day
Institutional Reforms	National Water Sector Transformation Task Force	Achieved Whole-of-Government approach
	Harmonising and strengthening the water legislative framework and Environmental, Sustainability, Governance (ESG) standards related to water	• Harmonize regulation and legislation between federal and state governments. • Incorporate ESG standards related to water sector management in green rating of buildings and halal certification.
	Increasing transparency and accountability	Water operators publish 5-year plans and annual audited reports against established targets.
Interconnected water supply system across the country to improve water supply, and quality of water, and water security	Develop a comprehensive national smart water grid system	• 50% of each state is covered by an integrated state water grid. • 20% of water grid and operators are digitalised and using best-practice technologies.
	Non-revenue water reduction	25%
	Water reserve margins	12% national average minimum / 5% state minimum
	National and regional water-related data sharing	A centralised database to integrate water related data and information on research, development, commercialisation, and innovation (RDCI).
Increase value creation of the local water sector to nurture and sustain a circular economy	Attract high quality local private sector and foreign direct investments into the water sector	Water-related local firms (including start-ups) growth of 5% per year.
	Increase quantum of funding for water related RDCI aligned to 10-10 *My*STIE framework to strengthen local technology companies in the water/aqua sector and strengthening the local water supply chain.	Funding growth of 5% per year.
	Competitive water tariff rates	Full adoption of updated tariffs for OPEX and CAPEX recovery for water operators.
	Establish collaborative platforms among multiple stakeholders to foster a strong spill over and multiplier effect to the water sector and from the water sector to the other sectors of the economy	National water centre of excellence to work closely with NTIS and i-Connect to foster strong collaborative partnerships in the water sector. Establish a CREST-like agency for the water sector to build trust and nurture knowledge sharing culture in the water sector.

Table 3.1.8.8. Strategies and targets for 13th Malaysia Plan

Strategies	Initiatives	Proposed Targets
Develop talent for water sector with multi/ inter-disciplinary skillsets	National Water CoE puts in place a talent review cycle based on technology trends and demand conditions	The CoE undertakes continuous review and refinement of the talent needs of the water sector to ensure the supply of talent meets the demand of the industry.
	Continuing to upgrade existing talent with key competencies across all key activity areas based on technology trends and demand conditions	• Skilled: Unskilled labour ratio – 1:3.5 • Number of employed persons growth of 5% per year
Demand Side Water Management	Ensuring refinements in educational capability and training programs, incentives, and policies are in place to encourage stronger water conservation practices	Water consumption per capita: 200L/Day
Institutional Reforms	Reviewing and refining the terms of reference of the National Water Sector Transformation Task Force according to the changing landscape of the water sector and the Malaysian economy	Achieved Whole-of-Government & Whole-of-Society approach.
	Continuing to harmonise and strengthen the water legislative framework to meet global best practices.	Aligning legislation with global best practices, including adherence to global ESG best practices and standards.
	Increasing transparency and accountability aligned to global best practices (e.g., ESG standards)	Water operators publish 5-year plans and annual audited reports against established targets including adherence to ESG standards.
Interconnected water supply system across the country to improve water supply, and quality of water, and water security	Continuing the development of the national smart water grid system to ensure a wider coverage across the country	• 75% of each state is covered by an integrated state water grid. • 40% of water grid and operators are digitalised and using best-practice technologies.
	Non-revenue water reduction	20%
	Water reserve margins	13% national average minimum / 7.5% state minimum
	National and regional water-related data sharing	Strong market intelligence for all domestic stakeholders.
Increase value creation of the local water sector to nurture and sustain a circular economy	Continuing to attract high quality local private sector and foreign direct investments into the water sector to modernize the water sector and move up the innovation value chain.	Water-related local firms (including start-ups) growth of 5% per year.
	Increasing quantum of funding for water related RDCI aligned to 10-10 *My*STIE framework based on more recent technology fore-sighting exercise to transition the local water industry up the innovation value chain	Funding growth of 5% per year.
	Review and revise the water tariff rates according to market conditions and costs structures	Continuous review of tariff model for OPEX and CAPEX recovery and expansion.
	Strengthen collaborative platforms among multiple stakeholders to foster a strong spill over and multiplier effect to the water sector and from the water sector to the other sectors of the economy	National water centre of excellence to work closely with NTIS and i-Connect to explore new frontier technologies and business models to enhance competitiveness of the water sector. The new CREST-like agency for the water sector to continue to foster strong collaboration among the key players in the water sector and water-related industries.

Table 3.1.8.9. Strategies and targets for 14th Malaysia Plan

Strategies	Initiatives	Proposed Targets
Develop talent for water sector with multi/ inter-disciplinary skillsets	National Water CoE puts in place a talent review cycle based on technology trends and demand conditions	The CoE undertakes continuous review and refinement of the talent needs of the water sector to ensure the supply of talent meets the demand of the water sector and other water-related industries (includes talent for the virtual water sector, water footprint, and water-food-energy nexus).
	Continuing to upgrade existing talent with key competencies across all key activity areas based on technology trends and demand conditions	• Skilled: Unskilled labour ratio – 1:3 • Number of employed persons growth of 5% per year
Demand Side Water Management	Ensuring refinements in educational capability and training programs, incentives, and policies are in place to encourage greater adoption of more sophisticated technology to ensure higher return on value on water to society and the Malaysian economy	Water consumption per capita: 185L/Day
Institutional Reforms	Reviewing and refining the terms of reference of the National Water Sector Transformation Task Force according to the changing landscape of the water sector and its deepening role in the Malaysian and regional economies	Regional outreach of taskforce based on past decade of achievements.
	Continuing to harmonise and strengthen the water legislative framework to meet global best practices.	Aligning legislation with global best practices.
	Reviewing and refining policies and strategies related to ensuring greater transparency and accountability aligned to global best practices (eg ESG standards)	Water operators publish five-year plans; annual audited reports and other key performance indicators against established targets annually, including ESG standards.
Interconnected water supply system across the country to improve water supply, and quality of water, and water security	Continuing the development of the national smart water grid system to ensure a wider coverage across the country	• 100% of each state is covered by an integrated state water grid. • 60% of water grid and operators are digitalised and using best-practice technologies.
	Non-revenue water reduction	15%
	Water reserve margins	14% national average minimum / 10% state minimum
	National and regional water-related data sharing	Regional data centre and sharing.
Increase value creation of the local water sector to nurture and sustain a circular economy	Continuing to attract high quality local private sector and foreign direct investments into the water sector to modernize the water sector and move up the innovation value chain.	Water-related local firms (including start-ups) growth of 5% per year.
	Increasing quantum of funding for water related RDCI aligned to 10-10 *My*STIE framework based on more recent technology fore-sighting exercise to transition the local water industry up the innovation value chain	Funding growth of 5% per year.
	Review and revise the water tariff rates according to market conditions and costs structures	Continuous review of tariff model for OPEX and CAPEX recovery and expansion.
	Strengthen collaborative platforms among multiple stakeholders to foster a strong spill over and multiplier effect to the water sector and from the water sector to the other sectors of the economy	National water centre of excellence to work closely with NTIS and i-Connect to explore new frontier technologies and business models to create wider spill over and multiplier effects across the different sectors of the economy. The CREST-like agency for the water sector to continue to foster strong collaboration among the key players in the water sector and water-related industries with clear focus on leading global multi-national entities in the water sector.

Table 3.1.8.10. Strategies and targets for 15th Malaysia Plan

Strategies	Initiatives	Proposed Targets
Develop talent for water sector with multi/inter-disciplinary skillsets	National Water CoE in place a talent review cycle based on technology trends and demand conditions	The CoE to play a leadership role in the talent development for the water sector in the region. The CoE and key institutions become a important training centre for nurturing next-generation talent for the water sector in the region and other developing countries.
	Continuing to upgrade existing talent with key competencies across all key activity areas based on technology trends and demand conditions	• Skilled: Unskilled labour ratio – 1:2 • Number of employed persons growth of 5% per year
Demand Side Water Management	Ensuring refinements in educational capability and training programs, incentives, and policies are in place to encourage greater adoption of more sophisticated technology to ensure higher return on value on water to society and the Malaysian economy	Water consumption per capita: 160L/Day
Institutional Reforms	Reviewing and refining the terms of reference of the National Water Sector Transformation Task Force according to the changing global landscape of the water sector and providing leadership at the regional level.	Regional leadership for water sector.
	Continuing to strengthen the national water legislative framework to meet global best practices and to contribute to the development of a regional water framework that harmonises the legislative and regulatory architecture in the region to foster the establishment of the regional water grid system and strengthen the virtual water sectors.	Promote water as a regionally strong economic sector, including the establishment of a vibrant regional virtual water sector (increase private sector participation & FDIs in the water sector and the virtual water sector).
	Reviewing and refining policies and strategies related to ensuring greater transparency and accountability aligned to global best practices (e.g., ESG standards)	Water operators publish 5-year plans; annual audited reports and other key performance indicators against established targets annually, including ESG standards.
Interconnected water supply system across the country and the region to improve water supply, and quality of water, and water security	Continuing the development of the national smart water grid system to ensure a wider coverage across the country and extend the reach to the other neighbouring countries in the region.	Connect the state integrated smart water grid system into a national grid. Extend the national integrated smart water grid system to the regional water grid system. 85% of water grid and operators are digitalised and by using best-practice technologies.
	Non-revenue water reduction	10%
	Water reserve margins	15% national average minimum / 15% state minimum
	National and regional water-related data sharing	Regional water resource planning and market intelligence.

Strategies	Initiatives	Proposed Targets
Increase value creation of the local water sector to nurture and sustain a circular economy	Continuing to attract high quality local private sector and foreign direct investments into the water sector to modernize the water sector and move up the regional value chain.	Water-related local firms (including start-ups) growth of 5% per year and extend their reach (and export their technology and know-how) to countries in the region.
	Increasing quantum of funding (from domestic and foreign investors) for water related RDCI aligned to 10-10 *My*STIE framework based on more recent technology fore-sighting exercise to transition the local water industry up the innovation value chain and extend its reach to other regional countries	Funding growth of 5% per year.
	Review and revise the water tariff rates according to market conditions and costs structures	Continuous review of tariff model for OPEX and CAPEX recovery and expansion.
	Strengthen collaborative platforms amongst multiple stakeholders to foster a strong spill over and multiplier effect across the region.	National water centre of excellence to work closely with NTIS, i-Connect and other leading institutions in the region to explore new frontier technologies and business models that meets the needs of the regional water sector. The CREST-like agency for the water sector to continue to foster strong collaboration among the key players in the regional water sector and water-related industries.

WES had identified **52 Targets** and **52 KPIs** for the four Malaysia Plans. The details are given in its Final Report (Volume 9).

Appendix 3.2

Definitions of the roadmap categories

No.	Sub-Category	Definition	
1.	Strategy	A plan of action designed to achieve a long-term or overall aim	
2.	Water User Category		Based on the Malaysian Water Vision, under "Water for Livelihood", the Users will be identified as follows: a. Water for People b. Water for Food, Agriculture and Rural Development c. Water for Economic Development d. Water for Energy e. Water for the Environment
3.	Initiatives/ Programmes	A set of related measures aimed at achieving a strategy over a particular time period	
4.	Activity	The measures undertaken	
5.	Hierarchical Level	**Water as a Resource:** To describe the activity being undertaken, whether at the National, Regional, State or at River Basin levels	**Water for Livelihood:** To describe the activity being undertaken, whether at the National, Regional, State, District, or Local Authority levels
6.	Lead Authority/ Collaborating Partner	**Water as a Resource:** **National Level:** Lead Authority: Apex Water body (MAN)/ Ministry mandated by its main functional role Collaborating Partner: Related Ministries/ Agencies associated at a lesser functional role **State Level:** Lead Authority: MSANg or equivalent Collaborating Partner: State Departments/ Agencies	**Water for Livelihood:** **National Level:** Lead Authority: Apex Water body (MAN)'s Mandated Ministry by its main functional role Collaborating Partner: Related Ministries/ Agencies **State Level:** Lead Authority: State Govt. Collaborating Partner: Line Agencies
7.	Implementing Authority	**Water as a Resource:** **National Level:** Line Departments/Agencies **State Level:** MSANg's Implementation Arm (eg LUAS, Selangor)	**Water for Livelihood:** **National Level:** Line Departments/Agencies **State Level:** State Govts/State and District Departments/Local Authorities/Agencies (eg urban drainage)
8.	Current Status	To describe, for continuing activities, the status of the activity	
9.	Target Completion	To describe when the activity is expected to be completed	
10.	Remarks	Additional comments to further explain the activity	

Appendix 3.3

Roadmap showing continuing projects/ activities carried over from the 11th Malaysia Plan (Source: Anggaran Perbelanjaan 2022 (mof.gov.my)

Continuing Strategies Projects/ Activities carried over from the 11th Malaysia Plan																	
No	Source	Element	Focus Area	Strategy	Projects/ Activities	Lead Authority/ (Collaborating Partner)	Implementing Authority	Current Status	Target Completion	Remarks (RM)	2020 Actual Expenditure (RM '000,000)	Budget (RM '000,000)					
												2021	2022	2023	2024	2025	Total 12MP
1	APP2022	Water as a Resource	Information & RDIC		Kajian Sumber Air Tanah Negara	KeTSA	JMG	Continuation		Budget shown under 12th MP is only for 2021/2022	8.05	24.00	5.00	N/G	N/G	N/G	29.00
2	APP2022	Water as a Resource	Infrastructure & Technology		Program Pembangunan Punca Air	MAFI		Continuation		Budget shown under 12th MP is only for 2021/2022	24.91	24.50	18.30	N/G	N/G	N/G	42.80
3	APP2022	Water as a Resource	Infrastructure & Technology		Peningkatan Inovasi dan Kemajuan Teknologi	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	5.45	7.90	10.94	N/G	N/G	N/G	18.84
4	APP2022	Water as a Resource	Infrastructure & Technology		Pembangunan Sumber Air Negara	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	6.16	6.06	12.70	N/G	N/G	N/G	18.76
5	APP2022	Water as a Resource	Infrastructure & Technology		Pemulihan Empangan	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	25.71	68.13	47.50	N/G	N/G	N/G	115.63
6	APP2022	Water as a Resource	Infrastructure & Technology		Jentera-jentera dan Kelengkapan	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	2.59	4.18	2.00	N/G	N/G	N/G	6.18
7	APP2022	Water for Livelihood	Infrastructure & Technology		Pemodenan Sistem Pengairan Padi	MAFI		Continuation		Budget shown under 12th MP is only for 2021/2022	40.51	79.40	60.52	N/G	N/G	N/G	139.91
8	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan-rancangan Pengairan Sabah	MAFI		Continuation		Budget shown under 12th MP is only for 2021/2022	1.64	3.87	17.65	N/G	N/G	N/G	21.52
9	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Pembangunan Sistem Saliran Pertanian	MAFI		Continuation		Budget shown under 12th MP is only for 2021/2022	2.50	7.54	2.10	N/G	N/G	N/G	9.64
10	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Johor	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	2.08	25.00	45.20	N/G	N/G	N/G	70.20
11	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Kedah	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	0.05	3.50	121.2	N/G	N/G	N/G	124.70
12	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Melaka	KASA		Continuation		Budget shown under 12MP is only for 2021/2022	0.47	5.19	15.20	N/G	N/G	N/G	20.39
13	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Kelantan	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	13.51	21.00	7.1	N/G	N/G	N/G	28.10

