

TRANSFORMING THE
WATER SECTOR:
**NATIONAL INTEGRATED WATER
RESOURCES
MANAGEMENT PLAN**
STRATEGIES AND ROAD MAP



VOLUME 2 - APPENDICES

Transforming the Water Sector:

National Integrated Water Resources Management Plan

Strategies and Road Map

Volume 2 - Appendices

Editors:

**Shahrizaila Abdullah,
Fateh Chand, Salmah Zakaria, and P. Loganathan**



© Academy of Sciences Malaysia 2016

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without prior permission of the Copyright owner.

Published by:
Academy of Sciences Malaysia
Level 20, West Wing, MATRADE Tower,
Jalan Sultan Haji Ahmad Shah,
off Jalan Tuanku Abdul Halim,
50480 Kuala Lumpur, Malaysia
Phone : +6 (03) 6203 0633
Fax : +6 (03) 6203 0634
admin@akademisains.gov.my

ASM Advisory : Integrated Water Report (Vol 2) 08/16
Endorsed : June 2016

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

Transforming the Water Sector : National Integrated Water Resources
Management Plan : Strategies and Road Map. Volume 2 / Editors:
Shahrizaila Abdullah, Fateh Chand, Salmah Zakaria and P. Loganathan
Bibliography: page 145
ISBN 978-983-2915-32-4
1. Water resources management series. 2. Water-supply--Malaysia.
3. Water resources development--Malaysia.
4. Water consumption--Malaysia. I. Shahrizaila Abdullah.
II. Fateh Chand. III. Salmah Zakaria. IV. P. Loganathan.
333.91009595

Contents

Foreword	i
Preface	iii
Acronyms	vi
Acknowledgements	xiv
Illustrations - Boxes, Figures and Tables	xx
Appendices	xxiv

VOLUME 1

Executive Summary

Chapter 1. Evolution of Integrated Water Resources Management (IWRM)

- 1.1 Global Evolution of IWRM
- 1.2 Evolution of IWRM in Malaysia

Chapter 2. ASM and the IWRM Agenda

- 2.1 ASM Vision, Mission, and Objectives
- 2.2 ASM Water Committee
- 2.3 IWRM Agenda and Sub-themes
- 2.4 Scope and Process of Component Plan Studies
- 2.5 Mega Science Framework Study for Sustained National Development (2011–2050)
- 2.6 Completed Strategy Plans/Advisory Reports

Chapter 3. Component Plan (IWRM Sub-theme) Studies by ASM - Summary Briefs

- 3.1 Summary Briefs of Component Plans

Chapter 4. Complementary Component Plan Studies - Summary Briefs and Reports / Expert Reviews

- 4.1 National Water Resources Policy (2012) Action Plan
- 4.2 Complementary Component Plans

Chapter 5. State IWRM Plans - Case Study on LUAS (Selangor)

- 5.1 State IWRM Plans: Governance, Scope, and Content
- 5.2 Overview of Current Status Nationwide
- 5.3 *Majlis Sumber Air Negeri* (MSANg) / State Water Management Authorities (SWMAs)—LUAS as a Case Study
- 5.4 Implementation Road Map for State IWRM Plans Nationwide

Chapter 6. Transforming the Water Sector: National Integrated Water Resources Management Plan - Strategies and Road Map

- 6.1 Malaysia's Vision 2020 and the National Transformation Programme
- 6.2 The Malaysian Water Vision and Framework of Action
- 6.3 The Malaysian Water Scenario
- 6.4 Transforming the Water Sector: National IWRM Plan and Implementation Road Map

Chapter 7. Conclusions and Recommendations

- 7.1 Conclusions
- 7.2 Recommendations

References

VOLUME 2

Appendices to Chapter 3. Component Plan (IWRM Sub-theme) Studies by ASM – Summary Briefs

3.2.1 Integrated Lake Basin Management	1
3.2.2 Integrated Aquifer Systems Management	15
3.2.3 Water Demand Management	33
3.2.4 Water Supply and Wastewater Management	49
3.2.5 National Agenda for Integrated Water Research	79
3.2.6 Climate Change and Water	93
3.2.7 Integrated River Basin Management	109
3.2.8 Agriculture Water Services for Agribusiness	129
3.2.9 National Key Priority Area (NKPA) on Water	161
3.2.10 ASM Mega Science Study: Water Sector	171

Appendices to Chapter 4. Complementary Component Plan Studies – Summary Briefs and Reports / Expert Reviews

4.2.1	Integrated Flood Management	183
4.2.2	Integrated Drought Management	187
4.2.3	Water Quality Management	191
4.2.4	Water and Land Use	203
4.2.5	Water and Health	215
4.2.6	Water and Green Growth	221
4.2.7	Water and Gender	241
4.2.8	Virtual Water and Water Footprint	249
4.2.9	Water Financing	265
4.2.10	Water-Energy-Food Nexus	273
4.2.11	S&T Awareness, Advocacy and Capacity Building	281
4.2.12	International Networking and Collaboration	297
4.2.13	Integrated Urban Water Management	309
4.2.14	National Water Resources Policy (NWRP) Action Plan	321

Appendix to Chapter 5. State IWRM Plans – Case Study on Lembaga Urus Air Selangor (LUAS)

5.5	Case Study on Lembaga Urus Air Selangor (LUAS) - Summary Brief	329

Appendix to Chapter 6. Transforming the Water Sector: National Integrated Water Resources Management Plan – Strategies and Road Map

6.5	A National Key Priority Area (NKPA) on Water	355

Foreword



The Academy of Sciences Malaysia (ASM), as a thought leader in science, technology, and innovation (STI), strives to address the needs of the nation by providing the best scientific advice and advocacy that is independent, credible, relevant, and timely. In fulfilling this mandate, the Academy engages a wide spectrum of expertise not only within the Academy but also its network and linkages with many prominent international and local partners.

The ASM Water Sector Studies provide comprehensive and strategic STI input to all stakeholders towards a better water future for Malaysia. The release of this Report, entitled *Transforming the Water Sector: National Integrated Water Resources Management Plan: Strategies and Road Map*, is a timely contribution by ASM to assist the government in meeting its commitment to the Sustainable Development Goals (SDGs) announced at the UNSD Summit in September 2015. Among 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*”.

The Report also marks the culmination of work of the ASM Water Committee, begun in 2008, following a series of Integrated Water Resources Management (IWRM)-related thematic studies undertaken earlier by designated Task Forces. The outcome of the completed studies formed the central basis to the formulation of this National IWRM Plan (NIWRMP) aimed at bringing all water-related stakeholders nationwide onto a common platform and mission, that is, to ensure the sustainable management of the country’s water resources. Business as usual following past fragmented lines must make way to IWRM in seeking integrated solutions to the multiplicity of issues and challenges faced by the water sector. Promoting participatory management and addressing trans-boundary issues through continuing dialogue are all important elements of this paradigm shift towards “making water everybody’s business”.

Despite the importance of the water sector to the national economy, ASM noted with concern that “water” was not included as a National Key Economic Area (NKEA) under the Economic Transformation Programme. In an attempt to fill the gap arising from the absence of a dedicated NKEA, ASM undertook an in-depth study in

2014 to justify a National Key Priority Area (NKPA) on water complete with a road map. The NKPA now forms an integral part of the “Investments in Water Infrastructure”, a crucial element of the NIWRMP.

We are confident that the findings, strategies, and recommendations contained in this report would provide the government and the various Federal and State water authorities concerned

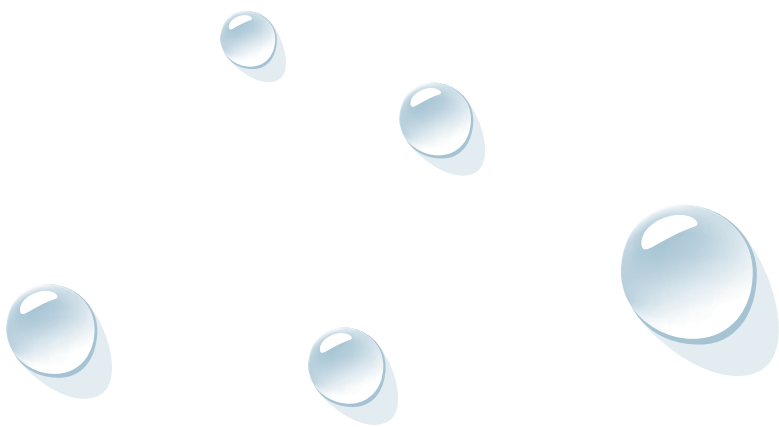
with the necessary stimulus to ensure that the transformation of the water sector advances in tandem with other sectors of the economy.

Congratulations to the members of the ASM Water Committee and its various Task Forces for their continued efforts and outstanding contribution towards yet another timely publication of national importance.

A handwritten signature in black ink, appearing to read 'Giddi Q.', with a horizontal line and two dots underneath.

Tan Sri Dr Ahmad Tajuddin Ali
FASc
President
Academy of Sciences Malaysia

Preface



The Academy of Sciences Malaysia (ASM) has since 2008 paid special focus on the water sector, considered strategic for the country's economic development. A dedicated ASM Water Committee was formed to address the issues facing this sector. Since then a number of water-related thematic studies were undertaken, each led by a Task Force appointed by the Water Committee and led by a Fellow of the Academy with the support from a small team of experts selected from agencies considered relevant to each field of study. The outcome of these thematic studies led to the release of Strategy Plans or Advisory Reports which have since been published and submitted to relevant authorities in government for their consideration and implementation. Some of the reports have been subsequently tabled and endorsed by *Majlis Sumber Air Negara* for implementation by designated lead ministries and State Governments.

This Report, entitled *Transforming the Water Sector: National Integrated Water Resources Management Plan: Strategies and Road Map*, herein referred to as the National Integrated Water Resources Management Plan (NIWRMP), marks the culmination of the

earlier efforts. The Report is a synthesis and consolidation of the strategies recommended in the thematic study reports to form an overall strategy plan targeted to assist the government in expediting the implementation of IWRM nationwide through the concerted efforts of all stakeholders involved in the water sector. IWRM is a declared national policy for the sustainable management of its water resources since the late 1990s.

The Report comprises an Executive Summary followed by seven chapters as follows:

Chapter 1 — Evolution of IWRM: The chapter focuses on the global evolution of the IWRM paradigm since the 1970s, its formal adoption at the *1992 Earth Summit* to current day reaffirmation at the *UNSD Summit* in September 2015 when the post-2015 Sustainable Development Goals were announced. The chapter also traces the progress achieved by Malaysia since formal adoption of IWRM at the turn of the century. It includes a listing of initiatives taken in chronological sequence.

Chapter 2 — ASM and the IWRM Agenda:

This chapter introduces ASM, its mission, and objectives, before proceeding to describe its special focus studies related to the national IWRM agenda and the processes adopted by the ASM Water Committee in undertaking these studies.

Chapter 3 — Summary Briefs of ASM

Component Plan Studies: This chapter is dedicated to reporting on the in-depth studies undertaken by ASM-led Task Forces on ten IWRM-related thematic areas for which summary briefs are reported as appendices.

Chapter 4 — Complementary Component Plan Studies: Summary Briefs and Expert Reviews:

The chapter focuses on invited contributions of a further 14 IWRM-related thematic areas from related agencies and subject matter specialists commissioned to review selected topics. These contributions in the form of summary briefs or expert reviews are reported as appendices.

Chapter 5 — State IWRM Plans - Case Study on Lembaga Urus Air Selangor (LUAS):

This chapter covers an overview of the status of IWRM implementation in the states. A summary brief of a case study on LUAS, Selangor is included as an appendix to showcase the progress made in institutionalising IWRM in the state since the formation of LUAS in the year 2000.

Chapter 6 — National Integrated Water

Resources Management Plan: This chapter is the centrepiece of the Report. It provides an overview of the Malaysian water scenario, highlighting the issues and challenges, followed by a synthesis of the strategies emerging out of the earlier chapters 3, 4 and

5, organised into a coherent National IWRM Plan following the IWRM General Framework format. The plan comes with a road map for implementation over a 15-year period until 2030.

Chapter 7 — Conclusions and

Recommendations: The first part of this chapter comprises a summary overview pertaining to the state of the country's waters. This is followed by a central recommendation for the adoption and implementation of the National IWRM Plan and Road Map. In addition, 24 specific recommendations have been highlighted to ensure that the enabling environment, the institutional framework, management instruments, and investments in water infrastructure are set in place together with a management structure to oversee the implementation of the plan.

A special Editorial Committee was appointed to prepare this consolidated Report comprising the following members:

1. Academician Tan Sri Ir. Shahrizaila Abdullah FASc — Founding Chairperson of the ASM Water Committee;
2. Academician Fateh Chand FASc — Second Chairperson of the ASM Water Committee;
3. Ir. Dr Salmah Zakaria FASc — Current Chairperson of the ASM Water Committee; and
4. P. Loganathan — ASM Research Fellow

The Editorial Committee was chaired by Academician Tan Sri Ir. Shahrizaila Abdullah. Apart from developing an appropriate report structure, the task entailed the compilation

of the outcomes from thematic studies undertaken earlier by the ASM-led Task Forces, contributions from other agencies, and expert reviews. Summary briefs and expert reviews included as appendices against relevant chapters of this Report have been duly accredited to the contributors. The opinions expressed are that of the reviewers and ASM may not fully agree with the views expressed. The focus of the Editorial Committee was mainly devoted to the development of the consolidated NIWRMP (Chapter 6) and the Conclusions and Recommendations (Chapter 7).

On behalf of the Editorial Committee, we take great pleasure in placing on record our deepest appreciation to all the Task Force Chairpersons

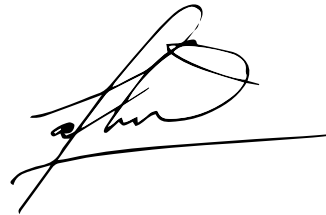


Academician Tan Sri Ir. Shahrizaila Abdullah
*Chairperson,
Editorial Committee*

and Expert Reviewers for their invaluable contributions to enable this publication to be possible. We thank the ASM Secretariat for the continuing administrative support provided at the many meeting sessions and for facilitating the compilation and printing of the Report.

Last but not least, we owe a debt of gratitude to all our members for coming on board and painstakingly working as a team to complete this Report on schedule.

This report is published in 2 volumes, volume 1 comprises the main report while volume 2 contains a set of appendices related to chapters 3, 4, 5 and 6.



Ir. Dr Salmah Zakaria
*Chairperson,
ASM Water Committee*

ACRONYMS

AACB	Awareness Raising, Advocacy And Capacity Building
ADB	Asian Development Bank
APWF	Asia Pacific Water Forum
AR5	Fifth Assessment Report
ARI	Average Recurrence Interval
ARSM	<i>Agensi Remote Sensing Malaysia</i> (Malaysian Remote Sensing Agency)
ASEAN	Association of Southeast Asian Nations
ASM	Academy of Sciences Malaysia
AWS	Agricultural Water Services
BCM	Billion Cubic Metres
BIMP-EAGA	Brunei Darussalam–Indonesia–Malaysia–The Philippines East Asean Growth Area
BKSA	<i>Badan Kawal Selia Air</i> (Water Regulatory Body)
BMP	Best Management Practices
BO	Business Opportunities
BOD	Biochemical Oxygen Demand
BPSP	<i>Bahagian Pengairan dan Saliran Pertanian</i> (Agricultural Drainage and Irrigation Division)
CBO	Community-based Organisation
CCIW	Climate Change Impacts on Water
CDD	Community Development Department (<i>Jabatan Kemajuan Masyarakat – KEMAS</i>)
CEB	Central Electricity Board
CGIAR	Consultative Group for International Agricultural Research
CSO	Civil Society Organisations
CTP	Community Transformation Programme
CWP	Country Water Partnerships Department of Irrigation and Drainage
DAN	<i>Dasar Agromakanan Negara</i> (National Agrofood Policy of Malaysia – NAPM)

DG	Director General
DID	Department of Irrigation and Drainage (<i>Jabatan Pengaliran dan Saliran – JPS</i>)
DMG	Department of Minerals and Geoscience
DOA	Department of Agriculture
DOE	Department of Environment
DOF	Department of Fisheries
DSAN	<i>Dasar Sumber Air Negara</i> (National Water Services Policy)
DSS	Decision Support Systems
EDC	Endocrine Disrupting Chemicals
EIA	Environmental Impact Assessments
EP	Entry Projects
EPP	Entry Point Project
EPU	Economic Planning Unit
EQA	Environmental Quality Act
ESC	Erosion and Sediment Control
ESCAP	Economic and Social Commission for Asia and The Pacific
ESCP	Erosion and Sediment Control Plan
ETP	Economic Transformation Programme
FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
FOG	Fats, Oil and Grease
FSE	Food Services Establishments
GEC	Global Environment Centre
GNI	Gross National Income
GWA	Ground Water Assessment
GWP	Global Water Partnership
IADA	Integrated Agricultural Development Area
IAHR	International Association for Hydro-Environment Engineering And Research

IAP	Inter-Academy Panel
IASM	Integrated Aquifer System Management
ICID	International Commission on Irrigation and Drainage
ICM	Integrated Catchment Management
ICSU	International Council for Science
ICWE	International Conference on Water and the Environment
ICZM	Integrated Coastal Zone Management
IDM	Integrated Drought Management
IDNDR	International Decade for Natural Disaster Reduction
IFM	Integrated Flood Management
IHP	International Hydrological Programme
IHT	International Herald Tribune
IIGH	International Institute for Global Health
ILBM	Integrated Lake Basin Management
ILEC	International Lake Environment Committee
IMT-GT	Indonesia–Malaysia–Thailand Growth Triangle
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
IUWM	Integrated Urban Water Management
IWA	International Water Association
IWK	Indah Water Konsortium
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JBA	<i>Jabatan Bekalan Air</i> (Water Supply Department – WSD)
JKR	<i>Jabatan Kerja Raya</i> (Public Works Department – PWD)
JKT	<i>Jabatan Kerajaan Tempatan</i> (Local Government Department)

JMG	<i>Jabatan Mineral dan Geosains</i> (Department of Minerals and Geoscience – DMG)
JPBD	<i>Jabatan Perancangan Bandar dan Desa</i> (Town And Country Planning Department – TCPD)
KADA	Kemubu Agriculture Development Authority
KeTTHA	<i>Kementerian Tenaga, Teknologi Hijau dan Air</i> (Ministry of Energy, Green Technology and Water – MEGTW)
KKLW	<i>Kementerian Kemajuan Luar Bandar dan Wilayah</i> (Ministry of Rural and Regional Development – MRRD)
KPI	Key Performance Index
LBC	Lake Basin Committee
LESTARI	Institute for Environment and Development
LPP	<i>Lembaga Pertubuhan Peladang</i> (Farmers' Organisation Authority – FOA)
LSANK	<i>Lembaga Sumber Air Negeri Kedah</i> (Kedah State Water Resources Board)
LUAS	<i>Lembaga Urus Air Selangor</i> (Selangor Water Management Authority – SWMA)
MADA	Muda Agriculture Development Authority
MANCID	Malaysian National Committee on Irrigation and Drainage
MCM	Million Cubic Meters
MDKS	<i>Majlis Daerah Kuala Selangor</i> (Kuala Selangor District Council)
MENGO	Malaysian Environmental NGO
MET	Meteorological Department
MEWC	Ministry of Energy, Water and Communications
MFT	Malaysia Federal Territories
MHLG	Ministry of Housing and Local Government
MLD	Millions of Litres per Day
MOA	Ministry of Agriculture and Agro-based Industry
MOH	Ministry of Health
MOHE	Ministry of Higher Education

MOSTI	Ministry of Science, Technology and Innovation
MOT	Ministry of Transport
MPIC	Ministry of Primary Industry and Commodities
MPOB	Malaysian Palm Oil Board
MSAN	<i>Majlis Sumber Air Negara</i> (National Water Resources Council – NWRC)
MSANG	<i>Majlis Sumber Air Negeri</i> (State Water Resources Council – SWRC)
MSMA	<i>Manual Saliran Mesra Alam</i> (Urban Storm-water Management Manual)
MUWHLG	Ministry of Urban Wellbeing, Housing and Local Government
MWA	Malaysian Water Association
MWFCD	Ministry of Women Family and Community Development
MWIG	Malaysian Water Industry Guide
MyCapNet	Malaysian Capacity Building Network
MyCDNet	Malaysian Capacity Development Network
MyWP	Malaysian Water Partnership
NAHRIM	National Hydraulics Research Institute of Malaysia
NBOS	National Blue Ocean Strategy
NC2	Malaysia's National Communication No. 2
NEM	New Economic Model
NGO	Non-governmental Organisation
NIWR	National Integrated Water Research
NKEA	National Key Economic Area
NKPA	National Key Priority Area
NPP	National Physical Plan
NRE	Ministry of Natural Resources and Environment
NRLC	National Lake Resource Centre
NRW	Non-revenue Water
NSC	National Steering Committee
NTC	National Technical Committee

NTP	National Transformation Programme
NTS	Natural Treatment Systems
NWQS	National Water Quality Standards for Malaysia
NWRD	National Water Resources Department
NWRDC	National Water Resources Development Council
NWRP	National Water Resources Policy
NWRS	National Water Resources Study
O&M	Operations and Maintenance
OPEX	Operating Expenditure
OPP3	Third Outline Perspective Plan
PAAB	<i>Pengurusan Aset Air Berhad</i> (Water Asset Management Company – WAMCO)
PES	Payment for Ecosystem Services
PPCP	Pharmaceuticals and Personal Care Products
PPj	<i>Perbadanan Putrajaya</i> (Putrajaya Corporation)
PPP	Public-private Partnership
PWSA	Penang Water Services Academy
R&D	Research and Development
RBIMS	River Basins Information Management System
RBMC	River Basin Management Committees
RBMU	River Basin Management Unit
RNA	Research Needs Assessment
RoL	River of Life
RUU	Rang Undang-Undang
RWP	Regional Water Partnerships
SDG	Sustainable Development Goal
SME	Small- and Medium-enterprises
SOM	Service-oriented Management
SOP	Standard Operating Procedures

SPAN	<i>Suruhanjaya Perkhidmatan Air Negara</i> (National Water Services Industry Commission)
SSL	Self-sufficiency Levels
STI	Science, Technology and Innovation
STP	Social Transformation Programme
SWMA	Selangor Waters Management Authority
SWRA	State Water Resources Agencies
SWRE	Sabah Water Resources Enactment
SYABAS	Syarikat Bekalan Air Selangor Sdn Bhd
TMDL	Total Maximum Daily Load
TNB	Tenaga Nasional Berhad
TOT	Training of Trainers
UKM	Universiti Kebangsaan Malaysia
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Conference on Sustainable Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework on Climate Change Convention
UNISDR	United Nations International Strategy for Disaster Reduction
UNSD	United Nations Statistics Division
UNU	UN University
VM	Value Management
VW	Virtual Water
WDM	Water Demand Management
WEF	Water, Energy, Food
WEM	Water Engineering and Management
WF	Water Footprint
WFD	Water Framework Directive

WFN	Water Footprint Network
WHO	World Health Organization
WMA	Water Management Authority
WMO	World Meteorological Organization
WQI	Water Quality Index
WRC	Water Research Consortium
WRD	Water Resource Department
WRDC	Water Research and Development Centre
WRM	Water Resources Management
WSIA	Water Services Industry Act
WSM	Water Supply Management
WSP	Water Safety Plans
WSSD	World Summit on Sustainable Development
WSWWM	Water Supply And Wastewater Management
WTP	Water Treatment Plant
WUGs	Water User Groups
WWC	World Water Council

ACKNOWLEDGEMENTS

The Academy of Sciences Malaysia (ASM) appreciates the contribution of the following:

Editorial Committee

- 1) Academician Tan Sri Ir Hj Shahrizaila Abdullah FASc (Chairperson)
- 2) Academician Datuk Fateh Chand FASc
- 3) Ir. Dr Salmah Zakaria FASc
- 4) P. Loganathan

ASM Water Committee

- 1) Ir. Dr Salmah Zakaria FASc (Chairperson)
- 2) Academician Tan Sri Ir Hj Shahrizaila Abdullah FASc
- 3) Academician Datuk Fateh Chand FASc
- 4) Tan Sri Ir. Syed Muhammad Shahabudin FASc
- 5) Tan Sri Ir. Omar Ibrahim FASc
- 6) Tan Sri Professor Ir Dr Sahol Hamid Abu Bakar FASc
- 7) Datuk Ir. Mohd Adnan Mohd Nor FASc
- 8) Dato’ Ir. Haji Hanapi bin Mohamad Noor
- 9) Professor Dato’ Seri Ir. Dr Zaini Ujang FASc
- 10) Emeritus Professor Dato’ Wira Ir. Dr Mohammad Noor Hj Salleh FASc
- 11) Dr Low Kwai Sim FASc
- 12) Professor Dr Fatimah Md Yusoff FASc
- 13) Professor Dr Ahmad Fauzi Ismail FASc
- 14) Professor Dr Zulkifli Yusop FASc
- 15) Professor Dr Joy Jacqueline Pereira FASc
- 16) Professor Dr Yang Farina Abdul Aziz FASc
- 17) Professor Ir. Dr Ruslan Hassan FASc

ASM Water Sector Task Forces

Integrated Lake Basin Management Task Force	
Academician Tan Sri Ir Hj Shahrizaila Abdullah FASc	
Chair	
Members	
Prof Dr Fatimah Md Yusoff FASc (UPM)	Abd Halim Hj Mohamad (NRE)
Ir. Dr Salmah Zakaria FASc (NAHRIM)	Dr Zati Hj Sharip (NAHRIM)
Hj Akashah Majizat (PPj)	Hoo Huey Ching (NAHRIM)
Dr Low Kwai Sim FASc (ASPEC)	Prof Datin Dr Ann Anton (UMS)
Sunitha Bisan (SUSDEN)	Ir. Dr Lee Jin (DRE Consulting)

Integrated Aquifer System Management Task Force

Academician Datuk Fateh Chand FASc
Chair

Members

Che Siti Noor Koh Poh Lee (NRE)	Ab. Rashid Ab. Rahim (DOA)
Izham Harith Ikhwan (MOH)	Muhamad Hilmi Abd. Rabiki (DOA)
Mr Mohd Rodzwan Baba Sakri (KeTTHA)	Saiful Azman Ibrahim (DOE)
Ms Nuraizah Mohd Zam (KeTTHA)	Nor Zamri Sondor (LUAS)
Siti Nurilam Abu Mansor (JBA)	Zaniah Ahmad (KKLW)
Dr Saim Suratman (NAHRIM)	Siow Suan Neo (JPBD)
Mohd Hatta Abdul Karim (JMG)	Tahsilazam Othman (SPAN)
Mohd Badzran Mat Taib (JMG)	

Water Demand Management Task Force

Tan Sri Ir Syed Muhammad Shahabudin FASc
Chair
Datuk Ir. Mohd Adnan Mohd Nor FASc
Co-Chair

Members

Dato' Ir. Hanapi Mohamad Noor (DID)	Ir. Ganeshalingam Rasiah (SMHB Sdn Bhd)
Ir. Noor Azahari Zainal Abidin (JBA)	Dr Zulkifli Abdul Rahman (DOE)
Atan Sapien (EPU)	Roowina Merican A. Rahim Merican (SYABAS)
Ir. Marzuki Mohamed (SPAN)	Prof Dr Zulkifli Yusop FASc (UTM)
Ir. Mohd Haniffa Abdul Hamid (IWK)	Dr Yeoh Oon Tean (FMM)
Ir. Hor Tek Lip (MADA)	Zalilah Selamat (MOA)
Ghazat Awang (TNB)	James T Cherian (MNS)
Ir. Mohammad Zaki Jalaludin (TNB)	

Water Supply and Wastewater Management Task Force

Prof Dr Zulkifli Yusop FASc
Chair

Members

Sutekno Ahmad Belon (KeTTHA)	Ir Hj Mohmad Asari Daud (MWA)
Noorhashim Baron (SPAN)	Prof Dr Azni Idris (UPM)
Ir. Mohamed Haniffa Abdul Hamid (IWK)	Prof Dr Mohd Razman Salim (UTM)
Faizal Othman (Ranhill)	

Integrated Water Research Task Force

Prof Dr Ahmad Fauzi Ismail FASc
Chair

Members

Prof Dr Zulkifli Yusop FASc (UTM)
Prof Dr Azmi Aris (UTM)
Dr Zainura Zainun (UTM)
Dr Mohd Shahir Shamsir (UTM)

Dr Noorul Hassan Zardari (UTM)
Dr Muhd Ali Muhamad Yuzir (UTM)

Climate Change Impacts on Water Task Force

Ir. Dr Salmah Zakaria FASc
Chair

Members

Dr Abdul Rahim Nik (FRIM)
Ir. Hj Mohd Fauzi Mohamad (NAHRIM)
Ir. Mohd Zaki Mat Amin (NAHRIM)
Dr Nik Muhammad Nizam Nik Hassan (IMR)
Dr Wan Azli Wan Hassan (MMD)
Ling Leong Kwok (MMD)

Hj Azmi Md Jafri (DID)
Dr Mohamad Zabawi Abd Ghani (MARDI)
Dr Dahlia Rosly (JPBD)
Nor Zaliza Mohd Puzi (JPBD)
Prof Dr Joy Jacqueline Pereira FASc (UKM)

Integrated River Basin Management Task Force

Dato' Ir. Lim Chow Hock FASc /
Dato' Ir. Hj Hanapi bin Mohamad Noor
Chair

Members

Mohd Said Dikon (DID)
Md Khairi Selamat (LUAS)
Wong Chee Ching (BSASH)
Ir. Dr Hasnul Mohamad Salleh (JBA)
Dr Zulkifli Abdul Rahman (DOE)

Dr Rahmah Elfithri (LESTARI, UKM)
Mohd Yazid Abdullah (BPSP)
Dr K Kalithasan (GEC)
Dr Lee Jin (MyWP, MyCBNet)

Water and Agriculture Task Force

Datuk Ir Mohd Adnan Mohd Nor FASc

Chair

Members

Hjh Zalilah Selamat (MOA)
Dr Vijaya Subramaniam (MPOB)
Dr Marlinda Abd Malek (UNITEN)
Dr Muhammad Che Husain (UNIMAP)
Dr Chan Chee Sheng (MARDI)
Dr Moktir Singh al Gardir Singh (DVS)
Ahmad Sofian Mohammad (LGM)

Muhammad Syaifudin Omar (MOA)
Dr Halimah Muhamad (MPOB)
Mohd Fauzi Mohd Yusoff (LGM)
Dr Zainura Zainon Noor (UTM)
Haslawati Baharuddin (DOF)
Azhar Mohd Isa (MOA)

A National Key Priority Area on Water Task Force

Dr Low Kwai Sim FASc

Chair

Members

Datuk Ir. Mohd Adnan Mohd Nor FASc (ASM)
Prof Dr Jamal Othman (UKM)

Integrated Urban Water Management on Water Task Force

Dr Low Kwai Sim FASc

Chair

Members

Dato' Ir. Lim Chow Hock FASc (ASM)
Datuk Ir. Abdul Kadir Mohd Din (IWK)
Dr Renard Siew (Sime Darby)
Hj Mohd Nazeri bin Salleh (JKT)
Nizarulikram Abdul Rahim (KWP)
Puan Sri Dr Jahara Yahaya (ASPEC)

Datin Zaharah Hj Mahmud (ASPEC)
Dr Ching Thoo a/I Kim (KeTTTHA)
Azizah Ariffin (NRE)
Dr Marlinda Abdul Malek (UNITEN)
Jenny Tan Suat Eam (ENSEARCH)
Ir. Kamalesen Chandrasekaran (ASM)

Lembaga Urus Air Selangor Case Study Team

Nor Zamri Sondor (LUAS)
Haslina Amer (LUAS)
Md Khairi Selamat (DID)

Guest Writers for Expert Reviews, Summary Briefs & Summary Reports

- 1) **Dato' Ir. Haji Hanapi bin Mohamad Noor**
Summary Brief on Integrated Flood Management (IFM),
Summary Brief on Integrated Drought Management (IDM) &
Summary Report on National Water Resources Policy (NWRP) Action Plans
- 2) **Dato' Halimah Hassan and Dr Saim Bin Suratman**
Expert Review on Water Quality Management in Malaysia
- 3) **Datin Paduka Dr Dahlia Rosly**
Expert Review on Water and Land Use
- 4) **Professor Dr Yang Farina Abdul Aziz FASc**
Expert Review on Water and Health
- 5) **Professor Dr Chan Ngai Weng**
Expert Review on Water and Green Growth
- 6) **Sunitha Bisan**
Expert Review on Water, Gender and Sustainability in Malaysia
- 7) **Dr Zainura Zainon Noor and Noor Salehan Mohammad Sabli**
Expert Review on Water Footprint and Virtual Water
- 8) **Datuk Ir Mohd Adnan Mohd Nor FASc**
Expert Review on Investment and Financing for IWRM
- 9) **Dr Ahmad Hezri Adnan FASc**
Expert Review on Water-Energy-Food Nexus
- 10) **Professor Dato' Dr Mazlin Mokhtar FASc & Dr. Rahmah Elfithri**
Expert Review on Awareness Raising, Advocacy and Capacity Building in IWRM
- 11) **Ir. Dr Salmah Zakaria FASc**
International Networking and Collaboration in IWRM Development
- 12) **P. Loganathan**
Summary Brief on Mega Science Framework Agenda for Sustained and Sustainable National Development (2011- 2050) – the Water Sector

ASM Analysts and Publication Team

- 1.) **Nitia Samuel**
Principal Analyst
- 2.) **Dr Tan Shu Ying**
Senior Analyst
- 3.) **Loh Chia Hur**
Analyst
- 4.) **Fatin Athirah Amani Mohd Nasir**
Analyst
- 5.) **Nurfatkehah Idris**
Analyst
- 6.) **Engku Sharmila Engku Ab. Latif**
Research Assistant
- 7.) **Hazrul Liki**
Executive (Science Communication)

ILLUSTRATIONS – BOXES, FIGURES, AND TABLES

Volume 1	
Executive Summary	
Table 1	Completed Component Plan Reports by ASM
Table 2	Complementary Component Plan Reports
Table 3	List of Programmes for Investments in Water Infrastructure
Chapter 1. Evolution of Integrated Water Resources Management (IWRM)	
Box 1.1	Dublin Principles (ICWE 1992)
Box 1.2	List of Targets under Sustainable Development Goal 6
Box 1.3	Integrated Agriculture Development Areas
Chapter 2. ASM and the IWRM Agenda	
Table 2.1	ASM Studies and the IWRM Agenda
Chapter 3. Component Plan (IWRM Sub-theme) Studies by ASM: Summary Briefs	
Table 3.1	Component Plan Study Reports by ASM
Table 3.2	Component Plan Summary Briefs
Chapter 4. Complementary Component Plan Studies: Summary Briefs and Reports/Expert Reviews	
Table 4.1	Complementary Component Plan Studies and the IWRM Agenda
Chapter 5. State IWRM Plans : Case Study on LUAS (Selangor)	
Figure 5.1	IWRM General Framework
Chapter 6. Transforming the Water Sector: National Integrated Water Resources Management Plan – Strategies and Road Map	
Box 6.1	Water Security Defined
Box 6.2	IWRM General Framework

Box 6.3	What are National IWRM Plans?
Figure 6.1	Consumptive Water Demand Projections (BCM/Year)
Figure 6.2	Ecosystem Services (Millennium Ecosystem Assessment 2005)
Figure 6.3	The IWRM Agenda Involves the Integration of both Natural and Human
Figure 6.4	IWRM General Framework
Figure 6.5	Proposed National Steering Committee
Figure 6.6	Proposed National Technical Committee
Table 6.1	National Key Economic Areas
Table 6.2	Total Consumptive Water Demand against Total Surface Water Availability for
Table 6.3	Climate Change and its Impact on Water Resources
Table 6.4	List of Programmes for Investments in Water Infrastructure
Chapter 7. Conclusions and Recommendations	
Table 7.1	List of Programmes for Investments in Water Infrastructure

Volume 2

Appendices to Chapter 3. Component Plan (IWRM Sub-theme) Studies by ASM: Summary Briefs

Box 3.2.3.1	Definition of WDM by David B. Brooks
Box 3.2.3.2	The 17 Strategies under Management Categories
Box 3.2.8.1	A Definition of Service-oriented Management
Box 3.2.8.2	Integrated Water Resources Management
Box 3.2.8.3	National Blue Ocean Strategy
Box 3.2.8.4	The Water-Energy-Food Nexus
	List of Targets under Sustainable Development Goal 6
Figure 3.2.6.1	Illustration of the Core Concept of the WGII AR5
Figure 3.2.8.1	Total Water Demand for the year of 2010 and 2050
Figure 3.2.8.2	Total Water Demand for All Sectors

Figure 3.2.8.3	Investment-service Linkages for Service-oriented Management
Figure 3.2.8.4	Risk Mitigation Measures
Figure 3.2.8.5	Northern Corridor Economic Region
Figure 3.2.8.6	Integrated Water Resources Management Framework
Figure 3.2.8.7	Supply Management to Water Demand Management
Figure 3.2.8.8	Conceptual Diagram of the Water-Energy-Food Nexus
Figure 3.2.8.9	WEF Security Nexus and Water Resources security
Figure 3.2.10.1	Risk-return Assessment for Opportunities for Creating New Wealth
Figure 3.2.10.2	Risk-return Matrix for Sustaining the Resource Opportunities
Table 3.2.1.1	Inventory of Lakes in Malaysia
Table 3.2.3.1	Activities to Enhance WDM in Malaysia
Table 3.2.4.1	Investments In Water Infrastructure for Water NKPA
Table 3.2.5.1	Research Themes for Water as a Resource and Related Wealth Creation
Table 3.2.5.2	Research Themes for Water for Livelihood and Wealth Creation
Table 3.2.5.3	R&D Launching Grant to Kick-start the National Agenda for Integrated Water Research in Malaysia
Table 3.2.8.1	Potential Irrigation Water Savings in the Granaries
Table 3.2.8.2	FFB yield in Malaysia
Table 3.2.8.3	Crop Damaged and Flood Aid in MADA Granary
Table 3.2.8.4	Strategies Implementation Road Map with Timelines and Relevant Lead Agencies
Table 3.2.9.1	Summary of Entry Points for a Water NKPA
Table 3.2.10.1	Risk-return Assessment for Opportunities for Creating New Wealth
Table 3.2.10.2	Risk-return Assessment for Opportunities for Sustaining the Resource
Table 3.2.10.3	Ministries Responsible for Implementing “Opportunities for Wealth Creation”
Table 3.2.10.4	Ministries Responsible for Implementing Opportunities for “Sustaining the Resource”

Appendices to Chapter 4. Complementary Component Plan Studies: Summary Briefs and Reports/ Expert Reviews	
Box 4.2.8.1	Different Composition of Water Footprint
Figure 4.2.6.1	The Strategic Approach Between Green Growth and Water
Figure 4.2.8.1	Average National WF per Capita (m3/capita/year)
Figure 4.2.8.2	Contribution of Different Consumption Categories to the Global Water Footprint, with a Distinction between the Internal and External Footprint
Figure 4.2.8.3	Projection of Total Domestic, Industrial and Irrigation Demand for
Figure 4.2.8.4	Contributions of Different Consumption Categories to the Global WF
Figure 4.2.12.1	Krabi Initiative, the Outcome of "The 6th Informal ASEAN Ministerial Meeting on Science and Technology: IAMMST" and "The 60th ASEAN COST" (2010)
Figure 4.2.13.1	Projected Water Scarcity in 2025 (International Water Management Institute)
Figure 4.2.13.2	Study Framework for IUWM in Malaysia Study
Figure 4.2.14.1	The NWRP Implementation Mechanism
Figure 4.2.14.2	Working Group by Relevant Government Departments and Ministry Division
Table 4.2.4.1	Type of Land Uses
Table 4.2.4.2	Relationship Between Land Use and Implication to Water Resources
Table 4.2.5.1	Statistics of Water-related Diseases in Malaysia, 2013
Table 4.2.8.1	Composition of the water footprint for some selected countries.
Table 4.2.8.2	Water Footprint, Water Scarcity and Water Dependency of Countries in the World
Table 4.2.13.1	Definitions of the Term Integrated Urban Water Management (IUWM)
Table 4.2.13.2	Four Major Conurbations in Peninsular Malaysia—Phase 1
Table 4.2.13.3	Water Consumption for States in Malaysia (2010–2050)