Continuing Strategies Projects/ Activities carried over from the 11th Malaysia Plan												Budget (RM '000,000)					
No	Source	Element	Focus Area	Strategy	Projects/ Activities	Lead Authority/ (Collaborating Partner)	Implementing Authority	Current Status	Target Completion	Remarks (RM)	2020 Actual Expenditure (RM '000,000)	2021	2022	2023	2024	2025	Total 12MP
14	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Sembilan	KASA		Continuation		Budget shown under 12MP is only for 2021/2022	5.98	4.02	12.59	N/G	N/G	N/G	16.61
15	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Pahang	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	3.44	7.50	31.1	N/G	N/G	N/G	38.60
16	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Perak	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	0.07	0.95	1.93	N/G	N/G	N/G	2.88
17	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Pulau Pinang	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	5.19	21.91	35.00	N/G	N/G	N/G	56.91
18	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Labuan	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	2.87	21.87	17.08	N/G	N/G	N/G	38.95
19	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Sabah	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	72.03	99.09	226.76	N/G	N/G	N/G	325.85
20	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Sarawak	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	95.69	99.40	156.4	N/G	N/G	N/G	255.80
21	APP2022	Water for Livelihood	Infrastructure & Technology		Penyaluran Air Antara Negeri	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	0.49	1.00	5.00	N/G	N/G	N/G	6.00
22	APP2022	Water for Livelihood	Infrastructure & Technology		Rancangan Bekalan Air Negeri Perlis	KASA		Continuation		Budget shown under 12MP is only for 2021/2022	4.56	30.00	21.14	N/G	N/G	N/G	51.14
23	APP2022	Water for Livelihood	Infrastructure & Technology		Projek Pembetungan Negara	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	584.72	764.27	817.52	N/G	N/G	N/G	1,581.79
24	APP2022	Water for Livelihood	Infrastructure & Technology		NRW Nasional	KASA		Continuation		Budget shown under 12th MP is only for 2021/2022	263.57	209.25	300.00	N/G	N/G	N/G	509.25
25	APP2022	Cross-cutting	Information & RDIC		Penyelidikan dan Pembangunan	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	4.03	7.60	15.70	N/G	N/G	N/G	23.30
26	APP2022	Cross-cutting	Infrastructure & Technology		Program Kawalan Banjir Kawasan Pertanian	MAFI		Continuation		Budget shown under 12th MP is only for 2021/2022	6.46	6.80	2.00	N/G	N/G	N/G	8.80
27	APP2022	Cross-cutting	Infrastructure & Technology		Rancangan Kawalan dan Isyarat Bahaya Banjir	KASA	JPS	Continuation		Budget shown under 12MP is only for 2021/2022	34.19	44.70	67.73	N/G	N/G	N/G	112.43
28	APP2022	Cross-cutting	Infrastructure & Technology		Pemulihan Struktur	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	9.36	18.00	1.00	N/G	N/G	N/G	19.00

Continuing Strategies Projects/ Activities carried over from the 11th Malaysia Plan																	
No	Source	Element	Focus Area	Strategy	Projects/ Activities	Lead Authority/ (Collaborating Partner)	Implementing Authority	Current Status	Target Completion	Remarks (RM)	2020 Actual Expenditure (RM '000,000)	Budget (RM '000,000)					
												2021	2022	2023	2024	2025	Total 12MP
29	APP2022	Cross-cutting	Infrastructure & Technology		Menaiktaraf Infrastruktur dan Saliran Bandar, Tebatan Banjir	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	39.15	33.52	17.70	N/G	N/G	N/G	51.22
30	APP2022	Cross-cutting	Infrastructure & Technology		Kerja-kerja kecil JPS, Pelbagai Negeri	KASA	JPS	Continuation		Budget shown under 12MP is only for 2021/2022	17.69	10.67	67.27	N/G	N/G	N/G	77.94
31	APP2022	Cross-cutting	Infrastructure & Technology		Memperbaiki, Mengindah, Membersih dan Merawat Air Sungai-sungai dan Infrastruktur MASMA	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	20.55	28.41	264.84	N/G	N/G	N/G	293.25
32	APP2022	Cross-cutting	Infrastructure & Technology		Mengorek Kuala-kuala Sungai	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	28.85	102.95	155.45	N/G	N/G	N/G	258.40
33	APP2022	Cross-cutting	Infrastructure & Technology		Rancangan Pengurusan Sungai Saliran Mesra Alam	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	121.14	87.59	68.01	N/G	N/G	N/G	155.59
34	APP2022	Cross-cutting	Infrastructure & Technology		Rancangan Tebatan Banjir (RTB) dan Saliran Bandar	KASA	JPS	Continuation		Budget shown under 12th MP is only for 2021/2022	345.27	575.78	730.34	N/G	N/G	N/G	1,306.13

Appendix 3.4

WST2040 roadmap from the eight sub-sectors

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
1	WST2040 (VW&WF)	Water as a Resource	People	Heightened VW&WF awareness among the public and industry	Conduction of awareness programme and knowledge dissemination for the public, industry, and school and university	Roadshows & Programmes	KASA	KASA	New	2022-2040	N/G	0.7	0.2	0.2	0.2	1.3	0.5	0.5	0.5
2	WST2040 (VW&WF)	Water as a Resource	People			Co-curriculum activities & Programmes for Schools	KASA & MOE	KASA & MOE	New		N/G	0.5	0.2	0.2	0.2	1.1	0.3	0.3	0.3
3	WST2040 (VW&WF)	Water as a Resource	People			Networking & Training for Industry on WF	KASA	KASA	New		N/G	0.3	0.1	0.1	0.1	0.6	0.2	0.2	0.2
4	WST2040 (WES)	Water as a Resource	People	Develop talent for water sector with multi/inter-disciplinary skillsets	Upgrade existing talent with key competencies	Review existing water-related research and development, research-inspired educational programs, training, and micro credentials in all educational institutions	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	On-going	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
5	WST2040 (WES)	Water as a Resource	People		Upgrade existing talent with key competencies across all key activity areas	Establish a National Water Centre of Excellence (CoE)	KASA	KASA	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
6	WST2040 (WES)	Water as a Resource	People			Talent mapping for water sector skill needs and technological foresighting based on global trends.	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
7	WST2040 (WES)	Water as a Resource	People			Review current curriculum to ensure 8Rs of water philosophy	KASA & MOHE	KASA & MOHE	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
8	WST2040 (WES)	Water as a Resource	People			Develop effective and attractive career pathways at all levels within the water ecosystem.	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
9	WST2040 (WES)	Water as a Resource	People			Establish talent pipelines from tertiary and TVET institutions	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
10	WST2040 (WES)	Water as a Resource	People			Incorporate continuous review and accreditation cycle of the current supply and demand talent requirements.	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
11	WST2040 (VW&WF)	Water for Livelihood	People	Enhance WF competency	Development of training modules and attainment of recognition by Certification Bodies (Statutory/Private)	Accreditation body	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2023	N/G	0.2	0.1	N/G	N/G	0.3	N/G	N/G	N/G
12	WST2040 (WES)	Water for Livelihood	People	Develop talent for water sector with multi/inter-disciplinary and entrepreneurial skillsets	Upgrade existing talent with key competencies across all key economic areas	Nurture next generation STI-preneurs within the water sector	KASA & MEDAC	KASA & MEDAC	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
13	WST2040 (WES)	Water for Livelihood	People		Upgrade existing talent with key competencies across all key economic areas	Knowledge Transfer	KASA	KASA	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
14	WST2040 (AWF)	Water for Livelihood	People	Encourage and support private investment and people participations in water supply, sewerage and other non-tariff activities in water sector	Encourage the private sector to invest in water sector	Establish Water Financing Coordination task force, consultation and engagement	KASA	UKAS, SPAN & Water Operators	New	2022 - 2025,2030,2035	N/G	1	N/G	N/G	N/G	1	1	1	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
15	WST2040 (AWF)	Water for Livelihood	People	Promote Disaster Risk Financing & Alternative Financing in Non-Commercial Water Project	Explore flexible social protection systems	Develop the model and priority of implementation, communicate, through engagement, develop option of implementation, implement.	KASA	SPAN & Water Operators	New	2022-2025	N/G	1	1	N/G	N/G	N/G			
16	WST2040 (AWF)	Water for Livelihood	People		Promote the role of the insurance market and property developer	Development the model, engagement, viability study, policy approval, Implementation.	KASA	SPAN, Water Operators, Financial Institutions (Banks, Insurance companies)	New	2023 - 2030	N/G	N/G	1	N/G	N/G				
17	WST2040 (AACB)	Cross-cutting	People	Institutionalization of public participatory platform (PPP)	To enhance participation of civil servants in PPPs	Training of 1 Focal Official in each 94 JPS District Offices for ToT. (RM 2,500/pax/training x 94 units)	KASA	KASA	New	12 th MP and Beyond	N/G	0.06	0.06	0.06	0.06	0.24	1.18	1.18	1.18
18	WST2040 (AACB)	Cross-cutting	People			Training of 222 Parliamentarian (Lump sum RM 3,000/pax/training x ~222 units)					N/G	0.17	0.17	0.17	0.17	0.67	0.84	0.84	0.84
19	WST2040 (AACB)	Cross-cutting	People			Training of 14 states' EXCO (RM 2,500/pax/training x 14 units)					N/G	0.02	0.02	0.042	0.042	0.13	0.21	0.21	0.21
20	WST2040 (AACB)	Cross-cutting	People			Training of 1 official in each 14 SEPU (RM 2,500/pax/training x 14 units)					N/G	0.018	0.018	0.035	0.035	0.11	0.11	0.11	0.11
21	WST2040 (AACB)	Cross-cutting	People			Training of 1 official in each 154 Local Authorities (RM 2,500/pax/ training x 154 units)					N/G	0.098	0.098	0.098	0.098	0.39	1.93	1.93	1.93
22	WST2040 (AACB)	Cross-cutting	People			Training of 1 official in each 171 District Offices. (RM 2,500/pax/ training x 171 units)					N/G	0.11	0.11	0.11	0.11	0.43	2.14	2.14	2.14
23	WST2040 (AACB)	Cross-cutting	People			Training of 27 Ministry Officials at Federal and State Levels (Lump sum RM 2,500/pax/training x ~80 units)	KASA	KASA	New	12 th MP and Beyond	N/G	0.067	0.067	0.067	0.067	0.268	1.69	1.69	3.38
24	WST2040 (AACB)	Cross-cutting	People			Training of PTD (40 pax X 6 training/ year x RM 2,500)	KASA	INTAN	New	12th MP and Beyond	N/G	3.60	3.60	3.60	3.60	14.40	18.00	18.00	18.00
25	WST2040 (AACB)	Cross-cutting	People	Reiterate importance of rivers as water resources for human and the environment	To train & retrain teachers on topics that are related to water resource management	Training & retraining teachers on topics that are related to water resource management	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	0.28	0.28	0.28	0.28	1.1	2.12	3.13	4.3
26	WST2040 (AACB)	Cross-cutting	People			Bahagian Pendidikan Guru (BPG) - Planning and conducting structured teacher professional development													
27	WST2040 (AACB)	Cross-cutting	People			Institut Pendidikan Guru Malaysia (IPGM) i) Training of Trainers ii) Teachers Training	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	N/G	N/G	N/G	N/G	0.01	0.01	0.01	0.01
28	WST2040 (AACB)	Cross-cutting	People		To train & retrain teachers on topics that are related to climate change education	Professional development program to familiarize teachers with climate science, active pedagogy and project design.	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	0.09	0.09	0.09	0.09	0.35	0.35	0.35	0.35
29	WST2040 (AACB)	Cross-cutting	People			BPG - Planning and conducting structured teacher professional development													
30	WST2040 (AACB)	Cross-cutting	People			IPGM i) Training of Trainers ii) Teachers Training					N/G	N/G	N/G	N/G	N/G	0.01	0.01	0.01	0.01

WST2040 Roadmap																			
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
31	WST2040 (AACB)	Cross-cutting	People	Inculcation of local values	To train & retrain teachers on activities that are related to water resource management.	Training & retraining teachers on activities that are related to water resource management.	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	0.28	0.28	0.28	0.28	1.1	2.12	3.13	4.3
32	WST2040 (AACB)	Cross-cutting	People			BPG - Planning and conducting structured teacher professional development for in-service teachers based on the guidebook or teaching module by ASM.													
33	WST2040 (AACB)	Cross-cutting	People			IPGM i) Training of Trainers ii) Teachers Training													
34	WST2040 (AACB)	Cross-cutting	People	Emphasize different responsibilities but common goals in ensuring good water quality and adequate water quantity	To train lecturers on topics and activities that are related to water resource management.	Training lecturers on topics and activities that are related to water resource management.	KASA & MOHE	KASA & MOHE	New	12th MP and Beyond	N/G	0.06	0.06	0.06	0.06	0.25	0.51	0.74	1.02
35	WST2040 (AACB)	Cross-cutting	People	Holistic "Training of Trainers" capacity building for business and industry cluster stakeholders	To train representative from each businesses and industries on IWRM and water resource management by providing AACB integrated training modules.	AACB "Training of Trainers"	KASA	KASA	New	12th MP and Beyond	N/G	0.18	0.18	0.18	0.18	0.72	1.2	1.2	1.2
36	WST2040 (AACB)	Cross-cutting	People	Provide competency certification for business and industry stakeholders who have undergone the training	Giving competency certification for EHS and Sustainability Professionals of business and industry.	Water management certificate	KASA	EiMAS	New	12th MP and Beyond	N/G	0.15	0.15	0.15	0.15	6	7.5	7.5	7.5
37	WST2040 (AACB)	Cross-cutting	People	Provide Continuing Professional Development (CPD) point to those Professional Practitioners (i.e. BEM, MBOT, MGBC, PAM, etc)	Giving CPD point to all staff and officer that attend business and industry module training.	CPD for water management	KASA & MOHR	HRDF	New	12th MP and Beyond	N/G	0.12	0.12	0.12	0.12	4.8	0.6	0.6	0.6
38	WST2040 (AACB)	Cross-cutting	People	Increasing community awareness and instil ownership towards rivers	To converge the issues and needs of ENGOs and community leaders in increasing IWRM awareness.	AACB Community Module Training Programme	KASA	KASA	New	12th MP and beyond	N/G	2.55	2.55	2.55	0.02	7.67	15.30	30.60	61.20
39	WST2040 (WFEN)	Cross-cutting	People	Capacity Building and Communication, Education and Public Awareness (CEPA) on WFE Nexus	Establish a WFEN Centre of Excellence (CoEs)		KASA	KASA	New	14th MP	N/G	N/G	N/G	N/G	N/G	25	30	15	N/G
40	WST2040 (WFEN)	Cross-cutting	People		Initiate and strengthen R&D in WFE Nexus/Nexus Modelling		KASA	KASA	New	15th MP	N/G	N/G	N/G	N/G	N/G	10.5	3	N/G	N/G
41	WST2040 (IR4.0WS)	Cross-cutting	People	Establishment of Innovation & Research and Development Centre (Centre of Excellence)	IR4.0 in water businesses	Create an ecosystem that supports training for IR4.0 amongst industry players	KASA, MITI, Sabah State Govt. & Sarawak State Govt.	KASA, MITI, Sabah State Govt. & Sarawak State Govt.	On-going	12th MP	30	50	70	100	150	300	500	500	500