APPENDICES

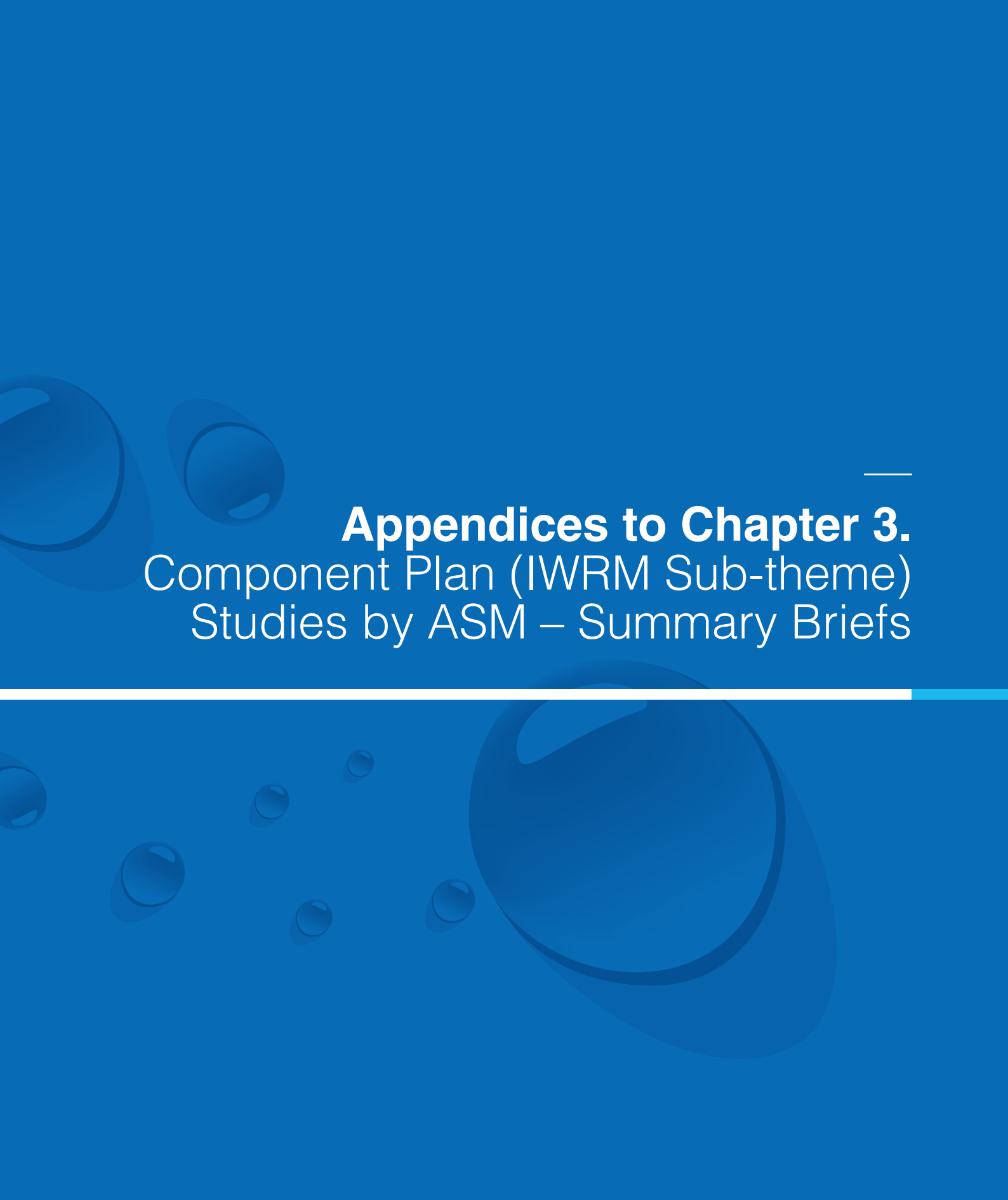
Volume 1	
Executive Summary	
Appendix 1	Summary of National IWRM Strategy Plan and Implementation Road Map: Enabling Environment
Appendix 2	Summary of National IWRM Strategy Plan and Implementation Road Map: Institutional Framework
Appendix 3	Summary of National IWRM Strategy Plan and Implementation Road Map: Management Instruments
Appendix 4	Summary of National IWRM Strategy Plan and Implementation Road Map: Investments in Water Infrastructure
Chapter 1. Evolution of Integrated Water Resources Management (IWRM)	
Appendix 1.1	World Summit on Sustainable Development 2002
Appendix 1.2	Sustainable Development Goals
Appendix 1.3	Policy Statements on Water Resources Management
Chapter 5. State IWRM Plans : Case Study of LUAS (Selangor)	
Appendix 5.1	Template of National IWRM Strategy Plan and Implementation Road Map: State IWRM Plans: Enabling Environment
Appendix 5.2	Template of National IWRM Strategy Plan and Implementation Road Map: State IWRM Plans: Institutional Framework
Appendix 5.3	Template of National IWRM Strategy Plan and Implementation Road Map: State IWRM Plans: Management Instruments
Appendix 5.4	Template of National IWRM Strategy Plan and Implementation Road Map: State IWRM Plans: Investments in Water Infrastructure
Chapter 6. Transforming the Water Sector: National Integrated Water Resources Management Plan – Strategies and Road Map	
Appendix 6.1	National IWRM Strategy Plan and Implementation Road Map: Enabling Environment
Appendix 6.2	National IWRM Strategy Plan and Implementation Road Map: Institutional Framework

Appendix 6.3	National IWRM Strategy Plan and Implementation Road Map: Management Instruments
Appendix 6.4	National IWRM Strategy Plan and Implementation Road Map: Investments in Water Infrastructure
Volume 2	
Appendices to Chapter 3. Component Plan (IWRM Sub-theme) Studies by ASM: Summary Briefs	
Appendix 3.2.1.1	NIRWM Strategy Plan and Implementation Road Map: ILBM: Enabling Environment
Appendix 3.2.1.2	NIRWM Strategy Plan and Implementation Road Map: ILBM: Institutional Framework
Appendix 3.2.1.3	NIRWM Strategy Plan and Implementation Road Map: ILBM: Management Instruments
Appendix 3.2.1.4	NIRWM Strategy Plan and Implementation Road Map: ILBM: Investments in Water Infrastructure
Appendix 3.2.2.1	NIRWM Strategy Plan and Implementation Road Map: IASM: Enabling Environment
Appendix 3.2.2.2	NIRWM Strategy Plan and Implementation Road Map: IASM: Institutional Framework
Appendix 3.2.2.3	NIRWM Strategy Plan and Implementation Road Map: IASM: Management Instruments
Appendix 3.2.2.4	NIRWM Strategy Plan and Implementation Road Map: IASM: Investments in Water Infrastructure
Appendix 3.2.3(a)	Strategies for WDM Implementation
Appendix 3.2.3(b)	Stakeholder Participation
Appendix 3.2.3(c)	Water Managers and Public Stakeholder Platforms
Appendix 3.2.3(d)	Outline Master Plan for WDM
Appendix 3.2.4.1	NIRWM Strategy Plan and Implementation Road Map: WSWWM and WDM: Enabling Environment
Appendix 3.2.4.2	NIRWM Strategy Plan and Implementation Road Map: WSWWM and WDM: Institutional Framework
Appendix 3.2.4.3	NIRWM Strategy Plan and Implementation Road Map: WSWWM and WDM: Management Instruments
Appendix 3.2.4.4	NIRWM Strategy Plan and Implementation Road Map: WSWWM and WDM: Investments in Water Infrastructure

Appendix 3.2.5(a)	National Agenda for Integrated Water Research in Malaysia
Appendix 3.2.5(b)	Research Themes for Water as a Resource and Related Wealth Creation
Appendix 3.2.5(c)	Research Themes for Water for Livelihood and Wealth Creation
Appendix 3.2.5(d)	R&D Launching Grant to Kick Start the National Agenda for Integrated Water Research in Malaysia
Appendix 3.2.5.1	NIRWM Strategy Plan and Implementation Road Map: NIWR: Enabling Environment
Appendix 3.2.5.2	NIRWM Strategy Plan and Implementation Road Map: NIWR: Institutional Framework
Appendix 3.2.5.3	NIRWM Strategy Plan and Implementation Road Map: NIWR: Management Instruments
Appendix 3.2.5.4	NIRWM Strategy Plan and Implementation Road Map: NIWR: Investments in Water Infrastructure
Appendix 3.2.6.1	NIRWM Strategy Plan and Implementation Road Map: CCW: Enabling Environment
Appendix 3.2.6.2	NIRWM Strategy Plan and Implementation Road Map: CCW: Institutional Framework
Appendix 3.2.6.3	NIRWM Strategy Plan and Implementation Road Map: CCW: Management Instruments
Appendix 3.2.6.4	NIRWM Strategy Plan and Implementation Road Map: CCW: Investments in Water Infrastructure
Appendix 3.2.7.1	NIRWM Strategy Plan and Implementation Road Map: IRBM: Enabling Environment
Appendix 3.2.7.2	NIRWM Strategy Plan and Implementation Road Map: IRBM: Institutional Framework
Appendix 3.2.7.3	NIRWM Strategy Plan and Implementation Road Map: IRBM: Management Instruments
Appendix 3.2.7.4	NIRWM Strategy Plan and Implementation Road Map: IRBM: Investments in Water Infrastructure
Appendix 3.2.8(a)	Review of Current Status and Needs Assessment
Appendix 3.2.8(b)	Approaches to Develop AWS for Agribusiness
Appendix 3.2.8(c)	Strategies Implementation Road Map with Timelines and Relevant Lead Agencies
Appendix 3.2.8.1	NIRWM Strategy Plan and Implementation Road Map: AWS: Enabling Environment

Appendix 3.2.8.2	NIRWM Strategy Plan and Implementation Road Map: AWS: Institutional Framework
Appendix 3.2.8.3	NIRWM Strategy Plan and Implementation Road Map: AWS: Management Instruments
Appendix 3.2.8.4	NIRWM Strategy Plan and Implementation Road Map: AWS: Investments in Water Infrastructure
Appendix to Chapter 5: State IWRM Plans - Case Study on Lembaga Urus Air Selangor (LUAS)	
Appendix 5.5.1	NIRWM Strategy Plan and Implementation Road Map: LUAS: Enabling Environment
Appendix 5.5.2	NIRWM Strategy Plan and Implementation Road Map: LUAS: Institutional Framework
Appendix 5.5.3	NIRWM Strategy Plan and Implementation Road Map: LUAS: Management Instruments
Appendix 5.5.4	NIRWM Strategy Plan and Implementation Road Map: LUAS: Investments in Water Infrastructure
Appendix to Chapter 6: Transforming The Water Sector: National Integrated Water Resources Management Plan – Strategies and Road Map	
Appendix 6.5	A National Key Priority Area (NKPA) on Water



The background is a solid blue color. It features several abstract water droplets of various sizes, some with highlights and shadows, giving them a 3D appearance. A thin white horizontal line runs across the middle of the page, with a small gap where the text is located. Above the text, there is a small white horizontal line segment.

Appendices to Chapter 3.

Component Plan (IWRM Sub-theme)
Studies by ASM – Summary Briefs

Integrated Lake Basin Management

Summary Brief

Academician Tan Sri Ir. Hj Shahrizaila Abdullah FASc and
Professor Dr Fatimah Md Yusoff FASc

Defining ILBM

“Integrated Lake Basin Management (ILBM) is an approach to achieving sustainable management of lakes and reservoirs through gradual, continuous and holistic improvement of basin governance, including sustained efforts for integration of institutional responsibilities, policy directions, stakeholder participation, scientific and traditional knowledge, technological possibilities, and funding prospects and constraints. ILBM also takes the position that the problems facing individual lakes cannot be properly addressed unless the fundamental issue of sustainable resource development, use, and conservation facing the lakes are addressed, and with strong, long-term political commitment” (Nakamura & Rast 2011).

Review of Current Status and Needs Assessment

The Academy of Sciences Malaysia (ASM) and the National Hydrological Institute of Malaysia (NAHRIM) jointly initiated in October 2004, a study to provide a baseline appraisal of the current state of the country's lakes and reservoirs. Undertaken by the

Institute of Environment and Water Resource Management, University Teknologi Malaysia, the resulting report entitled *A Study on the Status of Eutrophication of Lakes in Malaysia*, confirmed that out of the 90 lakes that were studied, 56 (62%) were in a poor condition (eutrophic), while the balance was in a mediocre to reasonably good state (mesotrophic). The study went on to conclude that eutrophication of lakes has reached levels for serious concern and restoration efforts were urgently needed for many lakes. In addition, the report called for a lake management and restoration plan, intensification of research in identified priority areas and increased public awareness and capacity building for lake managers.

In August 2007, a two-day colloquium on the *Management of Lakes and Reservoirs in Malaysia* was held among various stakeholders as well as invited speakers from other countries. The colloquium concluded that there was an urgent need for a National Plan for Integrated Lake Management for sound and comprehensive lake management in the country.

In 2008 and as an immediate follow-up to the colloquium, ASM and NAHRIM jointly established a Technical Committee on Lake Management to further develop a Strategic

Plan for Lake and Reservoir Management in Malaysia. Under this study an inventory of lakes and their distribution by States was prepared as shown in Table 3.2.1.1.

Table 3.2.1.1: Inventory of Lakes in Malaysia

No.	State	Number	Area (km ²)	Volume (M m ³)
1.	Perlis	2	13.33	40.00
2.	Kedah	7	105.625	2,486.36
3.	Perak	11	284.68	6,766.50
4.	Selangor	15	11.38	511.32
5.	Pahang	10	94.69	321.51
6.	Kelantan	4	17.41	88.94
7.	Johor	13	84.47	940.024
8.	Labuan	3	NA	5.4
9.	Melaka	4	8.75	81.3
10.	Negeri Sembilan	5	2.25	182.325
11.	Pulau Pinang	4	0.936	47.2
12.	Sabah	5	NA	29.61
13.	Sarawak	4	NA	6080
14.	Terengganu	2	370.8	13600
15.	Putrajaya	1	7.5	45
Total		90	1,001.821	31,225.489

NA: Not applicable.

Initially, the development of a Conceptual Framework Plan for Lake Management through a process of strategic consultation with wide-ranging stakeholders was followed by more focused consultations for the preparation of detailed Component Plans to address the following topical aspects pertaining to lake resources management:

- Governance
- R&D needs
- Capacity building for management agencies and other stakeholder communities

- Lake management
- Information management; and
- Community stakeholder participation in the management process

The collective outputs from the initial Conceptual Framework Plan and the various Component Plans formed the basis for the preparation of a draft Strategic Plan for Lake Management which was presented to an open forum comprising a larger multi-stakeholder audience to obtain further feedback and inputs. The two-year ILBM study was completed at

the end of the year 2009 culminating in the preparation and publication of a comprehensive report entitled *The Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia*. The report was presented to relevant authorities including the NRE Ministry. The report and the recommendations have since been tabled and endorsed for implementation by the *Majlis Sumber Air Negara* (MSAN 07) held in November 2012.

Recommended Strategies

The ILBM Study recommended the following strategies for implementation which have been categorised under three broad headers following IWRM General Framework format and guidelines:

(i) Enabling Environment

- a) *Strategy 1: Pass appropriate legislation to strengthen existing legal framework*

Both at National and State level, appropriate legislation adopting ILBM as the central management philosophy must be passed to enable management of lakes as a resource. Where such legislation already exists, management agencies in the States, such as *Lembaga Urus Air Selangor* (LUAS), should work with NRE and DID to ensure the sound management of lakes and reservoirs in their respective States.

(ii) Institutional Framework

- a) *Strategy 2: Identify and Empower a Lead Ministry/Agency*

Every policy needs a dedicated ministry and associated

implementing agency to champion its cause. Valuable resources and capacities within government agencies exist. State actions will require sustained Federal funding and incentives.

Water is a natural resource; hence, the overall responsibility for reaching out and integrating across boundaries the sound management of this resource (including lakes) rests largely with the Ministry of Natural Resources and Environment (NRE) consistent with its mandate.

In executing this role, the agency within NRE that best lends itself to be the implementing agency for the enhanced mandate is the Department of Irrigation and Drainage (DID), which in its present location within the NRE, is probably better described as the department in charge of water resources. The DID is already responsible for river management and extension into lakes would be relatively seamless, but it may require the setting up a dedicated lake division under its wing to perform the task.

In performing this function, it must be duly recognised that the ultimate management of lakes be decentralised and hence all intents and purposes shall remain with current owners/operators, many of which involve other agencies like TNB, Water Supply Department, MADA, Local Authorities and the like. Notwithstanding, the

management should conform to a common set of ILBM principles and practices. The DID was be responsible for, inter alia:

- Facilitating, developing and implementing jointly with various agencies ILBM programmes and initiatives, including lake rehabilitation and restoration works as and when required;
- Develop and disseminate common lake management standards for adoption and compliance by lake managers;
- Develop the necessary human resources, both within itself and in other management agencies, with respect to ILBM through:
 - Training; and
 - Extension and technical support.

Appropriate manpower and financial resources would have to be provided to NRE and DID to take on this burden.

- b) *Strategy 3: Establish a National Lake Resource Centre under NRE*
The National Lake Resource Centre will be a one-stop agency which will act as:

- A centre of excellence for research into lakes and lake management, bringing together experts from various research institutions and universities to focus on priority areas for research and study.

- A reference centre and database for all information and research on lakes in Malaysia.

The establishment of a new agency is not advocated but rather to vest this role in NAHRIM. This is because:

- NAHRIM is a research institute and has as its mission to be “an expert centre on water and its environment management to ensure sustainable growth in order to improve the quality of life and well-being”.
- NAHRIM already has strong links with local research institutions and universities.
- NAHRIM is located within NRE and this would better enable intra-agency coordination.

When established, the immediate tasks to be undertaken by the NRLC are:

- To develop together with relevant lake management stakeholders an agenda for sustained multi-disciplinary research related to the lake environment, its development and operational management; and
- To ensure the lake database already initiated by NAHRIM is populated and updated regularly to include lake briefs of all lakes in the country. Being web-based, all information

should be easily accessible to all stakeholders to facilitate sound and efficient decision making.

c) *Strategy 4: Establish a Standing Committee on Lakes within the Purview of the National Water Resources Council*

The National Water Resources Council (NWRC) is modelled after the National Land Council, the National Forestry Council and National Spatial Planning Council, all of which bring State and Federal stakeholders together to engender a consensus on land use, forestry and spatial planning respectively.

Considering those lakes comprise one of three vital yet vulnerable sources of water (the other two being rivers and groundwater) that is closely linked and impacted upon by land development within its basin, and involve many stakeholders, it would be appropriate that a standing committee be set up under the NWRC to oversee the integrated management of water resources (to include both lentic and lotic systems namely lakes, rivers and groundwater) so as also to enable policies that have an administrative trans-boundary dimension to be engendered and implemented. NRE would be best positioned to lead this standing committee having been mandated to deal with the integrated management of all natural resources in the country. Among the first tasks for this national level Committee is to develop a common set of guidelines for integrated lake basin management for use at all levels.

d) *Strategy 5: Establish Lake Management Committees at State Level*

These committees will be at the political level of the State Governments, allowing coordination among the various agencies that are involved in the management of lakes. The model for this would be State Agriculture Committees or State Industrial Committees that are headed by State Executive Councillors or State Ministers. Among the first tasks for this State level committee would be to ensure that all lakes and reservoirs within the State (inclusive of an adequate buffer zone around their periphery) are duly gazetted as environmentally sensitive areas.

Development in and around these gazetted lake areas would require prior clearance from this Committee. Water catchment areas above reservoirs and water intakes would normally have already been gazetted with appropriate development restrictions and controls. An immediate review and extension of this requirement to cover all lake and reservoir basins should also be undertaken. Where considered relevant and desirable, the need for Special Area Plans or such other equivalent statutory plans may also be prescribed.

e) *Strategy 6: Support the role of Local Communities in Lake Management*

As noted, lakes and reservoirs are complex aquatic ecosystems, as well as important sources of water for human use and ecosystem

maintenance. Many people assume that the management and protection of lakes and reservoirs is primarily a function of the local, State or Federal government.

However, the public can play a major role in such situations and it can be very beneficial to seek the public's view in the form of public hearings or other relevant fora. An example is the creation of a community stakeholder committees (alternatively called citizens' advisory committee, "rakan tasik" or "friends of the lake") that include inhabitants that live in the lake or reservoir drainage basin.

These committees can provide valuable insights and information about past conditions of a lake or reservoir, particularly in the absence of written records. The participation of non-technical individuals is equally important in protecting lakes and reservoirs, e.g. farmers, urban planners, lawyers, economists and communication specialists. Knowledge gained in this manner can be disseminated among the general basin population, and so prepare people for more informed future judgements and actions.

In this regard, environmental NGOs and CBOs have demonstrated capabilities in facilitating the formation of community-based movements (e.g. in Tasek Chini, and Kelana Jaya lakes). Their services could be solicited to extend to other lake basins around the country.

(iii) Management Instruments

a) *Strategy 7: Development of a Detailed Action Plan*

The establishment of an implementing agency without a corresponding action plan for the immediate term would be counter-productive. Under the ILBM Study to address lake management, a set of preliminary activities and action plans have been identified and collated through wide consultations with relevant stakeholders under five thematic areas, namely governance, management, R&D, capacity building, information management, and community stakeholder participation. The thematic outputs from livestock farming areas workshops held over the year 2008 can be found in compiled reports accompanying the study documents. Using these findings to start with, the implementing agency would be able to build on it to develop a detailed Plan of Action with necessary priority settings.

Notwithstanding that, it is recommended that a more detailed assessment nationwide be undertaken to determine the current geographical position of lakes, classification of these lakes into various categories, the issues and problems related to each of them, and the technical and/or management solutions and remedies that should be put in place to resolve them in the short, medium and long term.

Following the recommendations under Strategies 2 and 3 above, the responsibility of preparing the detailed action plan must fall on the collective efforts of NRE, DID and NAHRIM working closely with relevant stakeholders and lake managers at Federal and State levels.

b) *Strategy 8: Enhance Networking and Strengthen International Strategic Alliances*

The problems that beset Malaysian lakes are not unique. Globally, the sustainable management of water resources, particularly those within lakes, has taken on a crucial profile as freshwater resources in rivers have dwindled to leave only lakes as the only reliable sources. Networking and international alliances with other countries would enable the country to learn from experiences of other countries as well as share our own with them.

It is important to point out that such linkages have already been established. Malaysia is an important member of ILEC, participating actively in their ILBM-Governance Project, and has been represented in many conferences on lake and lake management in recent years. Steering Committee members of ILEC have also visited local lakes, to share their experiences and to recommended suitable human resource development regimes to empower local managers to ensure their sustainability.

It is crucial that these global links be pursued to their fullest. Malaysia has so much to share and learn, from other countries that are equal as diligent in ensuring the sustainability of their lake resources. Through these linkages, the country would be able to leapfrog into becoming a leading advocate of lake management in the region.

National ILBM Strategies Implementation Road Map

The ASM-initiated *ILBM Strategy Plan Report* was endorsed by MSAN 07 in November 2012. Through a coordinated multi-stakeholder meeting, the following Strategies Implementation Road Map was developed:

- (i) Appendix 3.3.1.1 (Enabling Environment)
- (ii) Appendix 3.3.1.2 (Institutional Framework)
- (iii) Appendix 3.3.1.3 (Management Instruments); and
- (iv) Appendix 3.3.1.4 (Investments in Water Infrastructure)

Reference

Nakamura, M & Rast, W 2011, 'Development of ILBM platform process. Evolving Guidelines through Participatory Improvement', RSCE–Shiga University and ILEC.

Appendix 3.2.1.1. NIWRM Strategy Plan and Implementation Road Map (ILBM): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	National Water Resources Policy (NWRP)	National	MSAN/ NRE	DID	Completed	Launched in March 2012	NWRP has adopted and accepted the ILBM approach
	Adoption of NWRP by States	State	NRE	UPEN	Completed	Completed	The 6th Meeting of National Water Resources Council (NWRC) dated 6 October 2011 has agreed for NWRP to be adopted by the Federal and State Government
Legislation	Pass appropriate legislation to strengthen existing legal framework	National	NRE	DID	Draft NWR Act	11MP	NRE is conducting roadshows to gain support from the States Selangor, Kedah and Sabah already have their own enactments
Regulation	Specific rules and guidelines to manage lakes to be developed for uniformity	National	NRE	DID	-	11MP	
Finance	Federal funding to be provided for: (i) ILBM as an integral component of IRBM studies and plans (ii) Capacity building (iii) R&D	National	NRE	DID/NAHRIM			ILBM Research Blueprint has been completed by NAHRIM

Appendix 3.2.1.2. NIWRM Strategy Plan and Implementation Road Map (ILBM): Institutional Framework

Water as a Resource							
Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Identify and Empower a Lead Ministry/ Agency	National	NRE (Lead Ministry), DID (Lead Agency)	KeTTHA, MOA, KPKT, KWP, Water Operators, MSANG	To lead other lake management agencies in developing and implementing ILBM programmes and initiatives	Completed	MSAN Meeting in 2012	
Establish a National Lake Resource Centre under NRE	National	NAHRIM	Research Institutes, IHLs, <i>Perbadanan Putrajaya</i> , Lake and reservoirs owners/ managers	1) To develop together with relevant lake management stakeholders an agenda for sustained multi-disciplinary research related to lake environment, its development and operational management 2) To ensure the lake database already initiated by NAHRIM is populated and updated regularly to include lake briefs of all lakes in the country in order to establish NAHRIM as the reference centre and database for all information and research on lakes in Malaysia 3) To act as a centre of excellence for research into lakes and lake management 4) To develop training programmes for lake management	In progress	11MP	A Lake Unit has been established in the interim by NAHRIM

Appendix 3.2.1.2. NIWRM Strategy Plan and Implementation Road Map (ILBM): Enabling Environment (continued)

Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Establish a Standing Committee on Lakes within the purview of the National Water Resources Council	National	NRE (Lead Ministry), DID (Lead Agency)	MOF, MOA, KeTTHA, KPKT, KWP, JAS, NAHRIM, FRIM, JKPTG, JMG, JPSM, EPU, UPEN	1) To oversee the integrated management of lakes 2) To develop a common set of guidelines for ILBM for use at all levels	Completed	10MP	<i>Jawatankuasa Tetap Mengenai Tasik, Empangan dan Kawasan Tadahan Air</i> was established and chaired by KSU NRE
Establish Lake Management Committees at State Level	State	MSAng	Local authorities, TNB, Water Supply, Forestry, Fisheries, JPBD, DID, DOE,	1) To allow coordination among the various agencies that are involved in the management of lakes 2) To ensure that all lakes and reservoirs within the State (inclusive of adequate buffer zone around their periphery) are duly gazetted as environmentally sensitive areas 3) To undertake an immediate review and to extend development restrictions and controls on gazetted lake areas. Special Area Plans is to be prescribed if need be	Ongoing	11MP	Lake management taken as integral part of IRBM

Appendix 3.2.1.2. NIWRM Strategy Plan and Implementation Road Map (ILBM): Enabling Environment (continued)

Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Support the role of Local Communities in Lake Management	Local	MSANG	Local communities, NGOs, Community based organisations (CBOs), JAKOA (Orang Asli)	To seek the public's view in the form of public hearings or other relevant fora. Local communities can provide valuable insight and information about past conditions of a lake or reservoir, particularly in the absence of written records. To develop "Rakan Tasik" groups	Ongoing	11MP	Examples: Local Agenda 21 for Putrajaya lakes Friends of Kelana Jaya Lakes Rakan Tasik Sarawak Save Tasik Chini Group

Appendix 3.2.1.3. NIWRM Strategy Plan and Implementation Road Map (ILBM): Management Instruments

3. MANAGEMENT INSTRUMENTS						
Water as a Resource						
Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
1. Planning and Development	Development of a Detailed Action Plan	NRE	NAHRIM/DID/ States	Completed	10MP	NRE has completed the Lake Action Plan. Refer to Appendix 5 – (<i>Pelan Pengurusan Lestari Tasik, Empangan dan Tadahan Air</i>)
2. International Collaboration	Enhance networking and strengthen international strategic alliances	NRE	NAHRIM/DID/ PPI/ IHLs	Ongoing	–	ILEC, UNESCO (Eco-hydrology and IHP), Regional Lake Network

Appendix 3.2.1.4. NIWRM Strategy Plan and Implementation Road Map (ILBM): Investments in Water Infrastructure

Water as a Resource						
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion (11MP/12MP/13MP)
1	Integrated Lake Basin Management	NRE DID	Water-related Ministries/ SWRCs	- Develop information management and decision support system - Development of Lake Briefs - Development and Implementation of Integrated Lake Basin Management Plan	RM20M per MP	Ongoing To complete all 90 lake briefs within 11MP 11MP 13MP To complete all 90 Integrated Lake Basin Management plan by 13MP inclusive of Economic Assessment

Appendix 3.2.1.4. NIWRM Strategy Plan and Implementation Road Map (ILBM): Investments in Water Infrastructure (continued)

2	Lake Rehabilitation Programme	NRE SWRCs	NAHRIM, Lake owners/ operators	- Lake Rehabilitation Programmes - Rehabilitation of 5 lakes per plan: 11MP—(1) Sembrong Reservoir, Johor (2) Machap Reservoir, Johor (3) Bukit Merah Reservoir, Perak 12MP—(1) Beris Reservoir, Kedah (2) Timah Tasoh Reservoir, Perlis (3) Labong Reservoir, Johor (4) Padang Saga reservoir, Kedah (5) Air Keroh Lake, Melaka (6) Titiwangsa Lake, WP KL 13MP—(1) Tok Uban Lake, Kelantan (2) Bekok reservoir, Johor (3) Layang Reservoir, Johor (4) Taiping Lake, Perak (5) Bera Lake, Pahang (6) Aman/ Permaisuri Lake, Kuala Lumpur - Urban landscape projects for recreational lakes - Conservation of Lake Ecosystem	RM20M per MP	13MP and beyond	According to priority list of the 90 lakes prepared by NAHRIM

Appendix 3.2.1.4. NIWRM Strategy Plan and Implementation Road Map (ILBM): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion (11MP/12MP/13MP)	Remarks
3	Develop lakes as a water resource	NRE SWRCs	DID/Lake owners and operators/ Water Operators	Storage system for unregulated flow	RM15M per MP	13MP and beyond	An alternative resource for emergency use / climate change adaptation (e.g. drought) Close coordination with JPBD to identify suitable locations and inclusion in National Physical Plan
4	Enhance Research, Development and Innovation	NRE DID NAHRIM	Research Institutes/ IHLs/ TNB Research	- Lake Research Centre - Implementation of Lake Research Blueprint	RM20M per MP	13MP and beyond	
5	Awareness Raising, Advocacy & Capacity Building	NRE DID	KeTTHA/ MOA/KPKT/ KWP/ SWRCs	- Capacity Building Programme for Lake Managers - Communication, education and awareness programs for wide-ranging target groups from public, private and community stakeholders	RM10M per MP	13MP and beyond	

Integrated Aquifer System Management

Summary Brief

Academician Datuk Fateh Chand FASc

Defining IASM

Integrated Aquifer System Management (IASM) is an approach to achieving sustainable management of aquifers, the adoption of which will ensure that the nation's groundwater resources are assessed, extracted and managed sustainably. Groundwater resource management is also a subset of the Integrated Water Resource Management (IWRM) regime, together with associated management instruments, such as Integrated River Basin Management (IRBM) and Integrated Lake Basin Management (ILBM). This synthesis, with overall catchment health, is embedded in what is referred to as Integrated Aquifer System Management (IASM).

Review of Current Status and Needs Assessment

The Academy of Sciences Malaysia (ASM) teamed up with the Mineral and Geosciences Department of Malaysia (JMG) in March 2009 to convene a two-day *Groundwater Colloquium* carrying the theme "Groundwater Management in Malaysia — Status and Challenges". Based on the outcome of this national colloquium,

ASM and JMG, with the support of the Ministry of Science, Technology and Innovation (MOSTI), the Ministry of Natural Resources and Environment (NRE), the Ministry of Energy, Green Technology and Water (KeTTHA), and the National Hydraulics Research Institute of Malaysia (NAHRIM) jointly organised five multi-stakeholder consultative workshops in 2009 with the ultimate aim of developing a Strategic Advisory Report on Groundwater Resource Management. The Workshops were structured and organised to address key aspects of Groundwater Resource Management, such as the following:

- Management and Governance;
- R&D Needs;
- Capacity Building Needs Assessment;
- Data Information System;
- Conjunctive Use; and
- Promotion and Advocacy.

The position papers, the outputs of the various workshop groups and their collective opinions were then collated and published as the *ASM Groundwater Workshop Proceedings* which

formed the basis of a draft Strategic Advisory Report that was then presented to an open forum comprising a larger multi-stakeholder audience to obtain further feedback and inputs before the Strategic Advisory Report was finalised.

The main findings of the Report regarding the current status and issues facing groundwater management are summarised below:

- (i) Groundwater is an important component of the water cycle. Groundwater is recharged from precipitation and eventually, flows to the surface naturally. Groundwater is an integral part of a river basin and must be managed as such.
- (ii) Groundwater resources in Malaysia, which is the volume of water stored in the aquifers, has been estimated at 5,000 billion cubic metres or 5 trillion cubic metres of water. This is nine times the volume of water that flows annually into our rivers (of 566 billion cubic metres).
- (iii) Current management of groundwater is fragmented, pursued by different management agencies. The main uses are as follows:
 - **Public Water Supply:** Current usage of groundwater is estimated at around 0.2 MCM per day or only 1.4% of total water supply annually. The largest use is in the State of Kelantan contributing to 41% of its requirements. The use of groundwater is also significant in Sabah. Small quantities are used in Pahang, Perlis, Labuan, and in islands off Sabah and
- (iv) Major issues facing groundwater management are:
 - **Industry:** The largest groundwater based industry is the bottled mineral water industry. There are currently 63 wholesalers of bottled mineral water in the country, while 45 licensees have been allowed to abstract mineral water from 17 aquifers. Large-scale groundwater abstraction amounting to 32 MCM annually is also undertaken by Lion Bhd's Megasteel plant in Olak Lampit, Selangor.
 - **Agriculture:** The use of groundwater in agriculture is widespread, largely confined to small-scale agriculture activities such as in vegetable farming and orchards.
 - Fragmented Policy, Legal and Governance Framework
 - Pollution
 - Lack of Sustained Research and Development
 - Shortage of trained Manpower and Human Resources
 - Resource Data Collection, Management, and Dissemination
 - Public Awareness and Stakeholder Participation.

the east coast of Peninsular Malaysia. Groundwater is presently the main source of water supply in several coastal villages in the State of Sarawak.

The two-year IASM study was completed in 2011 culminating in the preparation and publication of a comprehensive report entitled *The Strategies for the Sustainable Development and Management of Groundwater Resources in Malaysia*. The Report was presented to relevant authorities including the NRE Ministry. The Report and the recommendations were to be tabled for implementation by the *Majlis Sumber Air Negara* (MSAN), but since MSAN had already endorsed a set of strategies submitted by the Minerals and Geoscience Department/Ministry of Natural Resources and Environment in July 2008 at its 4th Meeting, the ASM Strategic Plan was taken note of by NRE.

Recommended Strategies

The IASM Report recommended the following strategies for implementation which have been categorised under three broad headers following IWRM General Framework format and guidelines:

(i) Enabling Environment

- a) *Strategy 1—Pass appropriate legislation to strengthen existing legal framework*

Both at National and State level, appropriate legislation must be passed to enable management of groundwater as a resource. It is clear that the Waters Act 1920 is archaic and not consistent with current economic and social conditions. States should enact specific laws and rules for the implementation of groundwater management. The Selangor Waters Management Authority Enactment of 1999 provides a good template for the holistic management of water resources, inclusive of groundwater.

(ii) Institutional Framework

- b) *Strategy 2—Identify and Empower a Lead Ministry/Agency at Federal Level*

Water is a natural resource; hence, the overall responsibility for reaching out and integrating across boundaries would rest largely with the Ministry of Natural Resources and Environment (NRE). To effectively manage the national water resource as a unitary entity, it follows that there must initially be intra-Ministry integration where the Ministry's surface water and groundwater divisions are integrated into one division.

Similarly, in undertaking water resources management on a holistic basis, NRE would have to nominate a department/agency that best lends itself for this mandate of assessing, developing and managing the national water resource (both surface water and groundwater). Currently, the Minerals and Geosciences Department is the agency mandated by the Geological Survey Act 1974 (Act 129) to assess and manage the nation's groundwater resources while the Department of Irrigation and Drainage assesses and manages surface water. With the intra-Ministry integration being proposed here, there is a need to also integrate both the agencies' roles in water resource management under a new Water Resource Department (WRD).

Appropriate manpower and financial resources would have to be provided to NRE and the WRD to take on this burden.

c) *Strategy 3—Establish a National Groundwater Research Centre under NRE*

The National Groundwater Research Centre would be a one-stop agency which would act as:

- A centre of excellence for research into groundwater resource and management, bringing together experts from various research institutions and universities to focus on priority areas for research and study.
- A reference centre and database for all information and research on groundwater in Malaysia.

d) *Strategy 4—Facilitate States to play a leading role in groundwater management*

While Federal agencies have their role, the custodianship of water resources, including groundwater, which are wholly located within State boundaries rest with the respective State Administrations. The establishment of State water resource management authorities for the holistic management of the States' water resources, inclusive of groundwater, has long been actively encouraged by the Federal Government. Only seven States have done so and only Selangor has gone the length to undertake groundwater management. In this

respect, the LUAS experience can serve as a template for other States to emulate.

e) *Strategy 5—Establish a Standing Committee on Groundwater within the purview of the National Water Resources Council (NWRC)*

Groundwater comprises one of three vital sources of water (the other two being rivers and lakes) that are closely linked and impacted upon by land development within their catchments while, at the same time, involving a wide spectrum of stakeholders.

A standing committee set up under the NWRC to oversee the integrated management of groundwater and to engage in continuous inter-ministry dialogue would ensure that policies that have an administrative trans-boundary dimension are implemented. NRE would be best positioned to lead this standing committee having been mandated to deal with the integrated management of all natural resources in the country. Among the first tasks for this national level Committee would be to develop a common set of guidelines for integrated groundwater management for use at all levels.

f) *Strategy 6—Establish Groundwater Management Committees at State Level*

These committees would be at the political level of government, allowing coordination among the various agencies that are involved in

the development and management of groundwater. The model for this would be State Agriculture Committees or State Industrial Committees that are headed by State Executive Councillors or State Ministers. Among the first tasks for this State level committee would be to ensure that all identified aquifer recharge areas are duly gazetted as environmentally sensitive areas. Development in and around these gazetted recharge areas would require prior clearance from this Committee.

Action plans should also be framed to ensure that clear targets for groundwater use are set for all water users. It is recommended that groundwater use is expanded by at least 20% over current levels by 2030. These action plans should also consider private sector involvement in groundwater development (through the appointment of Independent Groundwater Producers, or IGPs) with the provision of possible incentives to promote their involvement.

(iii) Management Instruments

a) *Strategy 7—Development of Detailed Action Plans*

Following the recommendations under Strategies 1 and 2 above, the responsibility of preparing the detailed action plans must fall on the collective efforts of NRE, the WRD and related agencies working in concert with other stakeholders and government agencies at Federal and State levels.

Of utmost priority is a more detailed assessment nationwide of the groundwater resource, following River Basin Management boundaries to begin with, to determine the current status of the groundwater resources in the country, including their various values, issues and problems related to the various aquifers, and the technical and/or management solutions and remedies that should be put in place to resolve them in the short, medium and long term.

b) *Strategy 8—Change public perceptions towards groundwater*

There is a crucial need for groundwater development to have a buy-in by the public as well as senior administrators and politicians. This can only occur if the disinformation that is associated with it is challenged by a concerted effort to address the biases against groundwater that is so prevalent. The lead agency, the WRD, would need to promote groundwater as a sustainable source of water to be used conjunctively with surface waters to meet the needs of the nation, without detriment to the environment among the public. The WRD would need to approach groundwater as a potentially vital reserve in times of water crisis and for security reasons.

At the same time, communities using groundwater should be adequately trained to ensure that the groundwater resource is managed sustainably through

the adoption of appropriate Best Management Practices.

Strategies Implementation Road Map with Timelines and Relevant Lead Agencies

Note: Prior to the ASM study, groundwater strategies (a set of six strategies, viz. (i) Strengthening Legislation (“Pemantapan Perundangan”) (ii) Resource Evaluation and Development (“Penilaian dan Pembangunan Sumber”) (iii) Groundwater Monitoring (“Pemantauan Air Tanah”) (iv) Capacity Building (“Pembangunan Modal Insan”), (v) Promotion and Awareness (“Promosi dan Kesedaran”), and (vi) Research and Development (“Penyelidikan dan Pembangunan”), prepared and submitted by the Minerals and Geoscience Department/Ministry of Natural Resources and Environment, had already been endorsed by MSAN in July 2008 at its 4th Meeting. It is now opportune to work with NRE and other relevant stakeholder agencies to prepare and develop

a more detailed Implementation road map for the recommended strategies with timelines and identification of respective lead agencies. As further information, the Minerals and Geoscience Department had, in 2008, prepared a set of Action Plans based on its six strategies. NRE and JMG should work out a detailed work-plan for a nation-wide implementation of aquifer mapping in both the alluvial and hardrock settings during the 11th and 12th Malaysia Plans in line with Integrated Aquifer System Management. The Strategies Implementation Road Map for IASM are as follows:

- (i) Appendix 3.3.2.1 (Enabling Environment)
- (ii) Appendix 3.3.2.2 (Institutional Framework)
- (iii) Appendix 3.3.2.3 (Management Instruments); and
- (iv) Appendix 3.3.2.4 (Investments in Water Infrastructure).

Appendix 3.2.2.1. NIWRM Strategy Plan and Implementation Road Map (IASM): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	National Water Resources Policy	National, inclusive of all States including Wilayah Persekutuan	MSAN/NRE/ Sabah Water Resources Council/ Sarawak Water Resources Council	NRE	Policy launched on 12th March 2012	-	To be used as the underlying Policy for all water resources nationally
Policy	Ground Water Policy	National, inclusive of all States including Wilayah Persekutuan	NRE/Sabah Water Resources Council/ Sarawak Water Resources Council	JMG and other groundwater-related agencies	No Policy as yet	11MP	Ground Water Policy needs to be developed and adopted nationwide. In the interim, the NWRP will be used
Legislation	Strategy 1 – Pass appropriate legislation to strengthen existing legal framework	National, inclusive of all states including Wilayah Persekutuan	State Governments	JMG	Geological Survey Act, covering ground water, enacted since 1974 (being amended now, tentatively called the Geological Survey and Geological Science Act)	11MP	State Enactments legislated in line with IWRM in Sabah, Sarawak, Selangor and Kedah and covers ground water too. NS, Melaka, Johor, Pulau Pinang, Perak, Pahang, Terengganu and Wilayah Persekutuan need some amendments to be more holistic

Appendix 3.2.2.1. NIWRM Strategy Plan and Implementation Road Map (IASM): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Regulation	Strategy 1 – Pass appropriate legislation to strengthen existing legal framework	National, inclusive of all States including Wilayah Persekutuan	State Governments	JMG	Regulations to be developed by State Governments	11MP	JMG to assist State Governments on developing Regulations
Finance	Strategy 2 – Identify and Empower a Lead Ministry/ Agency at Federal Level	National, inclusive of all States including Wilayah Persekutuan	NRE	JMG	Yearly allocation provided by Federal Government to undertake groundwater exploration and development on a piecemeal basis	11MP and beyond	Initial financing of groundwater mapping, assessment and development according to the 189 river basins needs to be funded by the Federal government

Appendix 3.2.2.2. NIWRM Strategy Plan and Implementation Road Map (IASM): Institutional Framework

Water As A Resource							
Strategy	Hierarchical Level	Lead Agency	Implementing Agency	Functions	Current Status	Target Completion	Remarks
Strategy 2—Identify and Empower a Lead Ministry/Agency at Federal Level	National	NRE	JMG	(i) Natural resources management: (a) Forest management (b) Irrigation and drainage management (c) Wildlife management (d) Minerals management (ii) Ground water exploration, development and management	(i) Est. 27th March 2004 (ii) Est. on 1st July 1999	Completed	According to ministerial functions
Strategy 3—Establish a National Groundwater Research Centre under NRE	National	NRE	NAHRIM	(i) To conduct both basic and applied research on groundwater such as geohydrology and water quality; (ii) To provide support services to both the public and private sectors in addressing groundwater issues; (iii) To act as the National Focal Point for research on groundwater and its environment; and (iv) To provide advisory services on groundwater and its environment.	Est. 14th April 1993	Completed	In line with ASM's Advisory Report on <i>Setting an National Agenda for Integrated Water Research</i>
Strategy 4—Facilitate States to play a leading role for groundwater management	National	NRE	JMG	To undertake systematic investigations on groundwater resources	Est. 1st July 1999	In progress	Need to develop state databases on GW