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
42	WST2040 (IR4.0WS)	Cross-cutting	People	Malaysia Smart Water & Smart Citizen	Smart Citizen - The Great Urban Challenge (Phase 1) i.e., focusing on existing occupancies of residents/ businesses	Smart Water devices	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	On-going	13th MP 14th MP	N/G	N/G	N/G	N/G	N/G	N/G	1000	N/G	N/G
43	WST2040 (IR4.0WS)	Cross-cutting	People		Smart Citizen - The Great Urban Challenge (Phase 2)			KASA, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	5500	15000
44	WST2040 (IR4.0WS)	Cross-cutting	People		Smart Water & Smart Citizen (Development Framework)	Establishment of new policies that govern future smart homes / smart buildings	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	On-going	14th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	5000	N/G
45	WST2040 (IR4.0WS)	Cross-cutting	People		Smart Water & Smart Citizen (Implementation Phase)	70 precent of self-sufficient level (SSL) achieved	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	On-going	15th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	5000
46	WST2040 (CCIA)	Cross-cutting	People	Enhancing Community Engagement and Capacity in Disaster Management	Community-based activities	Plan and implement community-based activities	NADMA	Relevant Ministries	New	12th MP and beyond	N/G	N/G	3	3	3	9	9	9	10
47	WST2040 (CCIA)	Cross-cutting	People		Capacity building for disaster managers.	Hands-on technical training for local authorities and other operational agencies	NADMA	NADMA	New	12th MP and beyond	N/G	N/G	2	2	2	6	6	6	8
48	WST2040 (CCIA)	Cross-cutting	People	Empowering People to Strengthen Adaptive Capacity to Climate Change	Awareness training and community-based adaptation efforts	Conduct awareness training and community-based adaptation efforts	KASA	KASA & Relevant Ministries	New	12th MP and beyond	N/G	N/G	1	1	1	3	5	5	5
49	WST2040 (CCIA)	Cross-cutting	People		Technical capacity building	Conduct technical capacity building across relevant sectoral Ministries and agencies	KASA	KASA & Relevant Ministries	New	12th MP and beyond	N/G	N/G	1	1	1	3	5	5	5
50	WST2040 (CCIA)	Cross-cutting	People			Programmes	KASA & MAFI	DOF & LKIM	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
51	WST2040 (CCIA)	Cross-cutting	People			Interact with and educate the community regarding port operations and environmental program	KASA & MOT	Port Authorities	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
52	WST2040 (CCIA)	Cross-cutting	People		Competency training and certification	Training Courses	KASA	EiMAS	New	12th MP and beyond	N/G	0.015	0.05	0.015	0.015	0.095	N/G	N/G	N/G
53	WST2040 (CCIA)	Cross-cutting	People			Provide training course to train EO for EIA project	KASA	EiMAS	New	12th MP and beyond	N/G	0.015	0.05	0.015	0.015	0.095	N/G	N/G	N/G
54	WST2040 (CCIA)	Cross-cutting	People			Certificate of Competency	KASA	EiMAS	New	12th MP and beyond	N/G	0.02	0.05	0.015	0.015	0.1	N/G	N/G	N/G
55	WST2040 (CCIA)	Cross-cutting	People			Criteria of competence	KASA	MITI & SAMM	New	12th MP and beyond	N/G	0.02	0.02	0.02	0.02	0.08	N/G	N/G	N/G
56	WST2040 (CCIA)	Cross-cutting	People		Technical capacity building for health professionals	Climate change and health vulnerability and adaptation assessment (VNA).	KASA & MOH	MOH	New	12th MP	N/G	N/G	0.08	N/G	0.08	0.16	N/G	N/G	N/G
57	WST2040 (CCIA)	Cross-cutting	People			Climate resilient health care facilities.	KASA & MOH	MOH	New	12th MP	N/G	N/G	N/G	0.05	-	0.05	N/G	N/G	N/G
58	WST2040 (CCIA)	Cross-cutting	People			Health co benefit of climate change mitigation.	KASA & MOH	MOH	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	0.1	N/G	N/G
59	WST2040 (CCIA)	Cross-cutting	People			Strengthen the role of health education officers	KASA & MOH	MOH & NIH	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
60	WST2040 (CCIA)	Cross-cutting	People			Develop inquiry-based climate change pedagogical resources	KASA & MOE	KASA & MOE	New	12th MP and beyond	N/G	0.1	N/G	N/G	N/G	0.1	N/G	N/G	N/G
61	WST2040 (CCIA)	Cross-cutting	People			Train the trainers	KASA & MOE	KASA & MOE	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	1.06	2.12	3.18	4.24
62	WST2040 (CCIA)	Cross-cutting	People			Conduct professional development program	KASA & MOE	KASA & MOE	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	1.06	2.12	3.18	4.24
63	WST2040 (CCIA)	Cross-cutting	People			Develop a climate literacy assessment instrument.	KASA & MOHE	KASA & MOHE	New	12th MP	N/G	0.02	N/G	N/G	N/G	0.02	N/G	N/G	N/G
64	WST2040 (CCIA)	Cross-cutting	People			Platform for Online resource for finding water- and climate-related education programmes and resources	KASA & MOE	KASA & MOE	New	12th MP	N/G	1	N/G	N/G	N/G	1	N/G	N/G	N/G
65	WST2040 (CCIA)	Cross-cutting	People			Expand digital platforms/tools for teaching and learning	KASA & MOE	KASA & MOE	New	12th MP	N/G	1	N/G	N/G	N/G	1	N/G	N/G	N/G
66	WST2040 (CCIA)	Cross-cutting	People			Promote awareness among school children	KASA & MOE	KASA & MOE	New	12th MP and beyond	N/G	0.0544	0.0544	0.0544	0.0544	0.272	0.272	0.272	0.272
67	WST2040 (CCIA)	Cross-cutting	People			Educate present and future generations about climate change	KASA & MOE	KASA & MOE	New	12th MP	N/G	N/G	N/G	N/G	N/G	104.11	N/G	N/G	N/G
68	WST2040 (CCIA)	Cross-cutting	People			Develop blueprint and GRI report system.	KASA & MOHE	KASA & MOHE	On-going	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	0.2	N/G	N/G
69	WST2040 (CCIA)	Cross-cutting	People			Green Curriculum for all Malaysian polytechnic and community colleges programs	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12th MP and beyond	N/G	N/G	N/G	0.03	0.03	0.06	N/G	N/G	N/G
70	WST2040 (CCIA)	Cross-cutting	People			Courses/program that emphasize on skills in green technology and sustainability	KASA, MOHE & MOHR	KASA, MOHE & MOHR	On-going	12th MP and beyond	N/G	0.375	0.375	0.375	0.375	1.5	N/G	N/G	N/G
71	WST2040 (CCIA)	Cross-cutting	People			Develop teacher professional development workshop	KASA & MOHE	KASA & MOHE	New	12th MP	N/G	0.02	N/G	N/G	N/G	0.02	N/G	N/G	N/G
72	WST2040 (CCIA)	Cross-cutting	People			Compile local and international case studies on the best practises	KASA & MOHE	KASA & MOHE	New	12th MP	N/G	0.02	N/G	N/G	N/G	0.02	N/G	N/G	N/G
73	WST2040 (CCIA)	Cross-cutting	People			Education on water and climate change.	KASA & MOE	MOE	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	1.022	1.022	1.022	1.022
74	WST2040 (CCIA)	Cross-cutting	People			Education programmes that involve learners use open government data	KASA & MOE	MOE	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	0.08	0.16	0.25	0.33
75	WST2040 (CCIA)	Cross-cutting	People			Bachelor course in Sustainability and Green Technology (PALS1012) and master course in Climate Change in the Tropics.	KASA, MOE & MOHE	KASA, MOE & MOHE	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
76	WST2040 (CCIA)	Cross-cutting	People			Develop educational resources and activities on water and climate change.	KASA & MOE	MOE	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
77	WST2040 (CCIA)	Cross-cutting	People	Strengthening Capacity of Operational Agencies at the River Basin Level	Capacity building for urban planners, supporting staff and related professional bodies in spatial integration of DRR and CCA.	Train urban planners and supporting staff	NADMA	PlanMalaysia	New	12th MP and beyond	N/G	1	1	1	1	4	5	5	5
78	WST2040 (VW&WF)	Water as a Resource	Governance	Enhancement of policy and law to support WF initiatives	Incorporation of WF component in Dasar Air Negara (DAN)	Inclusion of WF components in DAN	KASA	KASA	New	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
79	WST2040 (VW&WF)	Water as a Resource	Governance	Mainstreaming WF in business	Establish requirement for water accounting report	Incorporation of WF in water accounting report	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2030 - 2040	N/G	0.2	0.1	0.1	0.1	0.5	0.5	0.5	0.5
80	WST2040 (VW&WF)	Water as a Resource	Governance		Strengthening water accounting report	Review report submitted by the industries, identify gaps, and suggestion for improvement.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2040	N/G	N/G	N/G	N/G	N/G	N/G	0.3	0.2	0.2
81	WST2040 (VW&WF)	Water as a Resource	Governance	Becoming global champion	Position Malaysian WF experts at international platform.	Collaboration with researchers from China, the Netherlands, and Germany.	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	2031 – 2035	N/G	N/G	N/G	N/G	N/G	N/G	N/G	1.5	N/G
82	WST2040 (VW&WF)	Water as a Resource	Governance		Elevating Malaysia role as a major player in global WF initiative.	Increase WF related outputs in term of publications, joint research, and capacity building.	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	2022 – 2040	N/G	1	0.5	0.5	0.5	2.5	2	2	2
83	WST2040 (VW&WF)	Water as a Resource	Governance		Exporting WF knowledge	Conducting training module, certification program, WF calculator, and WF reporting in Southeast Asian countries	KASA	KASA	New	2036 - 2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	2.5
84	WST2040 (VW&WF)	Water as a Resource	Governance	Strengthening Institutional set up	Creation of taskforce and guidelines	1. Establishing national taskforce on VW&WF. 2. Formulate guidelines on WF implementation.	KASA	KASA	New	2022 -- 2024	N/G	0.3	0.2	0.2	N/G	0.7	N/G	N/G	N/G
85	WST2040 (VW&WF)	Water as a Resource	Governance	Enhancing global trade	White paper on VW for the purpose of international trade agreement	Establishing committee members to prepare on white paper	MITI	MITI	New	2031 – 2035	N/G	N/G	N/G	N/G	N/G	N/G	N/G	0.2	N/G
86	WST2040 (VW&WF)	Water as a Resource	Governance		Optimising global water management through VW trade under several trade agreements	Formulation of terms and conditions on VW for mutual trade	MITI	MITI	New	2031 – 2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	1	1.5
87	WST2040 (VW&WF)	Water as a Resource	Governance		Inclusion of VW in international trade agreement	Forming VW caucus for trade negotiation.	MITI	MITI	New	2036 -- 2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	1
88	WST2040 (WES)	Water as a Resource	Governance	Demand Side Water Management	Adopt the 4Es (Enable, Encourage, Engage, Exemplify) of demand side (public & industry) behaviour management Ensuring appropriate education, incentives, and policies are in place to encourage stronger water conservation practices	Enable: Embedding water education that incorporates the 8Rs of water philosophy in school curriculums, general public, and industrial practices.	KASA & MOE	KASA & MOE	Ongoing	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
89	WST2040 (WES)	Water as a Resource	Governance			Encourage: Review existing business/consumer-friendly policies/practices to ensure that they are consistent and aligned with 8Rs of water philosophy.	KASA, MITI & MEDAC	KASA, MITI & MEDAC	Ongoing	2024	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
90	WST2040 (WES)	Water as a Resource	Governance			Encourage: Review current tax incentives, subsidies and grants for local technology development aligned to 10-10 *My*STIE	KASA & MOSTI	KASA & MOSTI	New	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
91	WST2040 (WES)	Water as a Resource	Governance			Encourage: Adopt periodic review cycle for competitive water and sewerage tariff rate mechanisms	KASA	KASA	On-going	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

WST2040 Roadmap																				
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											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
92	WST2040 (WES)	Water as a Resource	Governance			Encourage: Provide tax rebates for consumers and industries that adopt water conservation technologies and systems.	KASA	KASA	New	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
93	WST2040 (WES)	Water as a Resource	Governance			Engage: Include private sector and consumer participation in the water management decision making process.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	Continuous	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
94	WST2040 (WES)	Water as a Resource	Governance			Engage: Intensify interactive community engagements	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	Ongoing	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
95	WST2040 (WES)	Water as a Resource	Governance			Exemplify: Identifying industry and community water champions/role-models/influencers/ambassadors	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2025	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
96	WST2040 (WES)	Water as a Resource	Governance	Institutional Reforms	National Water Sector Transformation	Establish river basin organisations	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
97	WST2040 (WES)	Water as a Resource	Governance			Establish the National Water Sector Transformation Task Force (strengthen Federal-State cooperation and collaboration)	KASA & EPU	KASA & EPU	New	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
98	WST2040 (WES)	Water as a Resource	Governance			Undertake STIE foresighting and scenario planning to future-proof water sector and water-related industries	KASA & EPU	KASA ,EPU & MIGHT	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
99	WST2040 (WES)	Water as a Resource	Governance		Harmonising and strengthening the water legislative framework and Environmental, Sustainability, Governance (ESG) standards related to water	Strengthen economic regulatory legislation (e.g. pricing policies, tax incentives, tariffs setting, FDI rules, and business-friendly policies) that encourage private sector participation and foreign investments into the water sector.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
100	WST2040 (WES)	Water as a Resource	Governance			Harmonize regulation and legislation between federal and state governments.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	On-going	2025	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
101	WST2040 (WES)	Water as a Resource	Governance			Incorporate ESG standards related to water sector management in green rating of buildings and halal certification.	KASA	KASA	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
102	WST2040 (WES)	Water as a Resource	Governance			Review and strengthening of laws and enforcement capacity on pollution control from non-point sources	KASA	KASA	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
103	WST2040 (WES)	Water as a Resource	Governance			Review laws on data/information sharing among government agencies and the public (e.g. Official Secrets Act)	JPM	JPM	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
104	WST2040 (WES)	Water as a Resource	Governance		Increasing transparency and accountability	Operators within the water-value chain need to provide 5-year business plans	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
105	WST2040 (WES)	Water as a Resource	Governance		Increasing transparency and accountability	Greater adoption of digital platforms aligned with 10-10 *My*STIE	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2025	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
106	WST2040 (VW&WF)	Water for Livelihood	Governance	Mainstreaming WF in business	Promotion of WF labelling scheme among local producers	1. Updating water scarcity index (WSI) with climate change scenario at district level 2. Preparing and dissemination information on the benefit of WF labelling	KASA & MITI	SIRIM	New	2024	N/G	N/G	1.5	0.5	N/G	2	N/G	N/G	N/G
107	WST2040 (VW&WF)	Water for Livelihood	Governance		Development of WF calculator	1. Identification of suitable online domain, theme, and big data compilation. 2. Inclusion of WF inventory from case studies	KASA	KASA	New	2040	N/G	0.3	0.25	0.25	0.2	1	0.5	0.5	0.5
108	WST2040 (VW&WF)	Water for Livelihood	Governance	Enhance WF competency	Conduction of competency training program for water managers	Conduction of training of trainers programme	KASA	KASA	New	2023 – 2040	N/G	N/G	0.2	0.1	0.1	0.4	0.5	0.5	0.5
109	WST2040 (VW&WF)	Water for Livelihood	Governance	Strengthening Institutional set up	Establishment of a model river basin to fully implement WF concept	1. Set up criteria for river basin selection. 2. Prioritize potential river basin.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2026 – 2035	N/G	N/G	N/G	N/G	N/G	N/G	50	20	N/G
110	WST2040 (AWF)	Water for Livelihood	Governance	Review and implement new policy and regulatory instruments to support AWF in water and sewerage	Amendment of existing policy and subsidiary legislation under Act 655 to support AWF	Establish policy options and proposed amendment, Consultation, Policy Approval, Implementation, Enforcement	KASA	SPAN,AGC	On-going	2022 (extension of license period),2032	N/G	0.5	N/G	N/G	N/G	0.5	N/G	0.5	N/G
111	WST2040 (AWF)	Water for Livelihood	Governance		Amendment of Act 655 to support AWF	Develop proposal of Amendment, Consultation, Policy Approval, AGC Approval, Policy Approval II, Law Making Process through Parliament, Enforcement	KASA	SPAN & Water Operators	On-going	2023 (1st Cycle), 2033 (if required)	N/G	N/G	1	N/G	N/G	1	N/G	1	N/G
112	WST2040 (AWF)	Water for Livelihood	Governance	Establish "facility licence" to finance, develop and own sewerage assets	Establishment of facility licencee for sewerage asset adopting PAAB Model	Develop business model, develop policy option (PAAB or new company), consultation, determine financing and repayment model, policy approval and implementation	KASA	SPAN,AGC	New	2025	N/G	N/G		1.5		1.5	N/G	N/G	N/G
113	WST2040 (IWSDC)	Cross-cutting	Governance	Enhancing Seamless Data Sharing	Initiatives, Policies and Laws to Enhance Data Sharing	Data Sharing Agreement/ Arrangement	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
114	WST2040 (IWSDC)	Cross-cutting	Governance			Malaysia to be part of international Open Data Alliance / Partnership	KASA & MCMM	KASA & MCMM	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
115	WST2040 (IWSDC)	Cross-cutting	Governance			Adoption of Open Science including indigenous knowledge and crowdsourcing programs and initiatives	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
116	WST2040 (IWSDC)	Cross-cutting	Governance			Data Sharing Policy Review	JPM	JPM (BHEUU)	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
117	WST2040 (IWSDC)	Cross-cutting	Governance			Data Sharing Law Review	JPM	JPM (BHEUU)	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
118	WST2040 (IWSDC)	Cross-cutting	Governance			Review of Fees Act 1951	JPM	JPM (BHEUU)	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
119	WST2040 (IWSDC)	Cross-cutting	Governance			Review of Statistics Act 1965 by DOSM	JPM	JPM (DOSM)	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
120	WST2040 (IWSDC)	Cross-cutting	Governance	Tools to Quantify and Assess Water Governance	Governance Tools and System Development	Water Accounting Tools	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
121	WST2040 (IWSDC)	Cross-cutting	Governance			Water Accounting System	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
122	WST2040 (IWSDC)	Cross-cutting	Governance			Water Auditing Tools	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
123	WST2040 (IWSDC)	Cross-cutting	Governance			Water Auditing System	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
124	WST2040 (IWSDC)	Cross-cutting	Governance			Water Security Report (annual)	KASA & MKN	KASA & MKN	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
125	WST2040 (IR4.0WS)	Cross-cutting	Governance	1. Establishment of new laws and policies for data sharing 2. Improvement and enhancement of existing laws and policies for data sharing	1. Water to be recognised as a National Security Agenda 2. Amendment of existing laws and policies for data sharing 3. Formulation of Cybersecurity Policy on Data Protection and Data Sharing 4. Data and information on water sector	1. Production of Annual Water Security Report 2. Enhancement to PDPA 2010 (Act 709)	KASA & JPM	KASA & JPM	On-going	1. 14th MP 2. 13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
126	WST2040 (IR4.0WS)	Cross-cutting	Governance		1. Review of Statistics Act 1965 2. Amendments to Statistics Act 1965	1. To propose water and water related data to be included in review of Statistics Act 1965 2. Amendments to STA 1965	KASA & JPM	KASA & JPM	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
127	WST2040 (IR4.0WS)	Cross-cutting	Governance		Freedom of Information Law	1. Establishment of Freedom of Information Law 2. Formulation of Right to Information legislation and repeal of Official Secrets Act (OSA). 3. Formulating Freedom of Information Enactments (FOIE)	KASA & JPM	KASA & JPM	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
128	WST2040 (IR4.0WS)	Cross-cutting	Governance		Review of Fees Act 1951	1. To establish a circular for zero (0) rate fees under the Fees Act 1951 2. To gazette a Warta Kerajaan on no fee for reproduction, scanning, digitizing of data among the government bodies, government agencies and local authorities for national interest 3. Overhaul of Fees Act 1951	JPM	JPM	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
129	WST2040 (CCIA)	Cross-cutting	Governance	Strengthening Governance and Partnerships at All Levels	National policy on disaster risk management	Develop a national policy on disaster risk management	NADMA	NADMA	New	12th MP and beyond	N/G	N/G	1	N/G	N/G	1	5	5	5
130	WST2040 (CCIA)	Cross-cutting	Governance		Improve the efficiency of disaster response measures.	Strengthen disaster risk management through establishment of NADMA office at state level.	NADMA	NADMA	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	50	100	50
131	WST2040 (CCIA)	Cross-cutting	Governance		Adaptation actions, implementation, monitoring and reporting of climate change adaptation progress at all levels.	National adaptation action plan	KASA	KASA	New	12th MP and beyond	N/G	N/G	1.5	1	1	3.5	10	10	10
132	WST2040 (CCIA)	Cross-cutting	Governance		CCA centre	Establishment of CCA centre	KASA	KASA & JPA	New	12th MP and beyond	N/G	N/G	N/G	0.5	1.5	2	20	10	10