Appendix 3.2.2.2. NIWRM Strategy Plan and Implementation Road Map (IASM): Institutional Framework (continued)

Strategy	Hierarchical Level	Lead Agency	Implementing Agency	Functions	Current Status	Target Completion	Remarks
Strategy 5— Establish a Standing Committee on Groundwater within the purview of the National Water Resources Council	National	MSAN/ NRE	Chaired by the NRE KSU with JMG as the Secretariat with Members from relevant Federal Ministries and all State Governments	(i) To plan ground water needs of States (ii) To develop ground water development programmes (iii) To obtain feedback on ground water development work undertaken nationwide (iv) To determine funding allocation needs for groundwater exploration and development nationwide	Proposed	11MP	Can be established under the proposed National Technical Committee
Strategy 6— Establish Groundwater Management Committees at State Level	States	MSAng/ JMG	Chaired by the MSANG Chairperson with State JMG/UPEN as the joint Secretariat with Members from relevant state Federal agencies and all relevant State agencies	(i) To plan ground water needs of the State (ii) To develop state groundwater development programme (iii) To obtain feedback on ground water development work undertaken nationwide (iv) To determine funding allocation needs for groundwater exploration and development statewide	Not established as yet	11MP	Can be established under the proposed State Technical Committee

Appendix 3.2.2.3. NIWRM Strategy Plan and Implementation Road Map (IASM): Management Instruments

Water as a Resource						
Strategy	Category	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
Strategy 2—Identify and Empower a Lead Ministry/ Agency at Federal Level	1. Information Management	NRE/ JMG	MOA/MOH/ MPIC/ KeTTHA	HYDRODAT	Ongoing	HYDRODAT is maintained by JMG
Strategy 2—Identify and Empower a Lead Ministry/ Agency at Federal Level	2. Planning	NRE/ JMG	MOA/MOH/ MPIC/ KeTTHA	Already identified and functioning	Ongoing	11MP and beyond
Strategy 2—Identify and Empower a Lead Ministry/ Agency at Federal Level	3. Economic and Financial Instruments	NRE	MOF	Yearly allocations and 5-year MP allocations	Ongoing	11MP and beyond
Strategy 1—Pass appropriate legislation to strengthen existing legal framework	4. Legal (Licences and Penalties)	NRE/ JMG	<i>Peguan Negara</i>	Geological Survey Act, covering ground water, enacted since 1974 (being amended now, tentatively called the Geological Survey and Geological Science Act)	Ongoing	Target for 11MP approval
Strategy 6—Establish Groundwater Management Committees at State Level	5. Participatory Management	NRE/ JMG	State UPEN and relevant state agencies	Proposed	11MP and beyond	Target for 11MP approval

Appendix 3.2.2.3. NIWRM Strategy Plan and Implementation Road Map (IASM): Management Instruments (continued)

Strategy	Category	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
Strategy 3—Establish a National Groundwater Research Centre under NRE	6. Research and Development	NAHRIM	JMG	Under consideration	11MP and beyond	Target for 11MP approval in line with ASM Advisory Report on “Setting a National Agenda on Integrated Water Research”
Strategy 2—Identify and Empower a Lead Ministry/Agency at Federal Level	7. Awareness, Advocacy and Capacity Building	NRE/JMG	MSAng and relevant State agencies	Being undertaken on a piecemeal basis	11MP and beyond	Target for implementation beginning 11MP with target audience being state agencies, NGOs and the ordinary <i>rakyat</i>
Strategy 2—Identify and Empower a Lead Ministry/Agency at Federal Level	8. International Collaboration	NRE/JMG	Ministry of Foreign Affairs	Currently, only with Bangkok-based CCOP and with the International Hydrological Programme	11MP and beyond	Need to identify international research agencies/organisations on groundwater

Appendix 3.2.2.4. NIWRM Strategy Plan and Implementation Road Map (IASM): Investments in Water Infrastructure

Water as a Resource							
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
1	Ground Water Development	NRE/JMG/NAHRIM	KeTTHA/ MOA/MOH/ MPIC/ SWRCS	- Identify, map and develop groundwater hard-rock aquifers - Groundwater metering and licensing (consider incentivising Independent Groundwater Producers, IGPs) - Develop groundwater recharge technologies - Develop groundwater infrastructure and service sector development - Develop RBF technologies	RM400 million per MP for all States for identifying, mapping and developing groundwater hard-rock aquifers	11MP and beyond	(i) States to meter and licence GW abstraction (ii) NAHRIM to develop GW Recharge Technologies (iii) IGPs to develop GW infrastructure etc.
2	Integrated Aquifer System Management	NRE/JMG	Water-related Ministries/ SWRCS	- Set up GW Training Centre - Setup GW units in all States - Develop trans-boundary GW resource management	RM1 million initially for training centre in JMG Ipoh	11MP and beyond	Develop Best Management Practices on Ground Water Abstraction and Protection of Well-Head sites and Basin and re-charge areas

Appendix 3.2.2.4. NIWRM Strategy Plan and Implementation Road Map (IASM): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
3	GW Research and Innovation Cluster	NRE/NAHRIM	JMG/Water-related Ministries/ IHLs/ SWRCS	• Set up a dedicated GW Research Centre • Establish a GW Data Centre • Develop GW Innovation and Industry Clusters • Develop Centres of GW Excellence in Local Academia	No additional funding necessary	11MP	• Under proposed Water Research Centre (or Water Research and Development Centre) to be established at NAHRIM • HYDRODAT already established in JMG • Under joint chairmanship of NRE/KeTTHA • Under chairmanship of MOHE

Appendix 3.2.2.4. NIWRM Strategy Plan and Implementation Road Map (IASM): Investments in Water Infrastructure (continued)

4	GW Pollution Monitoring and Rehabilitation	NRE	Water related Ministries/ SWRCs/ Local Governments	• GW Pollution Management Programme • Superfund for clean-up of polluted GW aquifers in Malaysia • Modernising GW quality monitoring network • Develop GW quality modelling tools and infrastructure • Community GW management programmes • Pollution control at source	• RM1 million/ year budget to JMG • RM20 million/ year • RM5 million to be outsourced by JMG nationwide • Existing budget sufficient • RM0.5 million/ year budget to JMG to conduct Community programmes • Under purview of Local Government, no additional funds necessary	11MP and beyond	Yearly report to MSAN/SWRCs

Appendix 3.2.2.4. NIWRM Strategy Plan and Implementation Road Map (IASM): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
5	Climatic Change Adaptation	NRE	Water related Ministries/ SWRCS	- Dedicated GW Research Centre to study impact of CC on aquifer depletion, salt-water intrusion, aquifer recharge - Develop GW/CC Impact Maps Adaptation	Additional funding necessary as recommended in the ASM Advisory Report on “Setting National Agenda for Integrated Water Research”	11MP and beyond	Both activities can be undertaken by the proposed Water Research Centre (or Water Research and Development Centre)

Appendix 3.2.2.4. NIWRM Strategy Plan and Implementation Road Map (IASM): Investments in Water Infrastructure (continued)

6	GW Development and Supply Sector	KeTTHA/SPAN	Sabah SWA/ Sarawak SWA/ SWRCS/NRE/ JMG	- Privatisation/ corporatisation of GW supply sector - Smart GW network monitoring system - Inter-basin GW transfer schemes - Commercialisation of technology and expertise - Identify, map, assess and develop GW from hard-rock aquifers - Groundwater metering and licensing of Independent Groundwater Producers (IGPs) - IGPs to develop groundwater recharge technologies - IGPs to develop groundwater infrastructure and service sector development - IGPs to develop RBF technologies - IGPs to develop desalination of brackish/ saline ground water using membrane technology technologies	To be discussed with state authorities and relevant Federal Ministries	11MP and beyond	(i) KeTTHA to consider appointing Independent Ground Water Producers (IGPs) (ii) MSANG to consider appropriate measures and action plans to implement Programmes

Water Demand Management

Summary Brief

Tan Sri Ir. Syed Muhammad Shahabudin FASc and
Datuk Ir. Mohd Adnan Mohd Nor FASc

Water Demand Management (WDM) and Its Objective

WDM is generally defined as the efforts to reduce the loss in quantity and quality of water as it flows from the source through to disposal.

A broader definition for WDM that would be most appropriate for the future water

management for the country is that as defined by David B. Brooks (2006) for operational WDM (see Box 3.2.3.1).

One of the five listed items, at (3), has generally been put into practice in the country. Nevertheless, the remaining options should be regarded as targets to be achieved in the future.

Definition of WDM by David B. Brooks

“A comprehensive definition of WDM must reflect both the series of steps that brings water from source to use and also the time and space dimensions of water use. Therefore, water demand management can be defined as any method—whether technical, economic, administrative, financial or social—that will accomplish one (or more) of the following five things:

- (1) Reduce the quantity or quality of water required to accomplish a specific task.*
- (2) Adjust the nature of the task or the way it is undertaken so that it can be accomplished with less water or with lower quality water.*
- (3) Reduce the loss in quantity or quality of water as it flows from source through use to disposal.*
- (4) Shift the timing of use from peak to off-peak periods.*
- (5) Increase the ability of the water system to continue to serve society during times when water is in short supply.”*

Box 3.2.3.1. Definition of WDM by David B. Brooks

Generally, the objective of WDM is essential to obtain a commitment by each sector to share water resources and agree on sectoral allocation, management and operating rules. Subsequently, each sector will have to implement its share based on that agreed allocation and rules and even commit to implementing measures that could relieve the other sectors of water demand pressures by their major end-users or beneficiaries.

The potential water savings with WDM by 2020 is estimated to be 12,371 million litres per day (MLD) [4,511 million cubic metres (MCM)]. This represents 26% of the total projected water demand in 2020. This requires concerted efforts by the major water sectors. For the water supply sector, the estimated potential saving is 5,966 MLD (2,176 MCM) from a reduction in NRW as well as capping consumption at 180 litres per day per capita. The eight matured granaries could potentially reduce demands by as much as 2,405 MLD (877 MCM) and the sewerage sector has the potential to contribute 4,000 MLD (1,495 MCM) through recycling back into the system.

The total water consumption by these two sectors, water supply and agriculture, is projected to increase from 3% of the total available water to 4% by 2050. Whilst this percentage may appear to be small, a large portion of the remaining 96% would be to sustain the wealth of existing ecosystem. WDM is also to ensure that this remainder is adequate and that in the long term, there may be a need to cap the total water availability and water demand for human use.

In water-stressed regions and cities, applications of the Reduce, Reuse and Recycle (3Rs) are elements of WDM that should be strongly promoted.

The role of groundwater in WDM is expected to be significant particularly in ensuring water availability during water stress periods in developed regions and cities. The need is to assess its quantity, protect its quality and ensure its availability whenever needed.

Review of Current Status and Needs Assessment

The report on Strategies to Enhance WDM in Malaysia has been prepared by the Academy of Sciences Malaysia (ASM) for the consideration of the Government for the people and economic growth of the country. An important aspect is to achieve sustainable water management status, a requirement of the Malaysian Water Resources Policy. In the process of preparing the report, over a period of three years (2012–2015), Six Strategic Consultations (SC) were held, preceded by the National Colloquium on WDM in 2009 (see Table 3.2.3.1).

Table 3.2.3.1. Activities to Enhance WDM in Malaysia

Activity	Remarks
National Colloquium, 2009	Proceedings published 2010
SC1—WDM for the Environment Sector	Collaborators NRE
SC2—WDM for the Agriculture Sector	Collaborators MOA
SC3—WDM for Water and Sewerage Services	Collaborators KeTTHA and SPAN
SC4—Inter-Sector WDM	Collaborators EPU
SC6—WDM Sarawak	State Government of Sarawak
SC6—WDM Sabah	State Government of Sabah

The National Colloquium on WDM (2009) was conducted in collaboration with Malaysian Water Partnership and the Department of Irrigation and Drainage. The six strategic consultations (SCs) were held with the close cooperation of the relevant sectors and the States of Sabah and Sarawak. The outputs of the various SCs and their collective opinions were then collated and published in the draft Strategic Report for Enhancement of WDM in Malaysia which was approved by the ASM Council in December 2015. When the report is printed, it will be presented to relevant authorities for implementation.

The synthesis following these SCs and supported by references, particularly the NWRS (2012), and personal communications with water experts and practitioners, established a number of areas of concern that threaten the sustainability of water development and constraining efforts for improved water management, particularly in water savings. Under the Needs Assessment for WDM, the Report identified four major challenges which need urgent attention and these are:

- Elements of water scarcity in five states in Peninsular Malaysia, namely Perlis, Kedah, Pulau Pinang, Selangor (including WP Kuala Lumpur) and Melaka which are already in a deficit of available (fresh water) unregulated flows (NWRS 2012). The unregulated flows in the remaining States, although not in deficit, are already in declining trend.
- The national water quality status is in the state of decline (NWRS 2012). Measured in terms of NWRVI, except for Sabah and Sarawak, all States in Peninsular Malaysia are below Low Vulnerability Index with Perlis, Pulau Pinang, Selangor (including WP Kuala Lumpur) and Melaka being already in vulnerable category.

- Overall water losses and wastages are excessive particularly in consumptive water use sectors of water supply and sewerage services WDM and Agriculture WDM. The Report estimates that the potential water savings in 2020 from a concerted effort in WDM represents 26% of the total potential water demand in 2020 – something worth following up especially in water scarce or deficit freshwater regions in the country.
- During the National Colloquium on WDM (2009) and SCs (2012–2015), it was generally agreed that the present pricing structure of treated water is low and this constraint any effort for improved WDM. This also stifles any scientific and technological advancement as well as discourages innovations towards water management for sustainable developments. Added to this is the fact that raw water supplied for agricultural use is virtually free of charge.

Implementing WDM provides tremendous opportunities for economic growth and employment opportunities. For this to happen, time is now right for water to be regarded as a commodity with the right pricing which will provide the impetus for the water industry to accelerate towards sustainable economic growth.

The Report identified 17 strategies and classified them under Management Categories, (see Box 3.2.3.2). The list of strategies is presented in Appendix 3.2.3(a).

1.	Governance	10.	Reduce, Reuse, and Recycle
2.	Policy	11.	Groundwater
3.	Law	12.	Capacity Building
4.	Institution	13.	Development Planning
5.	Operations and Maintenance and Service Levels	14.	Financing
6.	Data and Information	15.	Research and Development
7.	Science, Technology, and Innovations	16.	International Collaboration
8.	Wealth Creation	17.	Water-Energy-Food Nexus
9.	Participatory Management		

Box 3.2.3.2. The 17 Strategies under Management Categories

Recommended Strategies

The following are key strategies towards implementing a successful WDM with considerations of beneficial returns on investments.

i) Enabling Environment

(a) *Accounting and Auditing System*

The key enabling environment is for all water sectors to base its planning and decision-making processes and procedures on an agreed set of data and information on water resources and sectoral water management needs. Ultimately, these should be used to develop and establish a National Water Accounting system

and would be a basis for a National Water Auditing System.

(b) *Harmonised Rules and Regulations for Water Management*

Future water management consideration would have to emphatically recognise that water resources and water management are of national interest. Whilst continuing the respect for the Constitutional provisions of the Federal and State rights on land and water, the need is now to harmonise Federal-State, State-State and within State management practices on water policies and decision-making processes. A similar harmonisation is also required for inter-sector water management.

(c) *Public Participation*

Apart from Laws and Regulations, successful WDM within sectors and inter-sector would be highly dependent on Public Participation. Establishing a formal and structured Public Participation platform is therefore, a prerequisite for WDM.

ii) Institutional Framework

(a) *Permanent National Inter-sector Technical Water Committee*

This shall be a science-based committee with Government and Private Sector representations from all national and state water management related departments, agencies, private organisations, and NGOs. This committee shall be responsible for developing the Water Accounting and Auditing System

as well as developing the Federal-State, State-State and inter-sector harmonised rules and regulations. This committee should also take the role of being a science-based advisory committee on national and state water management for policy-makers.

(b) *Public Participation Platform*

A formal Public Participation Platform could be established with formal and structured linkages to the Institutional Water Managers and to the National Water Resources Council [refer Appendix 3.2.3(b) and Appendix 3.2.3(c)]. The provision for such platforms is recognised for the water supply sector is already in the Water Services Industry Act (WSIA) in the form of water forums. The agriculture sector is revitalising the water user groups (WUGs) in the granaries. The need is to formalise these as well as to expand similar groups for other sub-sectors of the agriculture, especially for vegetable farming. There is also a need to form similar platforms for water for the environment.

(c) *Water Industry Restructuring*

The water industry is now largely fragmented and not recognisable as one of the National Key Economic Areas (NKEAs). Yet in many advanced countries, the Water Sector is visible and recognised as one of the significant key economic growth sectors. The strategy would be to restructure the Water Industry in Malaysia to be an economic entity (an NKEA) in National development planning strategies.

(d) *Agriculture Water Services Commission*

At present, irrigation for paddy in the Agriculture Sector is the largest water user and therefore is also the source of the largest return of water use to the system. Future agriculture water requirement is on the rise and expanding spatially for high-value crops especially vegetables. There is a potential that even traditionally rain-fed crop such as oil palm would need some form of irrigation or higher precision water table management. Increases in water demand for livestock and inland fisheries and aquaculture are also anticipated to increase in specifically concentrated area. With more intensive farming, production inputs such as fertiliser and pesticides tend to increase and this invariably threatens water quality of the natural water resources. As such, as the biggest and a significant user of water, an Agriculture Water Services Board similar to that of the Water Services Industry Commission (SPAN) should be formed.

(e) *Agriculture Water Management Department*

At present, water development and management for the agriculture sector by the Ministry of Agriculture and Agro-Industry (MOA) is focused mainly for irrigation for paddy. There is now a need to expand the water management services to cover all agriculture production components namely non-paddy food crops, industrial crops, livestock, and inland fishery and aquaculture.

iii) Management Instruments

(a) *Translating Laws into Management Instruments for Water Demand Management*

There are already several laws that are directly or indirectly related to promoting and enforcing WDM. The major ones are the Waters Act 1920 (Act 418) (WA 1920), the Irrigation Areas Act 1953 (Act 386) (IAA 1953), Drainage Works Act 1954 (Act 354) (DWA 1954), Environmental Quality Act 1974 (Act 124) (EQA 1974) and Water Services Industry Act 2006 (Act 655) (WSIA 2006). A new law, the Water Resources Act has been drafted and is now in the process of reviewing.

Some of these laws such as the WA 1920, IAA 1953 and DWA 1954 may be outdated with respect to the social, economic and political landscape. However, the important point is that these laws are not repealed and therefore technically still in force. Also important is that within these laws are the principles of WDM that are still relevant and valid.

The need to review and update these laws and to introduce new ones could be a protracted exercise. Instead, a proposed strategy is to translate the WDM aspects of the contents of these laws as management guidelines and reference instrument for water managers.

(b) *Translating Policies into Management Instruments for Water Demand Management*

As with the Laws, there are already several Policies that relate to the practice and enforcement of WDM. These include the National Water Resources Policy, the Green Technology Policy, National Policy on Climate Change Policy and the National Blue Ocean Strategy (NBOS). The National Physical Plan 2 (NPP2) endorsed by the National Physical Planning Council has also incorporated WDM as one of the major strategies for sustainable resource management. Again, the WDM related aspects contained within these policies should be extracted and translated into management instruments for water managers.

Investments in water infrastructure

(a) *Investment for Green Growth*

Investments in water infrastructure for Water Demand Management should be based on Green Growth where water is managed as a natural capital for economic growth and ecological quality and in tandem with human capital development for higher skills and knowledge (Raekowon Chung 2015).

(b) *Investment for National Ownership of STI*

WDM infrastructure and management tools provide vast opportunities for National ownership in STI development for all sectors.

These include developing the Water Accounting and Auditing Tools, water saving devices, technologies for 3Rs, developing water needs assessment tools for the Environment and Ecological sector for the tropics and groundwater as an integral component of water management systems.

(c) *Applications of the NBOS*

Sectoral water management facilities such as conveyance and distribution channels of paddy irrigation systems and dams should now be redesigned such that their operations could accommodate multi-use and multi-sector functions rather than for sectoral exclusivity. All new dams and system designs should also be based on WDM criteria and multi-sector needs. New dams should not only function for say, hydropower generation, but to also incorporate the needs of flood management, agriculture, water supply, the environment, and navigation. This approach is in line with the NBOS that promotes cost-effective sharing of resources.

(d) *Strategic Project that Integrates Inter-sector as well as Sectoral Needs*

A strategic project that induces inter-sector integration is necessary to propel an immediate action plan towards WDM. This could be in the form of implementing a national water management data and information system integration. This then would subsequently lead to the development of a practical

water accounting and auditing system as well as a harmonised Federal-State and Inter-sector rules and regulations. Another strategic investment would be in establishing a “Water Hub”. This will provide a focused STI development for the full and complete chain of water technology and services for all sectors.

Strategies Implementation Road Map with Timelines and Lead Agency

Three agencies are involved in the proposed Strategies Implementation Road Map. The Ministries are KeTTHA, MOA, and NRE. The strategies involve specific target schemes mainly for sectoral interests and other essentials in implementing inter-sector WDM.

Specific Target Schemes: In as far as water and sewerage services are concerned, KeTTHA with support from SPAN, has set targets for improvements by 2020. The three targeted areas are a reduction in NRW to 25%, reduction in per capita demand of water to 180 litres per day and establishing a tariff setting mechanism for Peninsular Malaysia and WP Labuan that is fair and transparent. The aim is to harmonise the tariff structure by 2020.