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
133	WST2040 (AACB)	Cross-cutting	Governance	Training module to enhance leadership roles of civil servants	To enhance enforcement capacity of civil servants via AACB training program.	Training of 1 official in each 14 State Secretary of State Government offices (266 pax) at State and Federal levels. (RM 2,500/ pax/training x 266 units)	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and Beyond	N/G	0.035	0.035	0.035	0.035	0.14	0.175	0.175	0.175
134	WST2040 (AACB)	Cross-cutting	Governance			IWRM Expert in each 27 ministries at Federal (405 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/ training x 405 units)	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	0.34	0.34	0.34
135	WST2040 (AACB)	Cross-cutting	Governance			IWRM Expert in each 27 ministries at State (2, 025 pax) level under their jurisdiction for better coverage, monitoring and decision making. (Lump sum RM 2,500/pax/ training x 2,025 units)	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	1.69	1.69	1.69
136	WST2040 (AACB)	Cross-cutting	Governance			IWRM Expert in each 154 Local Authority (780 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 780 units)	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	0.49	0.49	0.98
137	WST2040 (AACB)	Cross-cutting	Governance			IWRM Expert in each 171 District Office (860 pax) level under their jurisdiction for better coverage, monitoring and decision-making. (Lump sum RM 2,500/pax/training x 860 units)	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	0.54	0.54	1.08
138	WST2040 (AACB)	Cross-cutting	Governance			1 IWRM expert to coordinate each of the 16 National AACB WST Training Centers (240 pax). (Lump sum RM 1,000/pax/240 units)	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	0.80	0.80	0.80
139	WST2040 (AACB)	Cross-cutting	Governance	Reiterate importance of rivers as water resources for human and the environment	Develop a guidebook on water sustainability climate change adaptation that could be used by teachers in Malaysia.	Develop teacher professional development workshop module and pedagogical activities	KASA & MOE	KASA & MOE	New	12th MP	N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
140	WST2040 (AACB)	Cross-cutting	Governance			Develop inquiry-based climate change pedagogical resources	KASA & MOE	KASA & MOE			N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
141	WST2040 (AACB)	Cross-cutting	Governance			Offering courses related to water sustainability and climate change education in Program Ijazah Sarjana Muda Pendidikan (PISMP)	KASA, MOE & MOHE	KASA, MOE & MOHE			N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
142	WST2040 (AACB)	Cross-cutting	Governance			Incorporate elements of sustainable water resources management into relevant teaching programmes	KASA & MOE	KASA & MOE			N/G	0.25	0.25	0.25	0.25	1	N/G	N/G	N/G
144	WST2040 (AACB)	Cross-cutting	Governance	Inculcation of local values	Compile case studies of best practises of river/ water management and climate adaptation	1. Compile local and international case studies on the best practices	KASA & MOE	KASA & MOE	New	12th MP	N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
145	WST2040 (AACB)	Cross-cutting	Governance			2. Strengthen collaboration and cooperation between TVET and industry	KASA & MOE	KASA & MOE			N/G	0.25	0.25	0.25	0.25	1	N/G	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
146	WST2040 (AACB)	Cross-cutting	Governance	Emphasize different responsibilities but common goals in ensuring good water quality and adequate water quantity	Compile success stories related to water resources management	To compile success stories related to water resources management	KASA & MOHE	KASA & MOHE	New	12th MP	N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
147	WST2040 (AACB)	Cross-cutting	Governance	Government to form strategic partnership with business and industry	Strategic partnership with business and industry	Water resource person network and directory	KASA	KASA	New	12th MP and Beyond	N/G	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
148	WST2040 (AACB)	Cross-cutting	Governance	Increasing community awareness and instil ownership	To establish a formal platform/ state IWRM Training Centre.	AACB Community Module Training Programme	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
149	WST2040 (CCIA)	Cross-cutting	Governance	Adopting Integrated Approaches for Climate Change Adaptation and Disaster Risk Reduction	Land use and spatial planning governance at all levels	Study the roles of land use and spatial planning governance in Peninsular Malaysia	NADMA	PLANMalaysia	New	12th MP	N/G	N/G	0.5	0.5	N/G	1	N/G	N/G	N/G
150	WST2040 (CCIA)	Cross-cutting	Governance		Guidelines for disaster resilient cities	Formulate disaster resilience guidelines, preparedness plans, building codes and retrofitting approaches	KASA, KPKT & NADMA	KASA, KPKT & NADMA	New	12th MP and beyond	N/G	N/G	N/G	2	3	5	10	10	10
151	WST2040 (CCIA)	Cross-cutting	Governance		Smart partnerships and coordination platforms	Strengthen coordination platform which relate environment & health	KASA & MOH	MOH	On-going	12th MP and beyond	0.5	0.5	0.5	0.5	0.5	2.5	2	2	2
152	WST2040 (CCIA)	Cross-cutting	Governance			Public health standard on drinking water quality	KASA & MOH	MOH	On-going	12th MP and beyond	N/G	N/G	19.3	15	15	49.3	75	75	75
153	WST2040 (CCIA)	Cross-cutting	Governance			Assess the resilience status of healthcare facilities	KASA & MOH	MOH	On-going	12th MP and beyond	N/G	N/G	0.1	N/G	N/G	0.1	0.1	N/G	N/G
154	WST2040 (CCIA)	Cross-cutting	Governance			Managing climate sensitive diseases	KASA & MOH	MOH	On-going	12th MP	3.00	5.26	6.02	6.77	7.52	28.57	N/G	N/G	N/G
155	WST2040 (CCIA)	Cross-cutting	Governance			Strengthen steering committee link with technical committee with regular meetings	KASA & MOH	MOH	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
156	WST2040 (CCIA)	Cross-cutting	Governance		Partnerships, coordination platforms and framework for integrating climate and disaster risks.	Implement MyGAP and registration for all farms	KASA & MAFI	DOF	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
157	WST2040 (CCIA)	Cross-cutting	Governance			Collaborate with UPNM in the study of the development of Wave Energy Converter	KASA & MOT	Port Authorities	On-going	12h MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
158	WST2040 (CCIA)	Cross-cutting	Governance		Comprehensive groundwater governance at all levels .	Standing committee on groundwater	KeTSA	JMG	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
159	WST2040 (CCIA)	Cross-cutting	Governance	Strengthening Regional Linkages on Disaster Risks, Climate Change and IWRM	International linkages on disaster management	Strengthen linkages with ASEAN and other international platforms	NADMA	KASA, MOHE & MOSTI	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	2	2	2

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
160	WST2040 (WFEN)	Cross-cutting	Governance	Multi-tiered institutional arrangement to govern WFEN approaches	Establish a National Water Department (NWD)		KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	13th MP	N/G	N/G	N/G	N/G	N/G	20	N/G	N/G	N/G
161	WST2040 (WFEN)	Cross-cutting	Governance		Establish a River Basin Organisation		KASA, Sabah State Govt. & Sarawak State Govt.	Local Authorities	New	14th MP	N/G	N/G	N/G	N/G	N/G	4.5	12.5	7.5	2.5
162	WST2040 (WFEN)	Cross-cutting	Governance		Develop informational policy instruments		KASA	KASA	New	15th MP	N/G	N/G	N/G	N/G	N/G	2.5	2.5	2.5	2.5
163	WST2040 (VW&WF)	Water as a Resource	Information & RDIC	Enhanced R&D in WF	Implementation of WF R&D within river basin framework	1. Conduction of comprehensive WF study for selected river basins. 2. Involvement of local authorities in the water planning at river basin level.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	2023 – 2040	N/G	N/G	0.5	0.5	0.5	1.5	2.5	2.5	2.5
164	WST2040 (VW&WF)	Water as a Resource	Information & RDIC		Implementation of WF R&D for selected sectors	Analyse and calculate WF for major products and services (20 selected case studies)	EPU	EPU	New	2023 – 2040	N/G	N/G	0.5	0.5	0.5	1.5	3.5	2.5	2.5
164	WST2040 (VW&WF)	Water as a Resource	Information & RDIC		Enhancing global trade	Comprehensive studies on global economic opportunities, drivers, and impacts of VW	MITI	MITI	New	2031 – 2035	N/G	N/G	N/G	N/G	N/G	N/G	N/G	0.2	N/G
165	WST2040 (IR4.0WS)	Cross-cutting	Information & RDIC	Digitalize all existing manual water ecosystem	1. Upgrade to full system, application, and technology development (digitalization) like water supply, water treatment, water health, water sewerage, ground water, smart meter, GIS, etc. 2. Redesign the water ecosystem to be more supportive of digitilisation	1. Talent grooming program inclusive of transformational existing talents into roles and functions that support digitilisation at all levels 2. Standardize roll out program supporting digitilisation	KASA	KASA	On-going	13th MP	2000	2000	2000	2000	2000	10000	5000	2000	2000
166	WST2040 (IR4.0WS)	Cross-cutting	Information & RDIC	Big Data Analytic & Data Warehouse	Data sharing & Integration Framework	1. Cloud computing & virtualization platform. 2. Centralize platform and database (Dashboard, KPI Management, Operation Tactical and Planning, Asset Management, Maintenance Planning, Reporting, etc) 3. Optimize the existing system like NAWABS, NaFFWS, etc 4. Business intelligence (BI) tools to improving strategic decision-making and providing a competitive advantage.	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	13th MP	40	40	40	40	40	200	500	N/G	N/G
167	WST2040 (AACB)	Cross-cutting	Information & RDIC	Integrated and comprehensive data sharing and management	To ensure flow of reliable data and information from relevant agencies to the local govt. for IWRM.	Digitalisation of WST 2040 AACB training module (Lump sum)	KASA	KASA	New	13th MP and Beyond	N/G	N/G	N/G	N/G	N/G	N/G	0.05	0.05	0.05
168	WST2040 (AACB)	Cross-cutting	Information & RDIC			GIS map preparation for district and local authority boundary of 189 river basins & Web-based pollution mapping via sensor	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and Beyond	N/G	1.89	0.05	0.05	0.05	2.04	0.1	0.1	0.1

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
169	WST2040 (AACB)	Cross-cutting	Information & RDIC	Reiterate importance of rivers as water resources for human and the environment	Information focusing on water	Develop a water and climate literacies assessment instrument	KASA & MOHE	KASA & MOHE	New	12th MP	N/G	0.01	0.01	N/G	N/G	0.02	N/G	N/G	N/G
170	WST2040 (AACB)	Cross-cutting	Information & RDIC			Establish a whole-school approach to promote water and climate literacies	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	0.21	0.21	0.21	0.21	0.85	0.17	0.2	0.33
171	WST2040 (AACB)	Cross-cutting	Information & RDIC	Inculcation of local values	Edutation on open government data related to water and climate change	Federal and state/local agencies education programmes	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	0.21	0.21	0.21	0.21	0.85	0.17	0.25	0.33
172	WST2040 (AACB)	Cross-cutting	Information & RDIC	Emphasize different responsibilities but common goals in ensuring good water quality and adequate water quantity	Database, RDCI Prioritisation & Outreach Programs	To establish a database of resource persons	KASA	KASA	New	12th MP and Beyond	N/G	0.01	0.01	0.02	N/G	0.05	N/G	N/G	N/G
173	WST2040 (AACB)	Cross-cutting	Information & RDIC			To mainstream water resource management as one of the priority research areas in RDCI	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	12th MP and Beyond	N/G	5.00	5.00	5.00	5.00	20.00	20.0	20.0	20.0
174	WST2040 (AACB)	Cross-cutting	Information & RDIC			Researchers' outreach program to government agencies.	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	12th MP and Beyond	N/G	1.25	1.25	1.25	1.25	5.0	5.0	5.0	5.0
175	WST2040 (AACB)	Cross-cutting	Information & RDIC			Researchers' outreach program to industry.	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	12MP and Beyond	N/G	1.25	1.25	1.25	1.25	5.0	5.0	5.0	5.0
176	WST2040 (AACB)	Cross-cutting	Information & RDIC			Researchers' outreach program to community.	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	12th MP and Beyond	N/G	1.25	1.25	1.25	1.25	5.0	5.0	5.0	5.0
177	WST2040 (AACB)	Cross-cutting	Information & RDIC	Resource person	Publication and dissemination of water best management practices	Water best management practices communication	KASA	KASA	New	12MP and Beyond	N/G	0.1	0.1	0.1	0.1	0.4	0.5	0.5	0.5
178	WST2040 (AACB)	Cross-cutting	Information & RDIC	Increasing community awareness and instil ownership towards rivers	To provide informative and compact data on water management	AACB Information Corner	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and beyond	0	0.01	0.01	0.01	0.01	0.04	0.10	0.15	0.20
179	WST2040 (AACB)	Cross-cutting	Information & RDIC			Notice Board by The River	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and beyond	0	0.05	0.05	0.05	0.05	0.20	0.50	0.75	1.00
180	WST2040 (CCIA)	Cross-cutting	Information & RDIC	Implementing Evidence-Based and Risk-Informed Actions	Multi-hazard risk management and vulnerability assessment	Expand multi-hazard risk management and vulnerability assessment	KASA, KeTSA, MOSTI & NADMA	MET Malaysia, JPS, JMG, MYSA & JKR	On-going	12th MP and beyond	4.5	N/G	N/G	N/G	N/G	4.5	15	20	30
181	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Establish a multi-hazard data centre and risk register platform	Strengthen one stop environment-related data centre	NADMA	NDCC	New	12th MP and beyond	N/G	12	N/G	50	N/G	62	150	50	50
182	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Streamline land use planning for river basins and administrative boundaries.	Conduct pilot studies to streamline land use planning with IWRM	NADMA	PLANMalaysia	New	12th MP	N/G	N/G	3	4.5	1.5	9	N/G	N/G	N/G
183	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Mainstream IWRM,IRBM, ESAs, climate change adaptation and disaster risk reduction	NADMA	PLANMalaysia	New	12th MP and beyond	N/G	N/G	N/G	1.75	4.25	6	2.5	N/G	N/G
184	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Monitoring and assessment of emerging groundwater hazards	Undertake vulnerability assessment and climate change impacts	KeTSA & NADMA	JMG	New	12th MP & beyond	N/G	N/G	N/G	1.5	2	3.5	30	40	50
185	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Conduct groundwater hazards mapping	KeTSA & NADMA	JMG	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	35	35	35

WST2040 Roadmap																			
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
186	WST2040 (CCIA)	Cross-cutting	Information & RDIC	Enhancing Capability for Data Driven Decision-making	Weather, climate and geophysical information services for water related hazards such as flood, drought and tsunami.	Strengthen the surface meteorological observations networks	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	1.00	5.00	N/G	4.00	6.00	16.00	10.00	10.00	10.00
187	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen the weather radar and satellite systems	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	30.00	25.00	4.00	N/G	29.00	88.00	30.00	30.00	30.00
188	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Empower Meteorological Main Computing System	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	N/G	1.30	4.00	9.00	6.00	20.30	25.00	30.00	30.00
189	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Enhance earthquake and tsunami monitoring and early warning systems.	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	8.00	8.00	9.00
190	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen seismic, tsunami siren and tide gauge monitoring networks.	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	6.19	8.12	N/G	N/G	N/G	14.31	10.00	25.00	10.00
191	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Enhance climate database and products	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	2.10	2.80	N/G	N/G	N/G	4.90	5.00	15.00	5.00
192	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop new method of cloud seeding	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	4.00	4.00	20.00	N/G	N/G
193	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Climate science and modelling for planning and implementation to support decision-making at the river-basin level.	Develop the Mesoscale Ensemble prediction System	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	6.49	N/G	N/G	N/G	N/G	6.49	N/G	N/G	N/G
194	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Improve numerical weather modelling product (WRF subkm).	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	N/G	N/G	10.00	38.00	N/G	48.00	100.00	N/G	200.00
195	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Improve Climate Change Resilience in Megacity	KASA & NADMA	MET Malaysia	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	50	N/G	100
196	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Atmospheric pollution-related monitoring and modelling	KASA & NADMA	MET Malaysia	New	12th MP and beyond	N/G	N/G	N/G	1.5	1.5	3	N/G	N/G	N/G
197	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen the National GHG monitoring station	KASA & NADMA	MET Malaysia	On-going	12th MP and beyond	2.00	2.80	N/G	N/G	N/G	4.80	15.00	N/G	30.00
198	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Simulate dynamics and interconnections between three major subsystems of the globe	KASA & NADMA	MET Malaysia	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	10	N/G	N/G
199	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Climate change impacts on water resources and supply at the river basin scale.	Expand National Water Balance System (NAWABS) and National Flood Forecasting and Warning system (NaFFWS) to other river basin in Malaysia	KASA, KeTSA, MAFI & NADMA	JPS	On-going	12th MP and beyond	24	24	24	24	24	120	120	120	120
200	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Smart technology for irrigation systems and crop production.	Implement IoT and sensor technologies	KASA & MPIC	MPB & DOA	On-going	12th MP Project	0.08	0.03	0.03	N/G	N/G	0.14	N/G	N/G	N/G
201	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Implement IoT and sensor technologies in production of white pepper berries.	KASA & MPIC	MPB & DOA	On-going	12th MP Project	0.03	0.02	0.02	0.02	0.02	0.11	N/G	N/G	N/G
202	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop water foot print for sustainable natural rubber production.	KASA & MPIC	MRB	New	12th MP and beyond	N/G	N/G	N/G	0.075	0.07	0.145	0.065	N/G	N/G
203	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Study on water use efficiency in oil palm plantation	KASA & MPIC	MPOB	New	12th MP	0.5	0.2	0.1	0.1	0.1	1	N/G	N/G	N/G
204	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Study on enhancement of oil palm water use efficiency in water deficit condition.	KASA & MPIC	MPOB	New	13th MP	0.05	0.05	0.05	0.05	0.05	0.25	N/G	N/G	N/G
205	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Organize workshop to introduce new technology packages to pepper growers.	KASA & MPIC	MPB & DOA	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	0.1	0.1	0.1

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
206	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Public health emergency preparedness	Integrated database system of epidemics and environmental disasters	KASA, MOH & NADMA	MOH	New	12th MP	N/G	N/G	N/G	N/G	N/G	1	N/G	N/G	N/G
207	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen (review) preparedness and response to extreme weather event	KASA, MOH & NADMA	MOH	On-going	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
208	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Surveillance system and early warning system	KASA & MOH	KASA & MOH	New	12th MP and beyond	N/G	N/G	0.2	0.2	0.2	0.6	1	1	1
209	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop Drinking Water Quality Index (DWQI)	KASA & MOH	MOH	New	12MP and beyond	N/G	N/G	0.2	N/G	N/G	0.2	N/G	N/G	N/G
210	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop environmental health information system for coordinating health data.	KASA & MOH	MOH	New	12th MP	N/G	N/G	5	5	5	15	N/G	N/G	N/G
211	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop climate-sensitive disease surveillance system; to integrate climate data with relevant diseases.	KASA & MOH	MOH	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	2	N/G	N/G
212	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Conduct vulnerability assessment of climate sensitive diseases.	KASA & MOH	IMR	On-going	12th MP and beyond	N/G	0.2	0.2	0.2	0.1	0.7	0.7	0.7	0.7
213	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Conduct impact assessment of climate sensitive diseases	KASA & MOH	MOH IMR	New	12th MP and beyond	N/G	N/G	N/G	N/G	0.3	0.3	0.3	0.3	0.3
214	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop GIS real-time monitoring and health-based warning system.	KASA & MOH	MOH	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
215	WST2040 (CCIA)	Cross-cutting	Information & RDIC	Assimilating Knowledge to Improve Planning and Implementation	Vulnerability, hazards and emerging issues to address the impact of climate change and disasters.	Vulnerability and adaptation assessment (VNA)	KASA & MOH	NAHRIM & IMR	New	12th MP and beyond	N/G	N/G	1	2	2	5	5	10	10
216	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Vulnerability, Impact and Integration of Climate Change Adaptation and Disaster Risk Reduction	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	1.50	1.50	1.50
217	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop long-term physical oceanographic monitoring station	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	6.00	3.00	1.50
218	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Reconciliate among the dominance forces	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	3.00	4.50	2.50
219	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Address coastal and marine related disaster	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	2.20	3.00	3.00
220	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research on identification of sensitive and high vulnerability areas	KASA & NADMA	NAHRIM	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	3.50	4.00	4.00
221	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research and integrating of climate change data and information in planning	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	2.30	3.00	3.00
222	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research on capacity building program and nature-based adaptation technology.	KASA & NADMA	NAHRIM	On-going	12MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	2.20	3.00	3.00
223	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen capacity and mechanism in risk assessment	KASA & NADMA	NAHRIM	On-going	12MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	1.50	1.50	1.50
224	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Develop of long-term physical oceanographic monitoring station	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	6.00	3.00	1.50
225	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Amplify and promote green infrastructure strategies	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	1.50	1.00	0.50
226	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research and study on improving resilience, vulnerability assessment, impact and adaptation of climate change on water resources and services.	KASA & NADMA	NAHRIM	New	12th MP and beyond	N/G	0.5	1.5	1.5	0.5	4	5	5	5

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
227	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research on identification of sensitive and high vulnerability areas	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	0.3	0.3	0.4	0.3	0.3	1.6	2	2	2
228	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research on Coastal Reservoir as a new freshwater resource	KASA & NADMA	NAHRIM	Pilot Project	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
229	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Research and integrating of climate change data and information in planning and risk reduction actions	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	0.7	0.7	1.1	1.2	0.7	4.4	5	5	5
230	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Mainstream sea level rise and storm surge projections into the Integrated Shoreline Management Plan (ISMP) .	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	2	3	4	3.5	1.5	14	8	5	3
231	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Increase diversification and exploration of alternative water sources.	KASA & NADMA	NAHRIM	On-going	12th MP and beyond	2	N/G	N/G	N/G	N/G	2	3	1.5	2
232	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Establish Malaysia Grand Challenge (MGC); offer five (5) R&D Funding Schemes.	KASA & MOSTI	MOSTI	On-going	12th MP	80	100	138	130.3	51.7	500	N/G	N/G	N/G
233	WST2040 (CCIA)	Cross-cutting	Information & RDIC		Strategic and emerging issues across terrestrial margins and oceans.	Capturing the impacts of environmental change	KASA, MAFI & MOHE	MOHE	On-going	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
234	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Strengthen impact assessment research	KASA & MAFI	DOF	New	13MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
235	WST2040 (CCIA)	Cross-cutting	Information & RDIC			Site visits to port operating area to improve water quality and reduce the Port's water usage.	KASA & MOT	LPKTN/KPC/ Port Authority & Terminals	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
236	WST2040 (WFEN)	Cross-cutting	Information & RDIC	Database	Establish a Decision Support System		KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	15th MP	N/G	N/G	N/G	N/G	N/G	20	30	5	5
237	WST2040 (IWSDC)	Cross-cutting	Information & RDIC	Establishment of an Integrated, Single-point Reference Centre	Establish IWSDC	Establish IWSDC	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
238	WST2040 (IWSDC)	Cross-cutting	Information & RDIC			WSDC Operation (Maintenance, Upgrading & Emoluments)	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
239	WST2040 (VW&WF)	Water as a Resource	Finance	Provision of financial rewards and incentives	Initiate tax incentive upon completion of water reporting	Drafting of financial rewards in the form of tax incentives	KASA & MOF	KASA & MOF	New	2027	N/G	N/G	N/G	N/G	N/G	N/G	0.5	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
240	WST2040 (WES)	Water for Livelihood	Finance	Increase value creation of the local water sector to nurture and sustain a circular economy	Attract high quality local private sector and foreign direct investments into the water sector	Ensure business-friendly policies to encourage greater private sector participations into the water sector	KASA & MITI	MIDA	On-going	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
241	WST2040 (WES)	Water for Livelihood	Finance			Instil a more competitive market structure for the water suppliers from the private sectors	KASA	KASA	On-going	2025	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
242	WST2040 (WES)	Water for Livelihood	Finance			Adopt competitive tariff rate mechanisms to ensure business sustainability	KASA	KASA	New	2022	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
243	WST2040 (WES)	Water for Livelihood	Finance			Long-term transition into property/ land-value based water tariff rate mechanism	KASA & EPU	KASA & EPU	New	2025	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
244	WST2040 (WES)	Water for Livelihood	Finance			Attractive incentives (e.g. grants, subsidies, tax) for STI within the water sector to encourage local technology and business development in the water sector	KASA & MOSTI	KASA & MOSTI	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
245	WST2040 (WES)	Water for Livelihood	Finance			Attractive incentives (e.g. grants, subsidies, tax) for adherence to ESG standards within the water sector.	KASA	KASA	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
246	WST2040 (WES)	Water for Livelihood	Finance			Increasing quantum of research grants and other support systems	KASA & MOSTI	KASA & MOSTI	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
247	WST2040 (WES)	Water for Livelihood	Finance			Review the current tax, grants, and incentive systems	KASA & MITI	MIDA	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
248	WST2040 (WES)	Water for Livelihood	Finance			Preferential investments are given for foreign companies that fill the gaps of the local water supply chain and undertake technology and knowledge transfer to local companies	KASA & MITI	MIDA	On-going	2023	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
249	WST2040 (WES)	Water for Livelihood	Finance		Establish collaborative platforms amongst multiple stakeholders	National water centre of excellence to work closely with NTIS and i-Connect	KASA	KASA	Ongoing	2024	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
250	WST2040 (WES)	Water for Livelihood	Finance		Establish collaborative platforms amongst multiple stakeholders	Establish a neutral entity to foster collaboration in the water sector	KASA	KASA	On-going	2024	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
251	WST2040 (AWF)	Water for Livelihood	Finance	Strengthen Financial Sustainability of Water and Sewerage Operators	Implementation of Tariff Setting Mechanism for Water Services	Consultation, Policy Approval, Implementation, Review, Periodic Tariff Review based on approved business plan	KASA	SPAN & Water Operators	On-going	2022 (1st Cycle) (2025 2nd,2028-2030 3rd, 2033-2035 4th,2038-2040 5th cycle)	N/G	1	N/G	N/G	1	2	1	1	1
252	WST2040 (AWF)	Water for Livelihood	Finance		Implementation of Tariff Setting Mechanism for Sewerage Services	Development of Concept, Consultation, Policy Approval, Implementation, Review, Periodic Tariff Review	KASA	SPAN & Water Operators	On-going	2022 (1st Cycle) (2025 2nd,2028-2030 3rd, 2033-2035 4th,2038-2040 5th cycle)	N/G	1	N/G	N/G	1	2	1	1	1