Reduction in NRW to 25% by 2020 is a national target which has already been achieved or bettered by some states in Malaysia. For states which have yet to achieve this targeted figure, it is a licencing condition for them to allow for such improvement in their water commercial plan, at their cost. Reduction in daily per capita demand to 180 litres may take longer to achieve mainly due to other factors, notably success in the promotion of mandatory use of efficient products or water saving devices

and encouraging manufacturers to produce efficient products. The other factor, which is equally important, is the eventual application of appropriate tariff structure to reduce wasteful consumption of water.

KeTTHA has commenced discussions on water demand masterplan for all sectors which also covers aspects on water to wealth initiatives.

It is understood that MOA and NRE have yet to commence discussion on WDM for agriculture and the environment (ecosystem) respectively. This has become more challenging because the 11th Malaysia Plan does not specifically identify WDM in these two areas.

Other Essential in implementing inter-sector WDM (summarised in Appendix 3.2.3(d)): By 2020, the major enabling environment for WDM should be well in place. The main enabling components are:

- (i) **Inter-sector Harmonisation for National WDM:** This is proposed to be led jointly by KETTHA and NRE. The members should be representatives from the major water managers that include water supply, sewerage, agriculture, and flood. The expected outputs are sectoral and inter-sector principles of WDM, Sectoral and Inter-sector WDM Code and Proposals for policies, new laws, and amendments to existing laws. The estimated budget is RM6 million;
- (ii) **Federal-state WDM Harmonisation:** This is proposed to be led by EPU with representatives from Federal Ministries and State Government.

The expected outputs are National Principles of WDM and a National WDM Code. The estimated budget is RM5 million;

- (iii) **Water Industry Structuring for Economic Growth:** This is proposed to be led by the Ministry of Trade and Industry. Membership should include NRE, KETTHA, Trade Organisations and NGOs involved in the water industry. The estimated budget is RM6 million. In addition to this is the proposed development of a water hub that is estimated to be RM37 million;
- (iv) **Government and Public Participation:** This is proposed to be led by the National Water Resources Council Secretariat. The membership shall be representatives from the Government Sector as well as from the public sector (NGOs). The estimated budget is RM6 million; and
- (v) Whilst these components are being activated and consolidated by 2020, the respective sectors should continue implementing sectoral and inter-sector WDM improvements in all approved projects. By the end of 2020, specific WDM programme should already be prepared.

Lead Agency: With such a background, it may be best for KeTTHA to take the lead since it has been mandated to prepare a water demand masterplan.

It is proposed that ASM should approach KeTTHA, in the best interest of WDM for all sectors, to consider a possibility for the ministry to convene a meeting with MOA and NRE (at top level) to discuss on finalising WDM implementation road map incorporating recommended strategies highlighted at *Section: Recommended Strategies* and specific target schemes for water supply, agriculture and environment (ecosystem) sectors.

Timeline: It is envisaged that the following programme could be followed.

- (i) **1st Step:** (First Quarter of 2016)
Preliminary meeting (at the top level) to agree on the need to cooperate on “common ground” to produce an overall Water Demand Masterplan for the 11th Malaysia Plan.
- (ii) **2nd Step:** (First Quarter of 2016 to 2018) Agree on equitable usage of water and one way of starting is on regional basis i.e. Northern Zone, Central Zone, Southern Zone, Eastern Zone, Sabah, and Sarawak. (Cooperation’s of NCER, ECER, Iskandar and SCORE may be sought)
- (iii) **3rd Step:** (to 2020) As it may not be possible to accomplish everything by 2020, it may be imperative to continue the onward path beyond 2020. The 11th Malaysia Plan’s aspirations for post-2020, is for Malaysians to be “passionate stewards” of the environment and modernising agriculture. In both cases, WDM would be finally accepted for full implementation by 2030.

As Water Demand Management covers water supply and sewerage services, agriculture water services and the environment, strategies within the report were tactfully incorporated into the respective Strategies Implementation Road Maps of the following component plan studies:

- (i) Water Supply and Wastewater Management (Appendix 3.2.4);
- (ii) Integrated River Basin Management (Appendix 3.2.7); and
- (iii) Water and Agriculture (Appendix 3.2.8).

Appendix 3.2.3 (a) Strategies for WDM Implementation

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
A	Governance	Strategy 1	Develop a comprehensive Water Accounting, Auditing, and Feedback system for within Sector and Inter-sector WDM - Review the water resources management accounting parameters and include wastewater and returned water to the system as resource components - Include WDM needs of the Ecosystem (Environment) Sector - Include water quality as a parameter in the accounting equations - Harmonise inter-sector water management terms and definitions - Install performance assessment tools and procedures - Install sector and inter-sector auditing and feedback system
		Strategy 2	Adopt WDM considerations in Policy and Operational Decisions on Water Management related issues
C	Law	Strategy 3	Review and update water and water management related laws to strengthen adherence to WDM in all sectors - Review and update of the Irrigation Areas Act and the Drainage Works Act - Consideration for a single Agriculture Water Management Act covering all sectors of agriculture
		Strategy 4	Form a dedicated Department of Agriculture Water Management under the Ministry of Agriculture and Agro-based Industry that is responsible for water management for all sub-sectors of agriculture including aquaculture, livestock, plantation and commodity crops - The existing Division of Irrigation and Agriculture Drainage (BPSP) of the Ministry of Agriculture and Agro-based Industry could be the nucleus institution to form this Department - The composition of this institution should be multi-disciplinary - Setting up of the Irrigation Management Modernisation Centre of Excellence
D	Institution	Strategy 5	Form a dedicated WDM Unit in all water management related Departments and Institutions
		Strategy 6	Form a dedicated Water Management Research and Development and Capacity Development Institution for Agriculture Water Management
		Strategy 7	Establish a special institution or section for Ecosystem (Environmental) Water Management
		Strategy 8	Establish of a Central Regulating Agency for water and WDM in each State of Sabah and Sarawak
		Strategy 9	Form a Permanent Inter-Sector Technical Water Committee for Federal-State and Inter-sector WDM harmonisation - To harmonise technical terms and definitions - A platform towards harmonising rules and regulations - A platform towards harmonised tariff

Appendix 3.2.3 (a) Strategies for WDM Implementation (continued)

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
E	Operations and Maintenance and Service Levels	Strategy 10	Develop Operations, Maintenance and Service Levels Excellence Plan Establish comprehensive Service Level Plan by all service providers in all sectors
F	Data and Information	Strategy 11	Integrate and share all hydrological and climatic and water quality data and information collection by all water management related institutions The key institutions now involved in water-related data and information collection are the Meteorological Services Department (Climate and Weather), Department of Drainage and Irrigation (Hydrology Division), Water Supply Department and Water Supply Service Providers, Sewerage Services Department and Sewerage Service Providers (e.g. IWK), Department of Environment (Water Quality), Department of Agriculture, MARDI (Research Stations), MADA, KADA and TNB (Hydroelectric Stations)
G	Science, Technology, and Innovations	Strategy 12	Implement WDM Programmes for WDM that allows for the development of advanced technologies for National ownership - Implement an integrated project with applications of advanced technologies. Examples are Wastewater Recycling Plant for non-potable water for industrial use (e.g. Bayan Baru Industrial Area); paddy irrigation water reuse and recycling in the MADA granary; in polluted urban rivers - Development of tools for WDM for the ecosystem (environment) - Development of tools for WDM in River Basins - Development of water saving devices - Development of WDM monitoring systems - Development of regional and national water grid - Setting up a National Water Hub
H	Wealth Creation	Strategy 13	Structure the Water Industry (all water sectors) by integrating all water developers and service providers from all sectors to be recognised as one of the key economic growth sectors - The water supply sector is recognised in developing countries as an economic growth sector - The water supply sector could be recognised as an NKEA to contribute to GNI and high-value job creation
		Strategy 14	Link water supply (all water sectors) development and services to Green Growth Economy with high elements of green technology applications

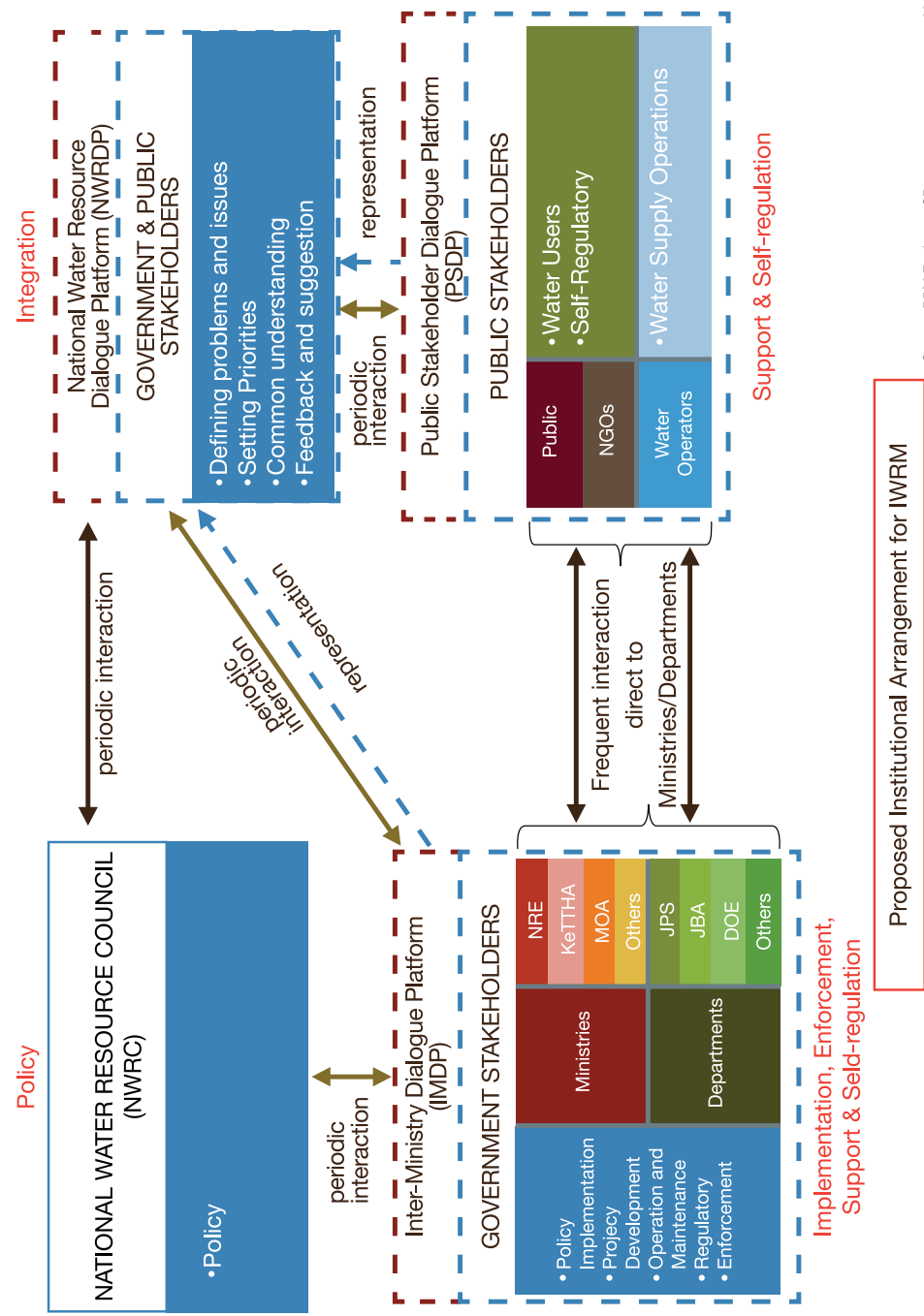
Appendix 3.2.3 (a) Strategies for WDM Implementation (continued)

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
I	Participatory Management	Strategy 15	Incorporate public (end-users) into the water management governance system with linkages from the local, basin, State and National levels - The paddy irrigation sector is revitalising its Water User Groups (WUGs). This should be a well-structured programme towards formal recognition as participatory platforms - WUGs should be extended to all other sectors of agriculture and other sectors including the ecosystem (environment) sector - To encourage the formation of NGOs for WDM and as elements of the Water Forum provided for in the WSIA - To form formal linkages of these WUGs and NGOs to State Water Resources Council and on to the National Water Resources Council
J	Reduce, Reuse and Recycle	Strategy 16	Establish target reduction of NRW by 25% for Peninsular Malaysia by 2020
		Strategy 17	Implement efficiency improvement and returned water quality control programs and projects in Granary irrigation systems - Many of the existing infrastructure are due for rehabilitation and upgrading - The system planning and design needs to be reviewed to incorporate WDM for within sector and inter-sector requirements as well as climate change adaptation - On-farm water management infrastructure improvement also necessary
		Strategy 18	Implement WDM programs for non-paddy sectors of agriculture to include horticulture, livestock, aquaculture and plantation and commodity crops
K	Groundwater	Strategy 19	To develop groundwater for emergency use - To undertake detailed groundwater assessment studies - To develop and maintain for use in emergency situations - Priorities for major urban areas in relatively dry regions
L	Capacity Building	Strategy 20	Develop comprehensive WDM Capacity Building Programme by all Sectors for staffs and for the public (Water User Groups/Water User Associations)
M	Development Planning	Strategy 21	Consolidate agriculture activities by crop types and industry in river basins for effective WDM This could be based on the granary model whereby small and contiguous irrigation schemes are consolidated into one large irrigation management area
		Strategy 22	Planning for new industrial zones to be based on potential recycling for non-potable water from sewerage system
		Strategy 23	Adopt applications of the National Blue Ocean Strategy in WDM - Planning for future WDM should consider sectoral and inter-sectoral sharing of existing facilities and resources such as dams and conveyance channels - Consideration for regional and national water grid
N	Financing	Strategy 24	To introduce financial incentives for wide-scale public adoption of water saving devices and installation

Appendix 3.2.3 (a) Strategies for WDM Implementation (continued)

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
O	Research and Development	Strategy 25	Undertake R&D specifically for WDM • Undertake research to strengthen rain-fed agriculture • Undertake research on Water Footprint for all sectors • Research on irrigation and yield responses to water for non-paddy crops especially for oil palm and horticulture • Use of artificial wetlands and green buffers along rivers for storages • Reactivating irrigation and drainage systems in irrigation schemes converted for non-paddy crops especially oil palm • Undertake climate change vulnerability and adaptation research for all sectors • Increase efforts on development of low-water consuming crops especially paddy
P	International Collaboration	Strategy 26	Strengthening international networking and enhancing strategic alliances with Regional and International Water Institutions
Q	Water-Energy-Food Nexus	Strategy 27	Develop Inter-sector framework for Water-Energy-Food nexus

Appendix 3.2.3 (b) Stakeholder Participation



Source: RPM Engineers SB

030610

Appendix 3.2.3 (c) Water Managers and Public Stakeholder Platforms

No.	SECTOR	NO'S	Notes
1	Water Supply	14	All States
2	Sewerage	14	All States
3	Water Resources	14	All States
4	Environment/Biodiversity/Wildlife	26	NGOs and Interest Groups
5	Agriculture (Paddy)	12	All Granaries
6	Agriculture (Non-Paddy)	5	NGOS (Vegetables and Tree Crops)
7	Agriculture (Livestock)	4	NGOs
8	Agriculture (Aquaculture)	4	NGOs
9	Urban Development	14	All States
10	Rural Development	14	All States
11	Gender Groups	5	Interest Groups
12	Resident Associates	5	Growth Regions
13	Humanitarian Relief	10	Interest Groups
	TOTAL	141	

Water Supply and Wastewater Management

Summary Brief

Professor Dr Zulkifli Yusop FASc

Defining Water Supply and Wastewater Management

For the purposes of this Component Strategy Plan study, “water supply” refers to that provided for domestic and industrial use only and “wastewater” refers to effluents originating from domestic and industrial usage which also termed as sewerage.

Water Supply and Wastewater Management (WSWWM) refers to the provision of utility services seen from an IWRM perspective whereby a holistic approach is pursued based on 1992 Dublin Principles on Water and encompasses technical, economic, administrative, financial and social considerations. As an IWRM sub-set falling under the category of “water for livelihoods”, WSWWM aims to integrate water supply and water demand, water, and wastewater, so as to ensure enhanced water supply security whilst safeguarding the sustainability of the water resource.

Review of Current Status and Needs Assessment

ASM undertook a *Study on the Current Status and Needs Assessment for Water Supply and Wastewater Management in Malaysia*. This Study commissioned in June 2012, which included a series of strategic consultations involving relevant stakeholders from the public, private, NGOs, and community stakeholders, was completed in July 2014. The report has since been published. The Study highlighted a number of issues and challenges facing the water supply and sewerage services sector with suggested recommendations. A summary list is as follows:

- Absence of National Water Services policy encompassing both water supply and sewerage sectors;
- Need for rationalisation of water tariffs;
- Need to strengthen the role of *Forum Air* to enhance collaborative governance and participatory management;
- High non-revenue water (NRW);

- Expedite the development of Water Safety Plans in both the water supply and sewerage sectors following international norms and standards;
- Recognition of aluminum as scheduled waste yet to be resolved;
- Need to expedite the integration of water supply and wastewater services sectors;
- In line with green growth, expedite efforts with regards to the 3Rs namely reduce, reuse and recycle;
- Need for review of coverage of sewerage services currently fragmented over three ministries (KeTTHA, MOH, and MHLG) to ensure greater efficiency and effectiveness; and
- Achievement of operational excellence in water supply and sewerage services delivery greatly hampered by a lack of trained personnel. A comprehensive capacity building programme nationwide to enhance competencies is sadly lacking.

Recommended Strategies

Upon completion of the position paper referred to in previous section, the ASM Task Force led by a Fellow of the Academy proceeded to develop the strategies needed for the formulation of Component Strategy Plan to chart the way forward for WSWWM in Malaysia. Reference was also made to parallel study reports undertaken by ASM under the IWRM agenda which are also relevant to the topic of water supply and wastewater management, namely:

- Water and Climate Change;

- Groundwater Resource Development and Management;
- Setting a National Agenda for Integrated Water Research in Malaysia;
- Water Demand Management;
- Water-Energy-Food Nexus; and
- Mega Science Study on Water.

Taking into account the above-mentioned considerations and the valuable feedback gathered from the stakeholder consultations, a comprehensive report entitled *Strategies for the Improvement of Water Supply and Wastewater Management Services in Malaysia* was completed in June 2015 which has since been published. 21 strategies were recommended which have been reorganised and grouped under three broad headers to be in compliance with a common IWRM General Framework format. They are as follows:

(i) Enabling Environment

a) *Strategy 1 — Formulation of a National Water Services Policy (NWSP)*

Since both water supply and wastewater (sewerage) sectors do not as yet have a policy, it is timely that a National Water Services Policy (NWSP), integrating both these sectors, be formulated that is consistent with the National Water Resources Policy (NWRP) 2012 and related policies such as the National Agro-Food Policy (NAP) 2011, National Green Technology Policy (NGTP) 2009 and the New Energy Policy (2010).

The proposed NWSP must adopt a holistic approach guided by IWRM

principles and practices in the management of water supply and wastewater (sewerage) services that emphasises not only the need for integration of water supply and water demand, quantity and quality, surface water and groundwater, water and wastewater, but also considers the impacts and links to externalities especially with regard to parallel national policies pertaining to energy, food, health and the environment. In providing effective and efficient services there should also be an inherent concern to ensuring the sustainability of the water resource.

b) Strategy 2 — Review all relevant legislation at both Federal and State levels to be consistent with the proposed NWSP

Pursuant to the implementation of Strategy 1 above, all existing laws regarding water supply and sewerage services applicable at various hierarchical levels need review and amendments with the view of the incorporating relevant provisions consistent with the proposed NWSP.

In this regard, water supply and wastewater (sewerage) services are currently regulated at the Federal level by three Acts, namely the Sewerage Services Act 1993 (Act 508), the National Water Services Commission Act 2006 (Act 654) and the Water Services Industry Act (WSIA) 2006 (Act 655). At the State level the list of relevant state

enactments/ordinances are as follows:

- Terengganu Water Resources Enactment 1938
- Melaka Waters Act 1920 (Revised 1989)
- Negeri Sembilan Water Act 1930 (Revised 1989)
- Kelantan Water Enactment 1935
- Sarawak Water Ordinance 1994
- Sabah Water Resources Enactment 1998
- Sabah Water Supply Enactment 2003
- Selangor Water Management Enactment 1999 (LUAS)
- Pahang Water Resources Enactment 2007
- Perlis Waters Enactment 2011
- Johor Water Enactment 2014
- Kedah Water Resources (Amendment) Enactment 2014

c) Strategy 3 — Expedite migration to WSIA

Since only six States have migrated to WSIA, a time target until 2020 is recommended for all Peninsular Malaysia States to migrate to WSIA.

(ii) Institutional Framework

- a) Strategy 4 — Review institutional structures at all hierarchical levels following the integration of the water supply and sewerage sectors*
- The integration of the water supply

and sewerage sectors must be undertaken on a priority basis with a target for completion before 2020. It will also entail the reorganisation of institutional structures at national, state and district level. In the same process, the reorganisation would also cater for the implementation of enhanced water demand management programmes and activities for greater effectiveness and efficiency in utility services provision.