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
253	WST2040 (AWF)	Water for Livelihood	Finance	Intensify implementation of Wakaf Air, Land Swap	Strengthen Wakaf Air to finance rural water supply and sewerage projects	Increase contribution through awareness and public participation, incentive program	KASA	KASA	On-going	2025 –2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
254	WST2040 (AWF)	Water for Livelihood	Finance		To improve the land swap for Wastewater project and introducing method for flood mitigation	Develop viable and transparent modus operandi for Wastewater and flood mitigation,	KASA	KASA, UKAS, IWK, Land Authority (PTP)	On-going	2025 – 2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
255	WST2040 (AWF)	Water for Livelihood	Finance	Implementation of PFI, PPP and PBC	Intensifying implementation of improved PFI in water projects	Develop viable Policy Option, Engagement, Policy Approval, Pilot project, Implementation	KASA	KASA, UKAS & IWK	New	2023 – 2024 (initialization) ,2025 - 2040 (implementation)	N/G	N/G	1.5	1.5	1.5	4.5	7.5	7.5	7.5
256	WST2040 (AWF)	Water for Livelihood	Finance		Introduce implementation of PPP (HAM Model) in water projects	Conduct feasibility study, develop Policy Option, Engagement, Policy Approval, Pilot project, Implementation	KASA	UKAS, IWK and Water Operators	New	2023 – 2024 (initialization) ,2025 - 2040 (implementation)	N/G	N/G	2	2	2	6	10	10	10
257	WST2040 (AWF)	Water for Livelihood	Finance		Intensifying implementation of improved PBC in non-revenue water reduction projects	Strengthen project financing model, Develop Policy Option, Engagement, Policy Approval, National Roll-out	KASA	KASA, Water Operator	New	2023 – 2024 (initialisation) ,2025 –2040 (implementation)	N/G	N/G	1.5	1.5	1.5	4.5	7.5	7.5	7.5
258	WST2040 (AWF)	Water for Livelihood	Finance	Utilization of GCF	Utilization of the Green Climate Fund (GCF)	Setting up a GCF task force, Identifying area and mode of financing, Development of Policy Option for implementation, Consultation, Policy Approval, Implementation, Review	KASA	SPAN, Water Operators, Financial Institutions (Banks, Insurance companies)	New	2025 – 2040	N/G	N/G	N/G	N/G			0.5		
259	WST2040 (AWF)	Water for Livelihood	Finance	Implementation of Minimum Exposure Policy	Develop Minimum Exposure Policy as AWF model	Develop financing and operational framework, Determine of size required investment, Identify model of Implementation, Policy approval, Implementation	KASA	Bank Negara and Financial Institutions	New	2026 – 2028 (initialization) ,2029 –2040 (implementation)	N/G	N/G	N/G	N/G	N/G	N/G	7.5	7.5	7.5
260	WST2040 (AWF)	Water for Livelihood	Finance	Implementation of Cash Waqf Sukuk	Implement application of Cash Waqf Sukuk as AWF model	Establish Water Financing Coordination task force, Engagement, Policy Option, Policy Approval, Implementation	KASA	Securities Commission (SC) and Financial Institutions	New	2030 – 2032 (initialization) ,2033 - 2040 (implementation)	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
261	WST2040 (AWF)	Water for Livelihood	Finance	Establishment of Development Bank for Water or Water Bank	Implement application of Cash Waqf Sukuk as AWF model	Establish Water Financing Coordination task force, Engagement, Policy Option, Policy Approval, Implementation	KASA	Bank Negara, Bank Pembangunan (BPMB), Financial Institutions	New	2036 – 2038 (initialisation) ,2039 (implementation)	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
262	WST2040 (VW&WF)	Water for Livelihood	Finance	Mainstreaming WF in business	Incorporate WF component in ESG initiative	Engagement with Bursa Malaysia to discuss on ESG reporting	KASA	KASA	New	2027 – 2040	N/G	N/G	N/G	N/G	N/G	N/G	0.5	0.5	0.5

WST2040 Roadmap																			
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
263	WST2040 (CCIA)	Cross-cutting	Finance	Investing in Disaster Risk Management	Disaster risk financing and social protection.	Conduct feasibility study	NADMA	MOF	New	12th MP	N/G	0.75	0.75	0.75	0.75	3	N/G	N/G	N/G
264	WST2040 (CCIA)	Cross-cutting	Finance		Mainstreaming disaster risk management in public investment.	Provide development grant for cities	NADMA	PLANMalaysia & Local Authorities	New	12th MP and beyond	N/G	N/G	0.5	5.5	5.5	11.5	27.5	30	30
265	WST2040 (CCIA)	Cross-cutting	Finance			Provide research grant for universities	KASA & NADMA	KASA	New	12th MP and beyond	N/G	N/G	0.6	0.6	0.6	1.8	2	2	3
266	WST2040 (CCIA)	Cross-cutting	Finance			Irrigation system and crop production technology for rural stakeholder	KASA & MPIC	MPB & DOA	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	1	1	1
267	WST2040 (CCIA)	Cross-cutting	Finance	Strengthening Financial Capacity for Climate Resilience	Climate resilient and environment-friendly financing and alternative sources of income.	Conduct feasibility study for adaptation and resilience	KASA	KASA	New	12th MP	N/G	0.75	0.75	0.75	0.75	3	N/G	N/G	N/G
268	WST2040 (CCIA)	Cross-cutting	Finance			Review the health financing mechanism.	MOH & MOF	MOH	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
	WST2040 (CCIA)	Cross-cutting	Finance			Provide insurance and disaster fund	MOF, KASA, MAFI & NADMA	MOF	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
269	WST2040 (AACB)	Cross-cutting	Finance	Adequate funds for non-structural capacity building towards IWRM.	Implement comprehensive AACB program at the PPPs.	Training of SMEs	KASA	KASA	New	12th MP and Beyond	N/G	N/G	0.625	0.625	2.275	3.525	6.5	6.5	6.5
270	WST2040 (AACB)	Cross-cutting	Finance	Green Incentives that is related to water management project	Promoting more business and industry to adopt and implement water management project in their premises.	Water incentives	KASA & MITI	MIDA	New	12th MP and Beyond	N/G	1.50	2.25	3.00	3.00	9.75	15.00	15.00	15.00
271	WST2040 (AACB)	Cross-cutting	Finance	Give tax incentives to business and industry	Giving tax exemption to business and industry	Company tax exemption	KASA & MITI	LHDN	New	12th MP and Beyond	N/G	1.00	1.00	1.00	1.50	4.50	7.5	7.5	7.5
272	WST2040 (AACB)	Cross-cutting	Finance	Give awards and recognitions to business and industry that succeed in applying best management practices in their premises	Giving annual award and recognition	Water Sustainability Award	KASA	KASA	New	12th MP and Beyond	N/G	0.15	0.15	0.15	0.15	0.6	0.75	0.75	0.75
273	WST2040 (AACB)	Cross-cutting	Finance	Empower community to effectively participate in IRBM	To incorporate IWRM/ IRBM in the structure or local plan	To incorporate IWRM/ IRBM in the structure or local plan	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and Beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
274	WST2040 (WFEN)	Cross-cutting	Finance	Increase the use of economic instruments to promote resource efficiency and nexus approach	Undertake assessments on the economic value of water at river basin levels		KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	15th MP	N/G	N/G	N/G	N/G	N/G	5	5	5	5

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
275	WST2040 (WES)	Water as a Resource	Infrastructure & Technology	Interconnected water supply system across the country to improve water supply, and quality of water, and water security	Develop a comprehensive national smart water grid system	Put in place a staged state-wide water grid system	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	State grid: 2030 National grid: 2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
276	WST2040 (WES)	Water as a Resource	Infrastructure & Technology	Interconnected national water supply systems across the SEA region	Extend the reach of national water grid to regional water hubs	Establish collaboration with regional partners to strengthen their national water grid system	KASA & MITI	KASA & MITI	New	2040	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
277	WST2040 (VW&WF)	Water for Livelihood	Infrastructure & Technology	Strengthening Institutional set up	Setting up WF centre	Identification of location, establishment of the physical centre and recruitment of experts and staff	KASA	KASA	New	2023 - continuous	N/G	N/G	2.5	2	2	6.5	10	10	10
278	WST2040 (WFEN)	Cross-cutting	Infrastructure & Technology	Pilot infrastructure and technology	Undertake pilot projects to address WFEN challenges and opportunities in critical/stressed river basins identified		KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	15thMP	N/G	N/G	N/G	N/G	N/G	N/G	30	N/G	N/G
279	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	IWRM training centres such as Pusat Informasi Sungai and other should have adequate online/on-site facilities considering the uncertainties.	To advocate IWRM by the civil servants via ToT using AACB training program.	Developing a portal and digital AACB content such as video clips, posters, infographics and podcasts for 189 river basin's management (LS RM750,000)	KASA	KASA	New	12th MP and Beyond	N/G	0.75	0.75	0.75	0.75	3.00	3.00	3.00	3.00
280	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			Establishment of WST 2040 AACB Water Hub in 13 States and 3 F.T. for public participatory and effective decision-making processes of IWRM. (Lump sum RM 15,000 x 16 units)					N/G	0.06	0.06	0.06	0.06	0.24	0.24	0.24	0.24
281	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			Training Events in every year (1 training = 4 days) Total 76 training events					N/G	1.36	1.36	1.36	1.36	5.45	6.82	6.82	6.82
282	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			1 Coordinator for IWRM Training with an FASc based at LESTARI, UKM (Lump sum RM15,000/pax/ month)					N/G	0.02	0.18	0.18	0.18	0.56	0.9	0.90	0.90
283	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			5 Assistants to facilitate IWRM Training based at LESTARI, UKM (Lump sump RM 5,000/pax/month)					N/G	0.30	0.3	0.3	0.3	1.2	1.5	1.5	1.5
284	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			Honorarirum for Resource Person to faciliate IWRM Training (Lump sump RM10,000/pax/training x 1,567 pax)					N/G	0.27	0.38	0.38	0.37	1.40	2.8	4.2	7.0

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
285	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	Reiterate importance of rivers as water resources for human and the environment	Online education tools	1. Expand digital platforms/tools for teaching and learning 2. Develop simulation-based games, mobile platforms, virtual environments, and augmented reality tools to heighten curiosity and increase learner engagement.	KASA, MOE & MOHE	KASA, MOE & MOHE	New	12th MP	N/G	0.25	0.25	0.25	0.25	1	N/G	N/G	N/G
286	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			Educate present and future generations about climate change by providing tools to help students learn science and geography more fun and effectively.	KASA & MOE	KASA & MOE	New	12th MP and Beyond	N/G	6.50	6.50	6.50	6.50	26.00	26.00	26.00	26.00
287	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology			Establish one-stop educational resources and activities on water and climate change in Digital Educational Learning Initiatives Malaysia (DELIMa) platform.	KASA & MOE	KASA & MOE	New	12th MP	N/G	0.25	0.25	0.25	0.25	1.00	N/G	N/G	N/G
288	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	Inculcation of local values	Project-based learning (PBL)	Establish a single, searchable, user-friendly online resource	KASA, MOHE & MOSTI	KASA, MOHE & MOSTI	New	12th MP	N/G	0.25	0.25	0.25	0.25	1.00	N/G	N/G	N/G
289	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	Emphasize different responsibilities but common goals in ensuring good water quality and adequate water quantity	Encourage interactive communication between HEIs (public and private) and public	To establish an interactive tool that encourage interactive communication between HEIs (public and private) and public	KASA & MOHE	KASA & MOHE	New	12th MP and Beyond	N/G	0.05	0.05	0.05	0.05	0.2	N/G	N/G	N/G
290	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	One-stop Training Centres at national and state	Water One-Stop Training Centre	Establish Water One-Stop Training Centre	KASA	KASA	New	12th MP and Beyond	N/G	0.10	0.10	0.10	0.10	0.40	0.50	0.50	0.50
291	WST2040 (AACB)	Cross-cutting	Infrastructure & Technology	Empower community to effectively participate in IRBM	To develop and establish an application to share/ link data needed for the community to decide on river basin.	Myriverbasin Apps	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	KASA, MSANg or Equivalent, Sabah State Govt. & Sarawak State Govt.	New	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	1.00	N/G	N/G	N/G
292	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology	Enhancing Early Warning Systems and Disaster Response	Framework for subsurface geological hazards	Subsurface geological systems: Greater Kuala Lumpur as a pilot.	KeTSA & NADMA	JMG, DBKL & Local Authorities	New	12th MP and beyond	N/G	2.5	2.5	2.5	2.5	10	15	20	30
293	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Subsurface geological systems	KeTSA & NADMA	JMG & Local Authorities	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	20	50	50
294	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology		Land use scenario planning model.	Develop land use scenario planning model	NADMA	PLANMalaysia & Local Authorities	New	15th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	7	7

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
295	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology	Developing Sustainable Infrastructure with Cost Effective Technology	Infrastructure and technology for flood and coastal protection.	Incorporate climate change factors (CCF) at river basin level	KASA & NADMA	JPS & NAHRIM	On-going	12th MP and beyond	2	2	2	2	2	10	10	10	10
296	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop and enhance existing infrastructures for NAWABS and NaFFWS	KASA	JPS	On-going	12th MP and beyond	40	40	40	40	40	200	100	100	100
297	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Flood barrier door system	KASA & NADMA	JPS	New	12th MP and beyond	N/G	1	1	1	1	4	N/G	N/G	N/G
298	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Remote sensing and related technologies	KASA & MOSTI	MYSA	New	12th MP	N/G	90	50	70	N/G	210	N/G	N/G	N/G
299	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology		Health, water, food and energy nexus at the river basin level.	Safe drinking water supply	KASA & MOH	KASA & MOH	On-going	12th MP and beyond	N/G	22.11	22.11	22.11	22.11	88.44	110.53	110.53	110.53
300	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Environmentally sustainable health care facilities	KASA & MOH	KASA & MOH	On-going	12th MP	N/G	N/G	N/G	N/G	N/G	1	N/G	N/G	N/G
301	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology		IoT for agriculture and forest sectors	Water management for agriculture	KASA & MPIC	MCB	On-going	12th MP	N/G	N/G	N/G	N/G	N/G	0.5	N/G	N/G	N/G
302	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop auto-control system of micro-irrigation in the cocoa nursery	KASA & MPIC	MCB	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	1	N/G	N/G
303	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop water recycle system for kenaf bio-retting processing	KASA & MPIC	LKTN	On-going	12th MP and beyond	N/G	1.25	1.25	1.25	1.25	5	6	N/G	N/G
304	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop water recycle system	KASA & MPIC	LKTN	On-going	12th MP	N/G	1	1	1	1	4	N/G	N/G	N/G
305	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop waste water treatment system	KASA & MPIC	MPB	On-going	12th MP	0.15	3.86	2.20	0.79	N/G	7	N/G	N/G	N/G
306	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Peat and oil palm plantations	KASA & MPIC	MPOB	New	12th MP	0.5	3	2	1	1	7.5	N/G	N/G	N/G
307	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Implement new water management technology	KASA & MPIC	MPB/DOA	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	1	N/G	N/G
308	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Implement new post harvest technology (IoT application)	KASA & MPIC	MPB/DOA	New	13th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	0.2	0.2	0.2
309	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Upgrade high-tech workstation towards the implementation of AI technology.	KASA & MOSTI	MYSA	On-going	12th MP	N/G	N/G	250	N/G	N/G	250	N/G	N/G	N/G
310	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Develop early warning systems to fisheries and aquaculture	KASA, MAFI & NADMA	DOF	New	13th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
311	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Use high resolution remote sensing data and Artificial Intelligence (AI) Technology	KASA & MOSTI	MYSA & Forestry Department	On-going	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
312	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology		Risk reduction and adaption for strategic infrastructure.	Establish emergency flood mitigation system at airports	KASA, MOT & NADMA	KASA, MOT & NADMA	New	12th MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
313	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Conserve energy and maximize energy efficiency of Port operations	KASA, MOT & NADMA	KASA, MOT & NADMA	On-going	12MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
314	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology			Use more energy efficient and environmentally friendly equipment	KASA, MOT & NADMA	KASA, MOT & NADMA	On-going	12th MP and beyond	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
314	WST2040 (CCIA)	Cross-cutting	Infrastructure & Technology	Enhancing Disaster Preparedness and Recovery	Resilient construction guidelines and standards	Develop design code related to earthquake resilient infrastructure, resistance and retrofitting of building.	NADMA	JSM	On-going	12th MP and beyond	0.15	0.2	N/G	N/G	N/G	0.35	N/G	N/G	N/G

WST2040 Roadmap																			
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
314	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology	Platform for infrastructure (including infostructure) that caters for IR4.0 for water sub-sectors	1. Roll out 4G & 5G for the entire Malaysia in phases to identify, standardize and achieve seamless technological upgrade 2. Cloud computing & virtualization platform 3. Smart Water Management Framework & Integrated Operational Data Centre	1. Review and strengthening the 4G/5G for the nation 2. Improving and expanding network services & coverage 3. Hyper-scale computing infrastructure	KASA, MCMC, Sabah State Govt. & Sarawak State Govt.	KASA, MCMC, Sabah State Govt. & Sarawak State Govt.	New	12MP	5066	5066	5066	5066	5066	15200	30500	10000	10000
315	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology		Roll out 5G & 6G entire Malaysia	1. Establish partnership with local or foreign cloud computing providers 2. Relying on authorised base map produced by JUPEM (rather than too dependent on third party mapping such as Google Map etc.) 3. Initiate collaboration between VAICE as the living lab for IR4.0 in water sub-sectors with institute of higher learning 4. Review and strengthening the 5G / 6G coverage entire Malaysia	KASA, MCMC, Sabah State Govt. & Sarawak State Govt.	KASA, MCMC, Sabah State Govt. & Sarawak State Govt.	New	12MP									
316	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology	Blockchain & Artificial Intelligence Framework	Setup taskforce to draft and develop full framework (end-to-end) using blockchain & AI technology in water ecosystem.	1. VAICE to monitor, supervise and consult the taskforce for blockchain and AI initiatives in water industry. 2. Provide means for budget allocation/ grant to agencies to adopt blockchain and AI technologies.	KASA	KASA	New	12MP	40	40	40	40	40	200	N/G	N/G	N/G

WST2040 Roadmap																			
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
317	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology	Technology advancement	1. Invest in Critical Technology related to Water Recycle and Water Treatment 2. Invest in Critical Technology related to Water Operation & Treatment 3. Invest in Critical Technology related to Water Operation, Supply & Distribution	1. Private & Public Partnership – Digital Strategy and Funding (International & Local) 2. Advanced Technology & Innovation. (Nano-Biotechnology & Intelligent Robots) 3. Private & Public Partnership – Digital Strategy and Funding Programme 4. Expansion of technology and systems to manage and minimise the impact of extreme fluctuations in water availability, including fast shifts from too much water to too little 5. Private & Public Partnership – Digital Strategy and Funding Programme	KASA	KASA	New	13MP	1000	1000	1000	1000	1000	5000	5000	5000	5000
318	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology		AI-Driven National Smart Water & Operation Centre (i.e., Langkawi as pilot project)	1. Launch Langkawi as pilot project for IR4.0 for water sub-sectors replicating the whole island as a catchment area 2. Focus on the National Project particularly on water quality and water management 3. National Project and part of smart cities development following Langkawi model 3. Water operators focus on assisting with end-user system design, installation, information, maintenance, and emergency response with Smart Meter (AI-Driven Smart Water System)	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	14MP	N/G	N/G	N/G	N/G	N/G	N/G	2000	N/G	N/G
319	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology		Ai-Driven National Smart Water & Smart Cities	1. Continue the National Smart Water & Smart Cities Development at national scale 2. Implementation of differential water pricing and services according to availability of supply, service plans, and customer behaviour (Smart Billing / repaid Concept)	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New	15MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	15000	5000

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No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
320	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology	Water Wise & Smart Cities	1. Water-Efficient Infrastructure & Water-Smart Cities (Phase 1) 2. Water-Efficient Infrastructure & Water-Smart Cities (Phase 2) 3. Shift from end users that pay for the delivery of services to those that pay for the cost of installing and maintaining infrastructures, either individually or collaboratively (**following user income segment)	1. Infrastructure services that enable communities to develop, run and maintain autonomous urban water systems. (Smart City / Smart Home / Smart Building) 2. Technology to monitor and reduce illegal water trade and theft, coupled with a reduction in leakages and wastage across the existing network 3. Development of smart cities shall also focus on advances in decentralised and centralised water storage solutions, coupled with intelligent demand management and higher water recycling and reuse rates	KASA, KPKT, Sabah State Govt. & Sarawak State Govt.	KASA, KPKT, Sabah State Govt. & Sarawak State Govt.	New	14MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	5500	5000
321	WST2040 (IR4.0WS)	Cross-cutting	Infrastructure & Technology		Autonomous and community-based water systems (Smart City)	1. Initiation of a taskforce team to drive the autonomous community-based water system inclusive of training, talent development etc.	KASA, KPKT, Sabah State Govt. & Sarawak State Govt.	KASA, KPKT, Sabah State Govt. & Sarawak State Govt.	New	15MP	N/G	N/G	N/G	N/G	N/G	N/G	N/G	300	5000
322	WST2040 (IWSDC)	Cross-cutting	Information & RDIC/ Finance/ Infrastructure &Technology	Strategic Reports on Water Management	Strategic Reports Publication (annual)	Stakeholder Management	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
323	WST2040 (IWSDC)	Cross-cutting				Virtual Water	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
324	WST2040 (IWSDC)	Cross-cutting				Water Footprint	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
325	WST2040 (IWSDC)	Cross-cutting				Water-Food-Energy Nexus	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
326	WST2040 (IWSDC)	Cross-cutting				Water for Environment and Biodiversity	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
327	WST2040 (IWSDC)	Cross-cutting				Water and Climate Change	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
328	WST2040 (IWSDC)	Cross-cutting				Water Efficiency	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
329	WST2040 (IWSDC)	Cross-cutting				Water Quality Monitoring	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
330	WST2040 (IWSDC)	Cross-cutting				Disaster Risk Management	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
331	WST2040 (IWSDC)	Cross-cutting				Water Safety Plan	KASA & MOH	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
332	WST2040 (IWSDC)	Cross-cutting				Rainfed Agriculture Monitoring	KASA & MAFI	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
333	WST2040 (IWSDC)	Cross-cutting				WST2040 Monitoring	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

WST2040 Roadmap																				
No	Source	Element	Focus Area	Strategy	Programmes/ Initiatives	Projects/ Activities	Lead Authority	Implementing Authority	Current Status	Target Completion	Budget (RM '000,000)								
											2021	2022	2023	2024	2025	Total 12 MP	13 MP	14 MP	15 MP
334	WST2040 (IWSDC)	Cross-cutting	People/ Governance/ Information & RDIC/ Finance/ Infrastructure & Technology	Water Data Platform (Water Data and Information Interactive Platform)	Establish Water Data Platform IWSDC Water Data Platform Pilot Projects	IWSDC Water Data Platform Pilot Projects: A) Sg Perak River Basin Pilot Project	KASA	Line Agencies & Water Operators	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
335	WST2040 (IWSDC)	Cross-cutting				B) Sg Linggi River Basin (N. Sembilan/ Melaka)	KASA	Line Agencies & Water Operators	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
336	WST2040 (IWSDC)	Cross-cutting				C) Sg Padas River Basin (Sabah)	KASA & Sabah State Govt.	KASA & Sabah State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
337	WST2040 (IWSDC)	Cross-cutting				D) Sg Miri River Basin (Sarawak)	KASA & Sarawak State Govt.	KASA & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
338	WST2040 (IWSDC)	Cross-cutting			Integrated River Basin Management System Solution for all other River Basins	A) Space Technology Applications in Water Management B) Ground-based Data Applications Framework	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
339	WST2040 (IWSDC)	Cross-cutting		Establish Water Hub	Physical Development of a Water Hub	Development of a Water Hub Master Plan	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
340	WST2040 (IWSDC)	Cross-cutting	Information & RDIC/ Infrastructure & Technology	RDIC Collaboration Platform	Water Research Collaboration Platform (RDIC) on Space Technology Applications	Space Technology applications on River Basin Management for entrepreneurs (including Citizen Developers)	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
341	WST2040 (IWSDC)	Cross-cutting			Water Research Collaboration Platform (RDIC) on Ground-based Applications	Ground based data Applications for Advanced Science Businesses	KASA, Sabah State Govt. & Sarawak State Govt.	KASA, Sabah State Govt. & Sarawak State Govt.	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
342	WST2040 (IWSDC)	Cross-cutting	People/ Governance	Public Participation Platform	Stakeholder Management Initiatives	Stakeholder Management A) Establish Stakeholder Platform Linkages B) Register of Stakeholders C) Capacity Building Programme	KASA	Line Agencies	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
343	WST2040 (IWSDC)	Cross-cutting	People/ Information & RDIC	Capacity Building and Talent Development	Continual Capacity Building and Talent Development Programmes for Water Stakeholders	Talent Development in: 1. Space Technology 2. Data Technology 3. Water Sector Management	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
344	WST2040 (IWSDC)	Cross-cutting	People/ Information & RDIC	Capacity Building and Talent Development	Continual Capacity Building and Talent Development Programmes for Water Stakeholders	Talent Development in: 1. Space Technology 2. Data Technology 3. Water Sector Management	KASA	KASA	New		N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G

Appendix 3.5

List of Invitees and Attendees for WST2040 Roadmap Sensitisation and Validation Workshop
8 June 2021 (Sensitisation Workshop) | 12 and 13 July 2021 (Validation Workshop)

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
1	Unit Perancang Ekonomi (EPU) Jabatan Perdana Menteri	Pn. Maniza Mahfuz Pn. Nor Azima Azman En. Mohd. Shahrizan Omar En. Mohd. Dinie Kamaruzaman En. Sobri Mohd Mansori Pn. Afiza Idris Pn. Zahiah Md. Alwee Datuk Yatimah Sarjiman	-
2	Kementerian Alam Sekitar dan Air (KASA)	Tengku Izam Tuan Ibrahim Dr. Razul Ikmal Ramli	Dr. Ching Thoo Kim Dr. Razul Ikmal Ramli
3	Jabatan Pengairan dan Saliran (JPS)	Ir. Dr. Asmadi Ahmad	Ir. Dr. Asmadi Ahmad Ir. Hajah Bibi Zarina binti Che Omar En. Mohammad Hakim Hasnul En. Wan Marhafidz Shah Wan Mohd Omar
4	JPS Sarawak	En. Rasyid Rohim Ir. Normahyusni Bt Hj Mohd Annuar	Pn. Bong Bok Eng En. Mazolizam Muhammad Ir. Sheela Charlene Nadison Ir. Normahyusni Bt Hj Mohd Annuar
5	JPS Sabah	-	En. Miklin Ationg En. Julsun @Joseph Sikui
6	Institut Pembangunan Modal Insan (IPMI) JPS	-	-
7	Institut Pembangunan Modal Insan (IPMI) JPS Zon Utara	-	-
8	Institut Pembangunan Modal Insan IPMI JPS Zon Timur	Pn. Marziah Mohamad En. Wee Yit Ming	-
9	Jabatan Alam Sekitar (JAS)	Pn. Mastawa Hj Zainudin	Pn. Mastawa Hj Zainudin
10	Jabatan Alam Sekitar Negeri (JAS) Sabah	En. Amirul bin Aripin En. Mohd Fauzi bin Mahmud	-
11	Institut Alam Sekitar Malaysia (EiMAS)	-	-
12	Jabatan Perkhidmatan Pembentungan (JPP)	-	-
13	Jabatan Meteorologi Malaysia (MET Malaysia)	En. Azlan Ross bin Omar	En. Amirul Nizam Marodzi
14	Pusat Teknologi Hijau dan Perubahan Iklim Malaysia (MGTC)	-	-
15	Bahagian Bekalan Air (BBA)	-	-
16	Institut Penyelidikan Air Kebangsaan Malaysia (NAHRIM)	Ir. Marini Mohamad Ideris En. Ismail Bin Tawnie Ir. Azman Mat Jusoh	Ir. Marini Mohamad Ideris En. Ismail Bin Tawnie Dr. Zati Sharip
17	Kementerian Sains, Teknologi dan Inovasi (MOSTI)	Pn. Suaibatul Aslamiah binti Abd Halim	Pn. Suaibatul Aslamiah binti Abd Halim
18	Jabatan Kimia Malaysia	Pn. Saeidah Binti Ja'afar En. Abdullah bin Mohd Yusof En. Harun Ahmad	-
19	Malaysian Institute of Microelectronic Systems (MIMOS) Bhd	Ir. Ts. Dr. Nordin Ramli	-
20	Kementerian Pertanian dan Industri Makanan (MAFI)	-	En. Syed Abdul Bari Pn. Noor Abidah Mohd Dawi

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
21	Jabatan Perikanan Malaysia (DOF)	Pn. Mazayu binti Mohamad Pn. Rosmawati binti Ghazali Pn. Yazeereen A. Bakar En. Kamarul Anwar Bin Mohamed Zabri En. Anuar Salam Bin Sulaiman	-
22	Jabatan Perkhidmatan Veterinar (DVS)	Pn. Maria Binti Jamli	-
23	Jabatan Pertanian (DOA)	-	Pn. Yaashini Peraniandy
24	Jabatan Pertanian Negeri Perak	En. Clyne Hardy anak Raymond Sakor	En. Clyne Hardy anak Raymond Sakor
25	Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI)	En. Eddy Herman Bin Sharu	
26	Lembaga Kemajuan Pertanian Kemubu (KADA)	-	-
27	Muda Agricultural Development Authority (MADA)	En. Nik Kun Nik Man En. Ahmad Sukri bin Saad	En. Mohd Fadzil Mat Desa
28	Lembaga Pemasaran Pertanian Persekutuan (FAMA)	-	-
29	Lembaga Pertubuhan Peladang (LPP)	-	-
30	Kementerian Pembangunan Luar Bandar (KPLB)	Pn. Mas Liza Mazlan	Pn. Norhafizah Sahar
31	Lembaga Kemajuan Wilayah Kedah (KEDA)	-	-
32	Rubber Industry Small Development Authority (RISDA)	En. Mohd Nor Hazlem Nor Azmi	En. Mohd Nor Hazlem Nor Azmi
33	Kementerian Komunikasi dan Multimedia (KKMM)	En. Kamarudin bin Abdul Rani Nurul Adiah Hani Husin Pn. Fariha Mastor En. Imran Ariff Mohammad Amin	-
34	Kementerian Perumahan dan Kerajaan Tempatan (KPKT) Jabatan Kerajaan Tempatan (JKT)	-	Pn. Raihani Che Mamat Pn. Hafizah Hussian
35	Jabatan Perancangan Bandar dan Desa Malaysia (PLAN Malaysia)	Pn. Nor Zaliza Mohd Puzi	-
36	Jabatan Pengurusan Sisa Pepejal Negara (JPSPN)	En. Arif Zulkifli	
37	Jabatan Bomba Dan Penyelamat Malaysia	-	-
38	Kementerian Perdagangan Antarabangsa dan Industri (MITI)	Dr. Syed Fatimah Kamal Batcha En. Afiq Asyraf Asmadi	-
39	Jabatan Standard Malaysia	En. Roslee bin Saad En. Bernados Anak Bingkang	-
40	Kementerian Pelancongan, Seni dan Budaya Malaysia (MOTAC)	-	Pn. Shereen Haron
41	Kementerian Pengangkutan Malaysia (MOT)	Pn. Priscilla Bong Anak Samson Onggie Ir. Tengku Kahar Muzaffar	Pn. Shazrina Binti Mohd Hanifiah En. Malvindran Ravie Ir. Tengku Kahar Muzaffar
41	Kementerian Perusahaan Perladangan dan Komoditi (MPIC)	En. Nazar Azly bin Zaberi Pn. Zulailatun Nor binti Zainuddin Pn. Nur Azreena Mahmud Pn. Emelia Fantoza Saraih	Pn. Zulailatun Nor binti Zainuddin En. Muhammad Imran Razali Pn. Noor Ashiqin Hambali
42	Lembaga Getah Malaysia (LGM)	Dr. Goh Sou Sheng Pn. Shima Nazri	Dr. Goh Sou Sheng Pn. Shima Nazri
43	Malaysian Palm Oil Board (MPOB)	Pn. Izzati Mohamad Noor Pn. Nur Amanina Shahabuddin	Pn. Izzati Mohamad Noor Pn. Nur Amanina Shahabuddin