(iii) Management Instruments

a) *Strategy 5 — Implement Management Information System (MIS) to cover both water supply and sewerage services at the national level*

The proposed MIS will encompass the following areas:

- Asset Management;
- Water accounting, auditing, and reporting;
- Infrastructure Systems Operation (diversion works, reticulation system, treatment plants); and
- Mathematical Modelling (demand forecasting, water quality management).

b) *Strategy 6 — Develop alternative sources of water supply for use singly or conjunctively with surface water*

Malaysia is now almost totally reliant (97%) on one source i.e. surface waters for its raw water supply, an undesirable situation over the long term from the standpoint of water

security. Recent water stress events affecting a number of States have further underlined the pressing need to ensure assured water supply more so for a nation that is blessed with ample rainfall. Diversification of sources of water supply needs to be actively pursued to include the following options:

- Conjunctive Use of Groundwater: Current usage of groundwater is limited, estimated to contribute about 0.2 MCM per day or only 1.4% of total water supply annually (based on 2010 data), the largest usage being in the state of Kelantan. An earlier study was undertaken by ASM in 2011 entitled *Strategic Advisory Report on Groundwater Resource Development and Management in Malaysia* recommended the following:
 - That the conjunctive use of groundwater is advocated to ensure sustainability and reliability of water supply to the nation, targeting 20% of water supply to be sourced from groundwater.
 - That the use of groundwater is advocated to ensure the reliability of water supply during periods of long drought due to climate change;
 - That the crucial role groundwater plays in ecological dynamics

of river basins are widely understood and appreciated;

- That groundwater has an important and critical role to play in the Water-Energy-Food nexus in the production of high-value crops through the use of sprinkler systems and drip irrigation; and
- That, where feasible, Green Technologies be applied in groundwater development, for example, through the use of appropriate wind and solar energy technologies to drive submersibles especially in food production of high-value food crops.

- Alternative Water Sources: The NWRS 2011, in identifying other alternate water resources, had listed the following:

- Rainwater harvesting;
- Recycling of treated sewerage;
- Desalination;
- Natural lakes/ponds/wetlands; and
- Inter-basin/State raw water transfers.

The factors that need to be considered when exploiting such alternative sources, among others, are economic, environmental and social.

Rainwater harvesting has been implemented in new housing development and government buildings in urban areas and has the potential of expansion on a more extensive scale. Uniform Building By-laws (Amendment) 2012 provides for Rainwater Harvesting and Utilisation system to be installed in bungalows and semi-detached houses with a roof area equivalent to or more than 100 m².

Recycling and Reuse of Wastewater poses a great opportunity and challenge to sustainable economic development under conditions of water scarcity. Wastewater reclamation is an attractive option for applications involving non-potable use such as in agriculture or in industries for cooling systems, boiler feed water, process water, site irrigation, fire protection, and in municipal use for cleaning purposes. Currently, sewerage treatment plants operated by Indah Water Konsortium Sdn Bhd (IWK) generate about 4,000 MLD of treated effluent that is discharged into receiving waters. This is about 25% of the total water supply production of the country available for non-potable use, not to mention the benefits of reduced pollution from return flows entering river systems.

- c) *Strategy 7 — Seeking exemption of Aluminum sludge as a Scheduled Waste (SW)*

Aluminum sludge currently appears in the list of scheduled wastes considered hazardous under

SW204. Based on the findings of the characteristics and following practices in other countries, such residues are not considered hazardous. Hence, the Study recommends that KeTTHA/JBA apply to relevant authorities to seek exemption of aluminum residues in potable water treatment sludge from the list of hazardous wastes.

d) *Strategy 8 — Evaluate Centralised versus Decentralised Wastewater Treatment System*

Millions of gallons of domestic wastewater are generated every day from sinks, showers, and toilets. This wastewater contains pathogens that are dangerous to human health and thus proper treatment and management are crucial for human safety.

Wastewater has traditionally been managed through large centralised treatment facilities in urban areas and septic tanks in rural areas. However, today, there is an array of innovative decentralised wastewater systems that collect and treat domestic wastewater on-site. These systems sometimes offer benefits over conventional treatment because they reduce the need for energy and large infrastructure, provide recycled water for use on site, and can be expanded to meet increasing demand.

Service providers had indicated on eagerness to implement a new decentralised system integrated with sustainability concept (resource

recovery, utilisation of natural plants, wastewater recycling) to improve Malaysia's sewerage management. The Study recommended that both systems be thoroughly reviewed from the view point of effective and efficient management in Malaysia prior to adoption.

e) *Strategy 9 — Review Scope and Coverage of Sewerage Services to ensure proper management of STP effluent*

There are nearly 6,000 public sewage treatment plants and nearly 2,400 private plants. The national coverage policies need to address issues pertaining to the operations and management of all the private and public STPs as poor management could result in pollution of rivers and water bodies.

Sullage should be part of the sewage to be treated in the existing STPs. However, preliminary treatment before entering into the sewerage system should be provided and monitored. The management of all aspects of sewerage services and other related issues should be under the purview of SPAN as the regulator. SPAN should regulate all types of sewerage systems, including the primitive pit toilets, pour flush, and direct discharges and upgrading of conventional and decentralised sewerage systems.

The standards of Sewage Treatment Plants' effluent need to be improved to enable reuse while

reducing pollution loading to rivers. In achieving this goal, the Study recommends that SPAN/Sewerage Services Department work with IWK to undertake plant evaluation towards proposing effective refurbishment works.

f) *Strategy 10 — Reduction in Non-revenue Water (NRW)*

A sizeable component of NRW is water leakage. Pipe replacement programme is an important asset replacement programme with the secondary benefit of NRW reduction. SPAN has set up a long-term NRW target over ten years commencing from 2011 for each operator towards achieving the national target of 25% by the year 2020 for Peninsular Malaysia.

Most States in Peninsular Malaysia are projected by SPAN to achieve 25% or less by year 2020. Currently, Pulau Pinang, Melaka, Labuan, and Bintulu have already achieved or exceeded this level.

The implementation of a holistic and systematic approach using **Water Balance**, a tool developed by the International Water Association (IWA) which enables the evaluation of every component of NRW needs to be considered. Accurate and reliable data is essential to obtain a useful Water Balance. Some States, such as Selangor, Johor, Malacca, Perak and Penang, have already established their own standard operation procedures in producing the Water Balance tool, thus can

be emulated by other States after standardisation is achieved at the national level. Overseen by SPAN, the step-wise measures to be taken are as follows:

- Accurate measure of water balance components
- Immediately attend to all complaints on visible leaks
- Metering of production
- District Metering Areas (DMA) and pressure management
- Selective pipe change

The role of The Water Asset Management Company (PAAB) is indeed crucial to sort out the high NRW in most States. Success in Malacca and Penang were very much attributed by the high management commitment in reducing NRW. Hence, NRW reduction should be an important component of the business plan that PAAB would need to look into to assist the water operators. To ensure conformity, the Study recommends that PAAB considers linking conventional project loans to NRW projects.

Asset management plan is part of the NRW reduction programme. Funding is required for the implementation of NRW reduction and sustaining it. The following strategies are proposed for Asset Management:

- Asset tagging and mapping;
- Proactive pipe replacement system;

- GIS for distribution system; and
- DMA establishment.

As NRW affects the public over the long run, the following strategies are proposed for public engagement:

- Media and public support for awareness on the value of water and NRW reduction;
- Continuous campaigns on the important and true/right value of water;
- Reward and appreciation platform to consumers; and
- Indicate actual cost of water in bills.

g) Strategy 11 — Water Safety Plans (WSPs)

WSIA requires all its licensees “to maintain at all times the security, integrity and safety of its water supply system and sewerage system and all other assets in relation to the systems”. However, WSPs have not been implemented by the water operators. In line with the World Health Organization-International Water Association (WHO-IWA) requirement for WSPs, which it had been promoting since 2005, the Ministry of Health Malaysia is currently championing the development of WSP and is planning to include WSP in the proposed Safe Drinking Water Act. At the national level, an action plan is being implemented to initiate the development of WSP. Each water operator has been assigned to develop a pilot project.

Currently, there are only 10 WSPs developed, or 1.5%, of the 458 water systems. WSP for sewerage systems has yet to be explored.

The Study recommends that SPAN enforces the mandated WSP formulation and implementation. The following targets have been suggested for achievement by the industry:

- Enforcing the development of WSP for all water and sewerage systems;
- Utilising WSP in improving operation and maintenance;
- Utilising WSP in the budget for improvement works to reduce risk and enhance reliability and efficiency; and
- All water operators to adopt WSP which covers from source to tap.

The Study recommended that the importance of WSP needs to be highlighted and adequate funding is provided to water operators to develop and implement WSP.

The Study further recommends that a national steering committee be established on WSP to deal with legislative and judicial uncertainties and the implementation programme. The steering committee is to be jointly managed by both KeTTHA and MOH whose task is to develop a master plan and implement the plan accordingly.

h) *Strategy 12 — Application of innovative Technologies for Water Supply and Wastewater Sectors*

A number of technological innovations have been successfully implemented in the country. Some of the innovations which had been implemented are as follows:

- Riverbank infiltration — cost saving in construction as well as operations. Reference project is the Jeli WTP, Kelantan;
- Using ozone in water treatment — current development in science and technology had significantly reduced the carbon footprint of the ozone plant and its energy utilisation;
- Hybrid system to treat brackish water in Labuan (Kinabenua) and Sarawak (Daro) — it is a two-stage process where the initial stage removes suspended and colloidal particles whereas the second stage remove the salinity in water using membrane technology;
- Use of streaming current in optimising floc formation and chemical consumption;
- Using other forms of chlorine to improve its optimum working pH and reduce the danger of chlorine gas leak — brine (Melaka), chlorine dioxide (Perak); and
- Expansion of reservoir capability by raising dam heights.

Technologies and Incentives to Achieve More Efficient Use:

Water demand management strategies include the mandatory use of efficient products or water saving devices. The legislation is required for uniform application of standards, building codes and water efficiency labelling schemes. Such products include water efficient WCs, showers, dishwashers, washing machines and efficient use of taps and restrictor valves. Efficiency labelling schemes are introduced to encourage manufacturers to produce efficient products which are recommended for use by consumers and users of water.

In Peninsular Malaysia, based on a study by FOMCA in 2007, water use in toilet facilities take up most water which is 26% of total water consumption in a home. Through the usage of the dual flush water closet, water consumption can be reduced by 20%. SPAN has enforced the Water Services Industry (Water Reticulation and Plumbing) Rules 2014 on 1 February 2014 with the use of dual flush toilets. This is mandatory for new development projects and renovated buildings.

SPAN has also encouraged the use of water efficient products by labelling. The purpose of labelling is to assist consumers to opt for products that use less amount of water but still provide satisfactory performance. However, SPAN has yet to make it a mandatory requirement.

SPAN's SPPCA Implementation Guidelines was launched in January 2013 for water closet, urinals, tap (basin, sink and showers). At the end of 2013, two more appliances were added which are washing machine and showerhead. The products are assessed based on usage efficiency for which star ratings are given. The number of stars reflects the more efficient use of water. When there is no significant price difference between a water-efficient and a standard appliance, it is often more expensive to retrofit the water appliances in an existing house than installing the same device in a new house. This is where incentives in the form of a rebate programme can be effective in persuading existing house owners to retrofit water appliances. The rebate programme subsidises the adoption of water efficient device by refunding the cost of the appliance partially or fully. It will encourage domestic consumers to purchase water saving devices when installing or retrofitting these appliances. The rebate programme has yet to be introduced in Malaysia but is widely practised in developed countries.

i) *Strategy 13 — Water Tariff Adjustment and Appropriate Tariff Structure to Reduce Wasteful Consumption*

Based on water supply consumption figures of the various States, the majority of Malaysians use more than the national average household consumption level of 210 litres per capita per day (l/c/d). The tendency for high consumption is largely

related to the prevailing low water tariff rate in the country.

There is a general consensus that the present pricing structure of treated water is low and this constraints effort for enhancing water demand management. Low water tariffs also limit the amount of resources operators can direct to technological innovation and R&D.

To ensure water supply security over the long term water services need to be restructured to enable the provision of affordable services on an equitable basis. Right pricing of water is an integral part of the water services reform initiatives. SPAN has embarked on establishing a tariff setting mechanism, for Peninsular Malaysia and F.T. Labuan, that is robust, fair and transparent where information on costs and performance levels will be disclosed to consumers and users of water who will know what they are paying for and what they are getting in return. In a way, relevant stakeholders will have a say in price increases which are not seen to be costly using a mechanism to capture fair and qualifying expenditure that is commensurate with the cost of providing it and the level of service being provided benefiting individuals and society.

It is understood that Sabah is now finalising a new tariff based on a 'rate structure' designed to progressively cover all costs and charges of managing water supply system.

Meanwhile, water rates in Pulau Pinang have been increased from 1 April 2015 in a move to reduce consumption and avoid rationing according to Penang Water Supply Corporation Sdn Bhd.

Consumption per capita promoted by World Health Organization (WHO) is 150 l/c/d, which would be a long-term target for Malaysia. Over the short-term measure, SPAN has targeted 180 l/c/d by 2020. Should this be achieved or even surpassed, the volume of water saved in 2020 would be in the order of 2337 MLD for Peninsular Malaysia and 267 MLD for Sarawak and 208 MLD for Sabah.

The volume saved is sizeable. Based on an average operational cost per cubic metre for Malaysia estimated at around RM1.20 per m³ (MWIG 2014), the savings in water consumption would translate to approximately a saving in OPEX of about RM1.23 billion annually. (The savings for Peninsular Malaysia will be about RM1.02 billion annually while that for Sabah and Sarawak will be about RM91 million and RM116 million, respectively).

The Study supports the initiatives taken by SPAN for initiating a tariff setting mechanism that is robust, fair and transparent executed in consultation with consumers and users.

j) *Strategy 14 — Engaging the Consumers and the Public in Water Conservation Initiatives and the role of Forum Air*

The Government, policy makers, and public authorities have a role to play in engaging the public on water security and its implications for such issues as the prudent use of water and reduction of pollution of water resources.

Some of the issues which the public and stakeholders need to be aware of are:

- Water scarcity and the need for rationing;
- Water pricing and the need to increase the charge; and
- Water service level, such as the reason why treated water delivered at household taps is not always clean.

On the other hand, some of the issues the Government and public authorities would want the public to understand are:

- The need to pay for sewerage services charges;
- The need to conserve and save water. Charges in water consumption at an individual level will be crucial to tackling water scarcity; and
- The need to Reduce, Reuse and Recycle water, especially for non-potable purposes.

The Water Forum (Forum Air) designated by SPAN keeps close contact with consumers and the public on water and sewerage services matters and providing feedbacks to SPAN on many issues.

In addition to engaging Water Forum who represents the interests of consumers, SPAN also continuously engages with the non-governmental organisations and the business communities to obtain proposals and feedback before the implementation or drafting of any new rules or regulations or taking any new initiatives.

Some of the water conservation initiatives taken by SPAN include:

- Requirement for water operators to develop and implement a water conservation programme on the maintenance of an efficient and economic water supply system;
- Relevant stakeholders are encouraged to take proactive measures to constantly educate the public on conservation matters. Schools should be the target group primarily because the future generation should be made aware of the importance of conservation. In this case, SPAN itself has carried out several outreach programmes in schools to educate the school children and deepen their understanding of the

water cycle, the benefits of conservation and the need for a clean environment; and

- Proposal to curb wastages by “Hose Ban Rule” during a period of crisis with deterrent penalties has been submitted to the Minister.

Other means of public engagement is through “Water Museums” or “Water Galleries” set up in major cities and towns with the sole purpose of attracting the public especially the younger generation to visit and be interested to learn. They will realise the intricacies on how water is produced and made available to them, and also how sewage is removed from houses, treated and subsequently disposed to receiving waters. In this way, the intrinsic value of water is fully appreciated by the public as a whole. The “Water Museums” or “Water Galleries” could possibly be located at Water or Sewerage Treatment Plants.

Unmitigated wastage of water on non-important activities during a crisis should be penalised. The Study supports the initiatives taken by SPAN pertaining to *Forum Air* and also regarding innovative communication packages being explored notwithstanding that in cases of persistent breaches or non-compliance, the imposition of penalties should be applied without fear or favour. The carrot and stick approach with continuous engagement with consumers and the public is the way forward.

k) *Strategy 15 — Reduce, reuse, recycle*

The Study has recommended water conservation, reuse, and recycling of the water supply and wastewater which also appear as part of other strategies listed above. Water used by large consumers is not lucrative to be recycled as the price of water is cheap. Similarly, in the wastewater sector, as the quality of Sewerage Treatment Plant (STP) effluent increases, there are opportunities for reuse for non-potable purposes and for industrial use by way of trade-off thereby providing some relief to the current water demand burden. Growing limitations in fresh water availability in the future would render the recycling and reusing effluents a viable option. This will also contribute significantly in support of green initiatives currently being pursued by the Government.

l) *Strategy 16 — Implement projects and services for wealth creation*

In 2010, the Academy produced a report entitled *Mega Science Framework Study for Sustained National Development 2011 – 2050 on the Water Sector*. This Report prioritised the ten highest rating STI opportunities for ‘creating new wealth’ and rated according to the highest returns and lowest risks. These were:

- Eco-tourism around high ecological value sites;
- Urban water-based tourism;

- Market and export high-quality water;
- Clean water for aquaculture industry;
- Malaysian brand for domestic water purification unit;
- World-leading tropical aquatic research and education;
- Knowledge export;
- Downstream water tapping;
- Rainwater harvesting; and
- Zero pollutant discharge.

m) *Strategy 17 — Implement adaptation and mitigation strategies in response to the impacts of climate change*

In 2014, the Academy produced an Advisory Report entitled *Strategic Plan for Addressing the Impacts of Climate Change on Water-related Issues in Malaysia*. The Strategies were clustered around three main sectors, that is, “Water Bodies Management Capacity”, “Water Services Management Capacity” and “Water-related Hazards Management Capacity”. The strategies listed in ‘Water Services Management Capacity’ specific to potable water supply are as follows:

For “Potable Water Supply (Water Resources Management)”, the following strategies were proposed:

- Protecting the river water catchments providing the potable water supplies through the adoption of the IWRM and

IRBM principles and approach in land use planning;

- Need to developing a long-term strategy for water resources management to achieve water security; and
- Need for water-resources-rich States to protect their water catchments and develop them for export to water-stressed States.

For “Potable Water Supply (Water Demand Management)”, the following strategies were proposed:

- Setting-up National and State-level IWRM Secretariats to develop strategies, implement, monitor and report regularly on the progress in the implementation of IWRM principles, including integrated thematic sector-based approaches based on IWRM principles, such as IRBM, Integrated Flood Management, etc.;
- Reviewing the existing and future water supply infrastructure development plans recommended in the NWRS (2011) study, to anchor the plans on a targeted, sustainable per capita water consumption figure that is benchmarked with the contemporary figures achieved by other countries;
- Adopting a policy of water supply capacity planning based on a targeted,

sustainable per capita water demand figure, and making water supply planners, operators and consultants aware of such a policy so that the planning and operations of water supply infrastructures will be based on a constrained demand;

- SPAN to impose requirement on water supply providers to develop and implement Water Safety Plans (WSP) to address the loss in confidence of the consumers in the drinking quality of our potable water supply;
- SPAN to set up a Water Demand Management Taskforce to develop strategies, implement, monitor and report on the country’s progress towards achieving the targeted, sustainable per capita water demand figures;
- SPAN to develop financial incentive structures to make water supply providers earn their revenue from delivering water supply performance rather than selling more water to consumers to waste; and
- Need to develop strategies to increase the resiliency of our water supply system to cope with the projected increased in the variability of our river run-off arising from climate change.

n) *Strategy 18 — Pursue sustained integrated research on Water Supply and Sewerage Systems, Products and Services*

In a recent ASM Study Report entitled “National Agenda on Water Research and Development”, water supply and sewerage services fall under the “Water for Livelihood and Wealth Creation” category. Two research themes applicable to both of these services are “Sustainable Water Supply Development and Management for Multi-purpose Use” and “Wastewater Management and Reuse”.

The first research theme on “Sustainable Water Supply Development and Management for Multi-purpose Use” has four Research Fields, of which three are applicable as follows:

- Advanced dam technology;
- Water-use efficiency; and
- Balancing water supply versus demand.

Under each Research Field, three related research topics have been listed, details of which are available from the ASM R&D Study report. Similarly, under the second research theme on “Wastewater Management and Reuse” has six Research Fields listed are as follows:

- Quality waters and wastewater reuse for irrigation;

- Integrated urban water management;
- Environmental and social impacts;
- Advanced and innovative technology for industrial wastewater treatment;
- Low carbon and energy efficient treatment system; and
- Zero discharge technology.

Each Research Field has three related research topics listed, details of which can be seen in the ASM R&D Study Report.

o) *Strategy 19 — Training of O&M Personnel towards achieving “Operation Excellence”*

All water supply and sewerage operators in Peninsular Malaysia are licenced under the Act. There are two categories of licensees or operators in the water supply and sewerage services industries. The main challenge to achieve “Operation Excellence” in the Water Supply and Sewerage Services sector is the lack of trained manpower at all hierarchical levels to operate and maintain water supply and sewerage systems.

Based on information from Water Services Industry Performance Report 2013 (SPAN) and Malaysia Water Industry Guide 2014 (MWA-KeTTHA and SPAN) and discussions with SPAN and several water supply operators, the ratio of trained manpower to consumer connections should be in the order of 1 to 450 – 500 largely

depending on the size and status of development of the area and that is whether the area is mainly urbanised (densely populated) or for all or most part still rural in nature. The trained personnel are mainly involved in plan processing, distribution pipeline, and reservoir inspections and pumping duties. Extra duties may be required to inspect works done by contractors, like pipe connections. Variation to this would include expected level of service, level of outsourcing services by water operators and also the level of automation of the facilities. The above ratio assumes a level of service to be mainly provided by in-house manpower and some automation of facilities.