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
44	Lembaga Lada Malaysia	Dr. Kevin Muyang Tawie Anak Sulok Dr. Chen Yi Shang	Dr. Kevin Muyang Tawie Anak Sulok Dr. Chen Yi Shang
45	Lembaga Kenaf dan Tembakau Negara (LKTN)	En. Mohd Norsyam bin Yahaya Pn. Farini Halim	Pn. Farini Halim
46			
47	Lembaga Perindustrian Kayu Malaysia	En. Azelan Ishak En. Mohd Nizam Hamid	-
48	Lembaga Koko Malaysia	Dr. Rozita Osman	Dr. Rozita Osman
49	Kementerian Kewangan Malaysia (MOF)	-	-
50	Bursa Malaysia	-	-
51	Bank Negara Malaysia (BNM)	-	
52	Kumpulan Wang Simpanan Persaraan (KWSP)	Pn. Farhana Hassan Naziri Pn. Norsamsida Hassan	-
53	Kumpulan Wang Persaraan (KWAP)	-	-
54	Securities Commission Malaysia (SC)	En. Ridzham Zaidi Pn. Zureena Mohamed	En. Ridzham Zaidi
55	Islamic Capital Market (ICM) Development Securities Commission Malaysia	-	-
56	AmBank Group	-	-
57	Bank Pembangunan Malaysia Berhad (BPMB)	Pn. Hildah Hamzah	-
58	SME Bank Malaysia	En. Abdul Rahman Mohd Ali	-
59	UOB	-	-
60	RAM Holdings Berhad (RAM Group)	En. Chong Van Nee Pn. Seri Nuralya Binti Munawir	-
61	HSBC Bank Malaysia	-	-
62	Lembaga Pembangunan Langkawi (LADA)	-	-
63	Kementerian Tenaga dan Sumber Asli (KeTSA)	En. Nor Azmi bin Ahmad	-
64	Lembaga Pembangunan Tenaga Lestari (SEDA) Malaysia	-	-
65	Jabatan Mineral dan Geosains Malaysia (JMG)	En. Roslan Rajali Pn. Asminah Rajuli	En. Roslan Rajali Pn. Asminah Rajuli En. Alvyn Clancey Mickey
66	JMG Sabah	En. Jaineh Lingi	En. Jaineh Lingi
67	Suruhanjaya Tenaga (EC)	-	-
68	Institut Penyelidikan Perhutanan Malaysia (FRIM)	Dr. Siti Aisah Shamsuddin	-
69	Kementerian Pendidikan Malaysia (MOE)	Dr. Haniza Mahmood Pn. Habibah Salim En. Faizul Azmin Bin Zamin	Dr. Haniza Mahmood En. Norhaziruldin
70	Kementerian Pengajian Tinggi (MOHE)	Pn. Anisah Binti Ghani	Pn. Nor Huda Kamaruzaman Pn. Juliana Abu Bakar
71	Universiti Malaya (UM)	Dato' Prof. Dr. Azizan Hj. Abu Samah	Dr. Zeeda Fatimah Mohamad
72	Universiti Sains Malaysia (USM)	Prof. Dr. Faisal Rafiq Mahamd Adikan FASc	Prof. Dr. Faisal Rafiq Mahamd Adikan FASc
73	Universiti Putra Malaysia (UPM)	-	-
74	Universiti Kebangsaan Malaysia (UKM)	-	-
75	Universiti Teknologi Malaysia (UTM)	Prof. Dr. Azmi Aris	Prof. Dr. Azmi Aris
76	Kementerian Sumber Manusia (MOHR)	Pn. Azreen Zuriathy Binti Abdul Halim	Pn. Azreen Zuriathy Binti Abdul Halim

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
77	Unit Pemodenan Tadbiran Dan Perancangan Pengurusan Malaysia (MAMPU)	-	-
78	Kumpulan Industry Kerajaan Malaysia untuk Teknologi Tinggi (MiGHT)	-	Ir. Qaharuddin Abdul
79	Agensi Pengurusan Bencana Negara (NADMA)	-	-
80	Kementerian Kerja Raya (KKR)	Ir. Mohd Sufyan Saupi	Ir. Mohd Sufyan Saupi
81	Jabatan Kerja Raya (JKR) Malaysia	Ir. Zuraida Binti Zaini Rijal Ir. Atikah Binti Abdul Hamid	Pn. Norlida Abd Aziz Ir. Normaya Abd Malek
82	Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB)	-	En. Mohamad Norsani Katap Pn. Fuhairah Ahmad Fuad
83	Bahagian Perkhidmatan Kejuruteraan Kementerian Kesihatan Malaysia (KKM)	En. Yahaya Bin Saad	En. Roslan Mohamed En. Norhafizan Daud
84	Suruhanjaya Perkhidmatan Air Negara (SPAN)	Dato' Ir. Mohd Shukri Abdul Razik En. Masdi Abdul Karim	Ir. Muhamad Sobri Zakaria Dato' Ir. Mohd Shukri Abdul Razik En. Masdi Abdul Karim
85	Pengurusan Aset Air Berhad (PAAB)	En. Abdul Hadi Ali	En. Abdul Hadi Ali
86	SME Corporation Malaysia	-	-
87	Lembaga Kemajuan Tanah Persekutuan (FELDA)	-	-
88	PadiBeras Nasional Berhad (BERNAS)	Pn. Noorfarizan Nasriah Mhamat Nasudin En. Megat Rosli Megat Diwa	Pn. Noorfarizan Nasriah Mhamat Nasudin
89	Alam Sekitar Malaysia Sdn Bhd (ASMA)	Ts. Ardi Bakhtiar En. Mohamad Iznul Muazim Mohamad Zabidi	Ts. Ardi Bakhtiar
90	Pertubuhan Peladang Kebangsaan (NAFAS)	-	-
91	Kerajaan Negeri Selangor	-	-
92	Unit Perancang Ekonomi Negeri (UPEN) Selangor	Pn. Mazidah Ahmad Ramli	-
93	Unit Perancang Ekonomi Negeri Melaka	-	-
94	Kerajaan Negeri Kelantan	-	-
95	Unit Perancang Ekonomi Negeri Kelantan	-	En. Nik Muhammad Faiz Nik Muhammad Hanif
96	Kerajaan Negeri Perak	-	
97	Unit Perancang Ekonomi Negeri Perak	En. Mohd Jaffrey Mohd Zainol	En. Mohd Jaffrey Mohd Zainol
98	Kerajaan Negeri Terengganu	-	-
99	Unit Perancang Ekonomi Negeri Terengganu	-	-
100	Kerajaan Negeri Kedah	-	-
101	Bahagian Perancang Ekonomi Negeri (BPEN) Kedah	En. Junaidi Bin Hj. Abdul Rani @ Abdul Ghani En. Mohammad Khairol Akmal Bin Adnan	En. Junaidi Hj. Abdul Rani @ Abdul Ghani En. Mohammad Khairol Akmal Bin AdnanBPEN
102	Kerajaan Negeri Pulau Pinang	-	-
103	BPEN Pulau Pinang	En. Muhamad Husni Bin Mahmud	En. Muhamad Husni Mahmud
104	Kerajaan Negeri Melaka	-	-
105	Jabatan Ketua Menteri Melaka	-	En. Amar Aizat Abdullah
106	Kementerian Wilayah Persekutuan	-	-
107	Kerajaan Negeri Sembilan	-	-
108	Unit Perancang Ekonomi Negeri Sembilan	Dato' Muhd. Nahar Hj. Muhd. Sidek	Dato' Muhd. Nahar Hj. Muhd. Sidek

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
109	Kerajaan Negeri Johor	-	-
110	Bahagian Perancang Ekonomi Negeri Johor	En. Mohd Gadaffie Bin Abd Aziz	En. Hayat Nurullah
111	Kerajaan Negeri Pahang	En. Norden Zakaria	En. Norden Zakaria Pn. Nabilah Haziqah
112	BPEN Pahang	-	En. Rudyfasla Hj. Mujid
113	Bahagian Perancang Ekonomi Negeri Perlis	Pn. Nur Liyana Che Umar	Pn. Nur Liyana Che Umar
114	Kerajaan Negeri Sarawak	-	-
115	Unit Perancang Ekonomi Negeri Sarawak	-	-
116	Kerajaan Negeri Sabah	-	-
117	Unit Perancang Ekonomi Negeri Sabah	-	En. Lahiree Rajim
118	Lembaga Sumber Air Negeri Kedah (LSANK)	-	En. Mohammad Ashran Hamzah
119	Pengurusan Air Selangor Sdn Bhd	-	
120	Lembaga Sumber Air Selangor (LUAS)	En. Ishak Kamaruzaman Ir. Muhamad Khairi bin Jalil En. Nor Zamri Sondor	En. Ishak Kamaruzaman Ir. Muhamad Khairi bin Jalil
121	Lembaga Air Perak	-	-
122	Badan Kawal Selia Air Negeri Johor (BAKAJ)	En. Mohd. Ridhuan Md Ali	En. Mohd. Ridhuan Md Ali En. Md Badarudin Bin Jamal
123	Badan Kawal Selia Air (BKSA) Penang	En. Zulkifli Bin Jahaya	-
124	Syarikat Air Darul Aman (SADA)	-	-
125	Tenaga Nasional Berhad (TNB)	En. Ahmad Lutfi Mohayiddin Pn. Wan Shakirah Wan Abdul Kahar	En. Ahmad Lutfi Mohayiddin
126	Lembaga Tabung Haji	En. Madon Mohd Jani	-
127	Malaysian Association of Hotels (MAH)	-	-
128	Malaysia Institute of Property and Facilities Managers (MIPFM)	-	-
129	Top Glove International Sdn Bhd	Pn. Ida Zuhana	-
130	Micron Semiconductor Malaysia	-	En. Hou Boon Foo
131	Fusionex	En. Ramesh Raj Singh	-
132	Indah Water Konsortium Sdn. Bhd (IWK)	En. Narendran Maniam Ir. Mohamed Anwar Naik Mohd Ir. Ts. Hj. Mohd. Haniffa Hj. Abdul Hamid Pn. May Lim Pn. Lina Ong	Ir. Mohamed Anwar Naik Mohd Ir. Ts. Hj. Mohd. Haniffa Hj. Abdul Hamid Pn. May Lim Pn. Lina Ong
133	RSTP Butterworth South	-	-
134	Perbadanan Bekalan Air Pulau Pinang (PBAPP)	-	-
135 136	Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam (SW Corp)	-	-
	MMC Corp	En. Adam Saffian Bin Ghazali	-
137	Alam Flora Sdn Bhd	-	-
138	Lembaga Pelabuhan Kelang	En. Suhairi Bin Nordin En. Mohd Hafiz Zulhairi Bin Muhammad Sapee	-
139	Lembaga Pelabuhan Johor	En. Mohd Zahari bin Mohd Rusjuna	-
140	Suruhanjaya Pelabuhan Pulau Pinang	Pn. Norlida Saad Md Saad	Pn. Norlida Saad Md Saad
141	Lembaga Pelabuhan Kuantan	-	-
142	Lembaga Pelabuhan Kemaman	-	-

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
143	Lembaga Pelabuhan Bintulu	En. Anuar Aikne En. Zakhir Khan Bin Yusop En. Mohammad Yoshikatriezan Bin Abeng En. Abang Afzanizam Syam Bin Abang Junaidi En. Abdul Mutalib Faisal Bin Lampong En. Awang Saffarudin Bin Awang Saifudin	En. Abang Afzanizam Syam Abang Junaidi En. Abdul Mutalib Faisal Lampong En. Awang Saffarudin Awang Saifudin
144	Leadership Institute of Sarawak Civil Service	-	-
145	Balai Ikhtisas Malaysia	-	-
146	Board of Engineers (BEM) Malaysia	-	-
17	Institut Tadbiran Awam Negara (INTAN)	-	-
148	INTAN Wilayah Utara (INTURA)	-	-
149	INTAN Wilayah Timur (INTIM)	-	-
150	Pusat Latihan Universiti Teknologi Malaysia (UTM)	-	-
151	Northern Region Office Malaysia Productivity Corporation (MPC)	En. Hj. Mohd. Shahril Ahmad Puzi	-
152	Pahang Skill Development Center (PSDC)	En. Zairi Suhardi Bin Mamat En. Mahfoodz Abu Bakar	En. Mahfoodz Abu Bakar
153	Akademi Perikanan Malaysia	-	-
154	Institut Latihan FAMA (ILFPD)	-	-
155	Persatuan Pekilang-Pekilang Malaysia (FMM) Wisma FMM	En. Faizul Hj Ideris Pn. Wan Haslina Wan Hussin	Pn. Wan Haslina Wan Hussin En. Pramekumar Nair
156	Global Environment Centre (GEC)	Dr. Kalithasan Kailasam Pn. Jagedeswari Mariappan	Dr. Kalithasan Kailasam Pn. Jagedeswari Mariappan
157	Wildlife Conservation Society (WCS)	Pn. Sylvia Ng Foon Yuan	-
158	Malaysian Nature Society (MNS)	Pn. Eda Izanie	-
159	World Wildlife Fund (WWF)	Pn. Daria Abdullah	Pn. Carys Wong Datin Daria Abdullah Pn. Dhiya Ridzuan
160	The Malaysia Water Association (MWA)	Dr. Ir. Hj. Mohmad Asari Daud Mr. Mansor Ghani En. Muhd. Hairi Basri	Dr. Ir. Hj. Mohmad Asari Daud Mr. Mansor Ghani
161	Eco Knights	-	-
160	Sarawak Eco-Warriors	-	-
162	Kesatuan Perkhidmatan Perguruan Kebangsaan Malaysia (NUTP)	-	-
163	Save Rivers Sarawak	-	-
164	UM Water Warriors	-	-
165	Sabah Wetlands Conservation Society	-	-
166	Treat Every Environment Special Sdn. Bhd. (TrEES)	Pn. Leela Panikkar En. Zarris Kem bin Hymeir	Pn. Leela Panikkar
167	Sahabat Alam Malaysia	Pn. Mageswari Sangaralingam	Pn. Mageswari Sangaralingam
168	Sahabat Alam Malaysia (Marudi Office)	-	-
169	Malaysian Water Partnership (MyWP)	Dato' Ir. Hj. Hanapi Mohamad Noor FASc	Dato' Ir. Hj. Hanapi Mohamad Noor FASc
170	Pertubuhan Rangkaian Pembangunan Kesinambungan Malaysia (SUSDEN)	En. Muhammad Sha'abu bin Abdullah	
171	Parti Sosialis Malaysia (PSM)	En. Sharan Raj En. Sanjay Augustine	En. Sharan Raj

No.	Ministry / Agency / Organisation Invited	Name of Attendees for Sensitisation Workshop (8 June 2021)	Name of Attendees for Validation Workshop (12 and 13 July 2021)
172	Gabungan Persatuan-Persatuan Pengguna Malaysia (FOMCA)	Pn. Saral James	-
173	Environmental Management and Research Association of Malaysia (ENSEARCH)	-	-
174	Kementerian Pembangunan Luar Bandar Sabah	-	-
175	Kementerian Pembangunan Perindustrian Sabah	-	-
176	Kementerian Kerajaan Tempatan dan Perumahan Sabah	-	-
177	Kementerian Kerja Raya Sabah (KKRS)	-	-
178	Jabatan Air Negeri Sabah (JANS)	-	Pn. Edna Lunchi En. Robert Gampawi
179	Jabatan Perkhidmatan Pembentungan Sabah (JPPS)	En. Shafie @ Awang Bin Semat En. Garry Maclean John En. Zabion Jimmy Ir. Mohd Nadzree Imran	En. Shafie @ Awang Bin Semat Ir. Mohd Nadzree Imran
180	Jabatan Pertanian Negeri Sabah	-	-
181	Jabatan Tanah dan Ukur Sabah	En. Wahap Hj. Kanak	Pn. Jovita Kastum
182	Jabatan Kerja Raya Sabah	-	-
183	Jabatan Perhutanan Sabah	-	En. Petin Kilou Dr. Reuben Nilus En. Daim Balingi
184	Sabah Electricity Sdn.Bhd	-	-
185	Kementerian Pemodenan Pertanian, Tanah Asli dan Pembangunan Wilayah Sabah	-	-
186	Kementerian Pendidikan, Sains dan Penyelidikan Teknologi Sarawak	-	-
187	Kementerian Utiliti (MOU) Sarawak	Ir. Ahong Manchu En. Wan Zubir Wan Kassim	Ir. Ahong Manchu
188	Kementerian Kerajaan Tempatan dan Perumahan Sarawak	-	-
19	Jabatan Bekalan Air Luar Bandar (BALB) Sarawak	-	-
190	Jabatan Perkhidmatan Pembentungan Sarawak	-	En. Tam Yin Foon Pn. Jennieve Peter En. Jamey Ngedat
191	Jabatan Alam Sekitar Sarawak	-	-
192	Jabatan Pertanian Negeri Sarawak	Magdelin ak Bigap En. Stonton Morse	En. Stonton Morse
193	Jabatan Tanah dan Survei Sarawak	-	-
194	Sarawak Energy Berhad	-	-
195	Lembaga Sungai-Sungai Sarawak	-	-
196	-	-	Dato Ir. Hj. Abdullah Isnin

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