The trained personnel should be subjected to continuous training (Human Capital Development) to upgrade skills and knowledge. Their service conditions should be conducive enough for the experienced personnel to be retained in operational services. There must also be management commitment in WDM and in particular NRW investments in order to maintain achieved levels of NRW at all times and reduction in per capita consumption.

For sewerage systems, the operations include sewer maintenance, sewage treatment plant operations, and sewerage services. Indah Water Konsortium (IWK) as the national sewerage company provides services to 21 million population equivalent in

most parts of Peninsula Malaysia excluding Kelantan, Johor Bahru and Pasir Gudang. In Non-IWK operational areas, the responsibility of operations is either taken up by the local government or private parties. IWK manages over six thousand sewage treatment plants which are connected via over 18,000 kilometres of sewers.

The current skilled manpower ratio of IWK is approximately 1 per 1000 connected accounts. However, the ideal range is envisaged to be in the order of 1 per 500 to 600 customers for now and this ratio should be decreasing over time to get better customer care and attention.

Staff training in water supply and sewerage services has mostly been operationally related in nature or in other words, subjected to in-house training. This method of training is time-consuming and inadequate to meet challenges to ultimately scale up the system to “Operation Excellence” level.

Penang is known to have a well-structured water academy (PWSA) established in 2007, accredited by SPAN and the Ministry of Human Resources. It has taken a step further by offering their training to school leavers and operators from neighbouring countries. Building on this example, and as a matter of urgency, the Study recommends that Government under the auspices of KeTTHA establishes centralised or regional training institutions in

Peninsular Malaysia, Sabah and Sarawak.

All water operators need to enrol in competency and training programmes currently carried out by training centres and institutions endorsed by SPAN, and with SPAN/PAAB ensuring that all stakeholders allocate the necessary funds for training.

The Study also noted Malaysian Water Association's interest in providing training facilities for the whole country by working closely with water supply operators and sewerage services providers in Peninsular Malaysia, Sabah, and Sarawak.

p) Strategy 20 — Develop together with the food and energy sectors a common Water-Energy-Food Nexus Framework

The Study recommends the formulation of a Water-Energy-Food (WEF) Nexus policy framework that would ensure a more balanced approach in determining the needs of the three inextricably linked components of water security, energy security and food security. All the three components are dependent on the availability of water resources.

q) Strategy 21 — Enhancing Networking and Forging Strategic Alliances with Regional and International Water Institutions

The problems that beset

water supply and wastewater management in Malaysia are not new. Globally, with dwindling fresh water supplies and poorly managed wastewater, the sustainable management of both water supply and wastewater has taken on a crucial profile. Networking with regional and international organisations, such as UN Water and International Water Association, would enable the country to learn from experiences of other countries as well as share our own with them. Strategic alliances with renowned regional and international water supply and sanitation research centres need to be nurtured for mutual benefit.

Strategies Implementation Road Map with Timelines and Relevant Lead Agencies

The Strategies Implementation Road Map was developed through a multi-stakeholder meeting. Strategies from the Water Demand Management component plan study relevant to Water Supply and Wastewater Management were included into the following road map:

- (i) Appendix 3.2.4.1 (Enabling Environment);
- (ii) Appendix 3.2.4.2 (Institutional Framework);
- (iii) Appendix 3.2.4.3 (Management Instruments); and
- (iv) Appendix 3.2.4.4 (Investments in Water Infrastructure).

Appendix 3.2.4.1. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Enabling Environment

Water for Livelihood							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	National Water Resources Policy	National	MSAN, NRE	BKSA/SWRC, DID and relevant line agencies	Completed	Launched in March 2012	Five working groups were formed to look into the implementation of NWRP. In principle, Federal and State Governments have agreed to adopt NWRP in the 6th Meeting of National Water Resources Council dated 6 October 2011. A gap analysis is recommended to identify the pertinent issues that are been faced in the implementation face and then a SOP is to be developed MSANG was formed in each respective state to look into implementation at the state level SOP is recommended for the implementation of the policy at the State and Federal level
	Formulation of a National Water Services Policy (NSWP)	National	KeTTHA	SPAN, Water Services Licensees	Proposed	11MP	Includes Water Supply and Sewerage Services Management A detailed Action Plan is recommended to be prepared immediately after the policy has been passed by the cabinet
	Develop a common Water-Energy-Food (W-F-E) Nexus Policy	National	EPU	MOA, NRE, KeTTHA	Proposed	11MP	An overarching review has been published by ASM/DID

Appendix 3.2.4.1. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Legislation	Migration to Licensing Regime	National	KeTTHA	SPAN, Water Services Licensees	Six States have migrated	Launched in 2006	The six States that have migrated to licensee regime (WSIA) are Perlis, Penang, Perak, Negeri Sembilan, Johor, Melaka. (Does not apply to Sabah and Sarawak)
	Review and update WSIA to be consistent with the proposed NWSP	National	KeTTHA	SPAN, Water Services Licensees	Proposed	11MP	Consideration to extend WSIA to Sabah and Sarawak The review of WSIA shall address the service licensees predicament of having a sustainable tariff structure with full cost recovery. The review shall be holistic, transparent and sustainable taking into consideration the needs of the people, environment and the country
	Seeking exemption of Aluminium sludge as a Scheduled Waste	National	KeTTHA	SPAN, Water Services Licensees	Reactivate	11MP	SPAN has initiated discussions with the Department of Environment, but the idea was not well accepted
Regulation	Water Services Industry (Rates for Water Supply Services) (State of Penang) (Amendment) Regulations 2015	State	SPAN	SPAN	Completed	Operational on 15 February 2015	
	Water Services Industry (Rates for Water Supply Services) (State of Johor) (Amendment) Regulations 2015	State	SPAN	SPAN	Completed	Operational on 1 August 2015	

Appendix 3.2.4.1. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Regulation (continued)	Water Services Industry (Rates for Water Supply Services) (WP Labuan) Regulations 2015	State	SPAN	SPAN	Completed	Operational on 1 August 2015	
	Water Services Industry (Rates of Water Supply) (State of Melaka) (Amendment) Regulations 2015	State	SPAN	SPAN	Completed	Operational on 1 May 2015	
	Water Services Industry (Rates of Water Supply) (State of Neg-eri Sembilan) Regulations 2015	State	SPAN	SPAN	Completed	Operational on 1 May 2015	
	Water Services Industry (Water Services Deposits, Fees and Charges) Regulations 2014	National	SPAN	SPAN	Completed	Operational on 1 February 2014	
	Water Services Industry (Sewerage Capital Contribution Fund) (Amendment) Regulations 2012	National	SPAN	SPAN	Completed	Operational on 2 May 2012	

Appendix 3.2.4.1. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Regulation (continued)	Water Services Industry (Sewerage Capital Contribution Fund) Regulations 2011	National	SPAN	SPAN	Completed	Operational on 1 January 2011	
	Water Services Industry (Compounding Offenses) 2008	National	SPAN	SPAN	Completed	Operational on 1 August 2008	
	Water Services Industry (Licensing) Regulations 2007	National	SPAN	SPAN	Completed	Operational on 1 January 2008	
Finance	Formulate fair and equitable financing strategies to facilitate the migration of states to licensing regime (WSIA)	National	KeTTHA	SPAN, Water services licensees	Ongoing Negotiations	11MP	
	Federal funding to be provided for Capacity Building and R&D	National	KeTTHA	SPAN	Ongoing	11MP and beyond	RM4.65 million of funding from EPU was given to SPAN to collaborate with MWA to develop training modules and syllabus

Appendix 3.2.4.2. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Institutional Framework

Water for Livelihood							
Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Review institutional structures at all hierarchical levels following the integration of the water supply and sewerage sectors	National	KeTTHA and SPAN	State Governments, water service licensee	-	Ongoing	11MP	
Form a dedicated Water Demand Management Division at all water managements and Institutions	National State	KeTTHA, state	SPAN, Water service licensee at all levels	To balance the supply and the demand of water to achieve sustainability To develop SOPs and monitor progress	Proposed	11MP	A need for a standard form of reporting with SOP and Guidelines whereby analysis can be carried out and important information and trends can be conveyed to all relevant parties for necessary actions to be taken

Appendix 3.2.4.3. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Management Instruments

Water for Livelihood						
Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
2. Planning and Development	1. Information Management	KeTTHA	State Government, line agencies (DID, MET) and state water operators	Ongoing	11MP	KeTTHA Information System is in development
	Develop alternative sources of water supply for use singly or conjunctively with surface water (e.g. Groundwater, Rainwater Harvesting, Wastewater Recycling, etc.)	KeTTHA and NRE	JMG, DID, JKT, State Governments, water service operators	Ongoing	11MP and beyond	In the 11MP, JMG was given RM41 Million to develop 200 tube wells and RM27 Million for groundwater studies in five river basins JKT has implementation of rainwater harvesting in urban areas through local authority Wastewater recycling is not economical at the moment due to low water tariff. There is a need to review the Water Tariff to the true value to encourage and provide incentive in recycled water usage
	Centralised versus Decentralised Wastewater Treatment System	SPAN	Water service licensee (IWK is appointed as project implementer), relevant line agencies	Commenced on 1st April 2016 (drafting of policy and strategy followed by plan)	11MP (1st quarter of 2018)	Covered in National Sewerage Catchment Strategy
	Review scope and coverage of sewerage services to ensure proper management of STP effluent					

Appendix 3.2.4.3. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
2. Planning and Development (Contd.)	Planning for new industrial zones to be based on potential recycling for non-potable water from Bio-effluent, energy recovery from bio-gas and bio-solid conversion to fertilisers for agriculture (non-food base crops)					
	Implement adaptation and mitigation strategies in response to the impacts of climate change	KeTTHA and NRE	Water service licensee, relevant line agencies	Ongoing	11MP and beyond	To be in line with the National Policy on Climate Change launched in 2009
	Adopt applications of the National Blue Ocean Strategy for water supply, water demand and wastewater management	SPAN	Water service licensee, relevant line agencies	Ongoing	11MP and beyond	On the sewerage sector, the National Sewerage Catchment Strategy shall be used as a basis to steer the future direction of the sewerage industry
	Sullage connection to sewerage systems	KPKT	SPAN, JPP and Water Service Licensee (IWK) and <i>Jabatan Berkuasa Tempatan</i>	Proposed	11MP	
3. Operation and Maintenance	Develop a comprehensive Water Accounting, Auditing and Feedback system for within Sector and Inter-Sector WDM	KeTTHA	Water service licensee, relevant line agencies	Proposed	11MP	
	Water Safety Plans	MOH and KeTTHA	Water service licensee, relevant line agencies	Ongoing (27 WSPs have been developed)	11MP	As a nucleus of IWRM implementation
	Develop Operations, Maintenance and Service Levels Excellence Plan	SPAN	Water service licensee, MWA, MyWP	Ongoing	11MP and beyond	

Appendix 3.2.4.3. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
4. Economic and Financial Instruments	Grants from Federal Government to encourage States' migration to WSIA	EPU	KeTTHA, KKLW, SPAN, State Governments	Proposed	11MP and beyond	Until new tariffs are able to recover operation expenses This applies to rural areas as well
	Water and sewerage tariff adjustment and appropriate tariff structure to reduce wasteful consumption	SPAN	State Governments, Water service licensee	Proposed	11MP	
	Financial incentives for wide-scale public adoption of water-saving devices and installation, such as rebate	KeTTHA	MGTC, NGOs, Community	Proposed	11MP and beyond	
5. Wealth Creation	Structure the water industry (all water sectors) by integrating all water developers and service providers from all sectors to be recognised as one of the key economic growth sector	KeTTHA	SPAN, Water Service licensee and developers	Proposed	12MP	

Appendix 3.2.4.3. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
6. Green Growth	Green Growth -- Waste to Wealth Initiative	KeTTHA	SPAN, IWK, Water service licensee and development industry, beneficiary sectors	Proposed	12MP	IWK propagates Green Growth with our main initiative focused on sewage treatment plants output to be seen as “Waste to Wealth”. Bio-effluent reuse for non-potable use, bio-gas conversion into energy (Feed in Tariff) and Bio- solids conversion to Fertilisers for non-food base crops. As a result of this holistic approach in “Zero Waste” management, the Nation, people and the environment are key beneficiaries. Clean environment is a catalyst to economic growth i.e. foreign Investment, increase in tourism and related industries. It is proposed that the beneficiary sectors are imposed with “Green Tariff” to support the future growth of the sewerage industry. The service licensees shall be incentivised for promoting Reduce, Reuse and Recycle (3R) in its SOP.
	Engaging the consumers and the public in water conservation initiatives and the role of <i>Forum Air</i>	SPAN	Community, Water service licensee operators, NGOs	Ongoing	11MP and beyond	Strengthen <i>Forum Air</i> by involving industry players and more NGOs to as supported in SPAN act
8. Research, Development and Innovation	Pursue continuous integrated research on water supply, water demand and sewerage systems, products and services	KeTTHA	MOSTI, SPAN, NAHRIM, RIs, IHLs	Ongoing	11MP and beyond	
	Application of innovative technologies to the water supply, water demand and wastewater sectors	KeTTHA	MGTC, SPAN, Water service licensee, NGOs, Community	Ongoing	11MP and beyond	

Appendix 3.2.4.3. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
9. Awareness, Advocacy and Capacity Building	Develop comprehensive water supply, water demand and wastewater management capacity building programmes by all sectors for staffs and for the public (Water User Groups/Water User Associations) to achieve “Operation Excellence”	SPAN	Water service licensee, relevant line agencies, NGOs	Ongoing	11MP and beyond	
10. International Collaboration	Enhancing networking and international cooperation	KeTTHA	Water service licensee, relevant line agencies, NGOs	Ongoing	11MP and beyond	

Appendix 3.2.4.4. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Investments in Water Infrastructure

Water for Livelihood							
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion (11MP/12MP/13MP)	Remarks
1	Water Supply Sector	KeTTHA/ KKLW/ MOH/ SPAN JBA/Sabah SWA/ Sarawak SWA/SWRCs	Line agencies, Water Operators	• Privatisation/ corporatisation of water supply sector • Smart water network monitoring systems for non-revenue water reduction • Improve urban and rural water supply infrastructure • Develop water demand management initiatives • Inter-basin water transfer schemes • Commercialisation of technology and expertise	Pending for SPAN's feedback	13MP 12MP 11MP 12MP 13MP 13MP	Estimated cost depends on established targets set by respective MPs

Appendix 3.2.4.4. NIWRM Strategy Plan and Implementation Road Map (WSWWM & WDM): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion (11MP/12MP/13MP)	Remarks
2	Wastewater Sector	KeTTHA/ SPAN/ JPP/Sabah LAs/ Sarawak LAs/ SWRCs	Line agencies, Water service licensee	- Expand sewerage infrastructure and regionalisation of sewerage networks - Waste to wealth — bio-effluent, bio-solids and bio-gas industry - Potable and non-potable wastewater recycling - Tertiary treatment for sewage to reduce eutrophication in public waters - Develop industrial wastewater treatment systems (Need input from the other line agencies)	RM52 billion for next 30 years (Approx. RM9 billion per MP) Only focused on Peninsular Malaysia excluding Sabah, Sarawak, Kelantan and JB, Pasir Gudang.	Ongoing till 16MP 12MP 12MP 12MP 13MP	Estimated cost based on National Sewerage Development Plan submitted by IMK to KeTTHA, SPAN and JPP. Phase 1 scope of works shall be to upgrade all catchment "A" plants to Category 1 by year 2020 and catchment "B" by 2025 via a systematic approach taking into consideration: 1. Mini regionalisation of plants also calls for consolidation into sub-regional plants, 2. Connect to existing regional plants and lastly regional plants and lastly Standalone upgrade. 3. The total estimate cost for this initiative is about RM6.1 billion which is partly ongoing via several National Sewerage Development Projects i.e. GKL, Papan Regionalisation, Bukit Besar Terengganu Regionalisation, Kuantan and Indera Mahkota Regionalisation. Remaining RM46 billion shall be for future regionalisation projects; upgrade of existing aging sewers, provision of bio-solid treatment plants, acquisition of land for future sewerage works Estimated cost depends on established targets set by respective MPs

National Agenda for Integrated Water Research

Summary Brief

Professor Dr Ahmad Fauzi Ismail FASc and
Professor Dr Zulkifli Yusop FASc

Defining Integrated Water Research

In line with the NWRP 2012 and in moving away from sectoral management to integrated water resources management (IWRM) would require the application of sustainable solutions to address rather complex integrated water systems involving both natural and human systems.

UNESCO-IHE has defined integrated water systems as “as a dynamic system of natural and man-made water assets, associated social and economic processes, corresponding institutional structures and arrangements aimed at their management and governance, together with the virtual world of mathematical, computer-based and physical models simulating aspects of the behaviour of the real-world physical and socio-economic processes for better understanding, management, optimisation and prediction”.

Hence, integrated water research involves the study of social, biophysical and technological processes that are intrinsically linked and give rise to the dynamics of integrated water systems. Research to understand the complexity of these water systems is therefore

necessarily interdisciplinary covering “a broad range of disciplinary knowledge — natural sciences, sociology, law, economics, public administration, political science, information technology, mathematics, hydrological and hydraulic modelling sciences, engineering, knowledge management, and innovation studies”.

Review of Current Status and Needs Assessment

In June 2012, ASM commissioned a two-year study on the Current Status and Needs Assessment for Water Resources Research in Malaysia over the medium term until the year 2020. The Study also took into consideration the long-term needs as contained in the *ASM Mega Science Framework Report on Water* taken to the year 2050 completed in 2009.

Briefly, the Study found that the past and current research on water in Malaysia has been largely ad hoc, fragmented, and very often undertaken with a limited and narrow focus to meet academic interests. Water R&D is not specifically listed as a research priority area under the research listing for MOSTI or MOE

Funds. There is no clear direction in place to ensure the harnessing of science, technology and innovation to address the country's water management issues and challenges through integrated and coordinated multi-disciplinary research. Annual budgets for NAHRIM have largely been curtailed over the past years. NAHRIM does not have the necessary human and financial resources to undertake water research that it is mandated to do.

The Study also undertook a Research Needs Assessment for Water R&D until the year 2020 covering a broad spectrum of water resources research areas spanning topics covering management, environment, policy, planning, supply, demand, storage, stakeholder engagement, hydrology, ecology, irrigation and drainage, water footprint, etc. The RNA was undertaken through a process of stakeholder consultations involving all water-related ministries, departments, agencies, private companies, and NGOs, followed by conducting interviews with water experts. The Study team identified 97 R&D topics and classified them into five categories as follows:

- Water Resources and Watershed Management;
- Water Supply and Demand;
- Irrigation and Drainage;
- Sanitation, Wastewater Treatment and Environmental Issues; and
- Water and Climate Change.

ASM Advisory Report Recommendations

Having considered the findings of the commissioned Study report reported in *Section: Review of Current Status and Needs Assessment* above and noting the absence

of a demand-driven research programme, ineffective research governance and the serious under-provision of resource allocation (both human and financial) to undertake water-related research, the ASM Advisory Report 2/2014 entitled *Setting a National Agenda for Integrated Water Research Volume 1* has subsequently recommended that the following actions be considered for implementation by the Government:

(i) **Adoption and Dissemination of the National Integrated Water Research (NIWR) Agenda**

The 97 research topics identified by the RNA as reported in *Section: Review of Current Status and Needs Assessment* above have been realigned and listed to conform to a strategically designed integrated water research framework. The consolidated document (Appendices 3.2.5 (a), 3.2.5 (b) & 3.2.5 (c)) referred to as the **National Agenda for Integrated Water Research in Malaysia** is recommended for adoption by the authority concerned, namely the NRE Ministry and NAHRIM.

Upon its adoption, it is recommended that the national integrated water research based on research needs until the year 2020 be widely disseminated and used as the central document that shall form the basis for all parties who wish to undertake water-related research and for finance allocation by funding agencies.

(ii) **Water Research Governance Options**

Noting shortcomings in the current water research governance, its immediate review is recommended to be undertaken by the NRE Ministry. Two options are offered for consideration, namely the preferred longer term establishment

of a national **Water Research and Development Centre (WRDC)**

proposed as a statutory body to act as a clearinghouse and one-stop centre to deal with all aspects of water R&D in the country. As an interim solution towards improved water research governance, it is recommended that a **Water Research Consortium (WRC)** be formed of the existing water related public and private sector ROs and research centres at the local universities, and led by NAHRIM to facilitate coordinated water-related research to meet the multi-faceted needs of the water sector in Malaysia.

(iii) **Provision of adequate Human and Financial Resource (Launching Grant)**

The implementation of the proposed research agenda is a major undertaking involving concerted and parallel multi-disciplinary thematic research efforts along many fronts. “Business as usual” is no longer an option. Most importantly, it requires the strengthening of implementation capacity through the deployment of adequate human resources in specialised areas and the appropriation of adequate funding to implement the multi-faceted research programmes and initiatives. It is therefore recommended that the NRE Ministry together with NAHRIM in spearheading the implementation of the national integrated water research agenda work closely with other related ministries and the central agencies to ensure **commensurate human and financial resources, including a launching grant of RM100 million** be allocated to the chosen overseeing research organisation (WRDC or WRC) to kick-start the Water Research Agenda. The breakdown of the grant according to the 21 research themes is as provided in Appendix 3.2.5 (d).

(iv) **Implementation of the NIWR Agenda**

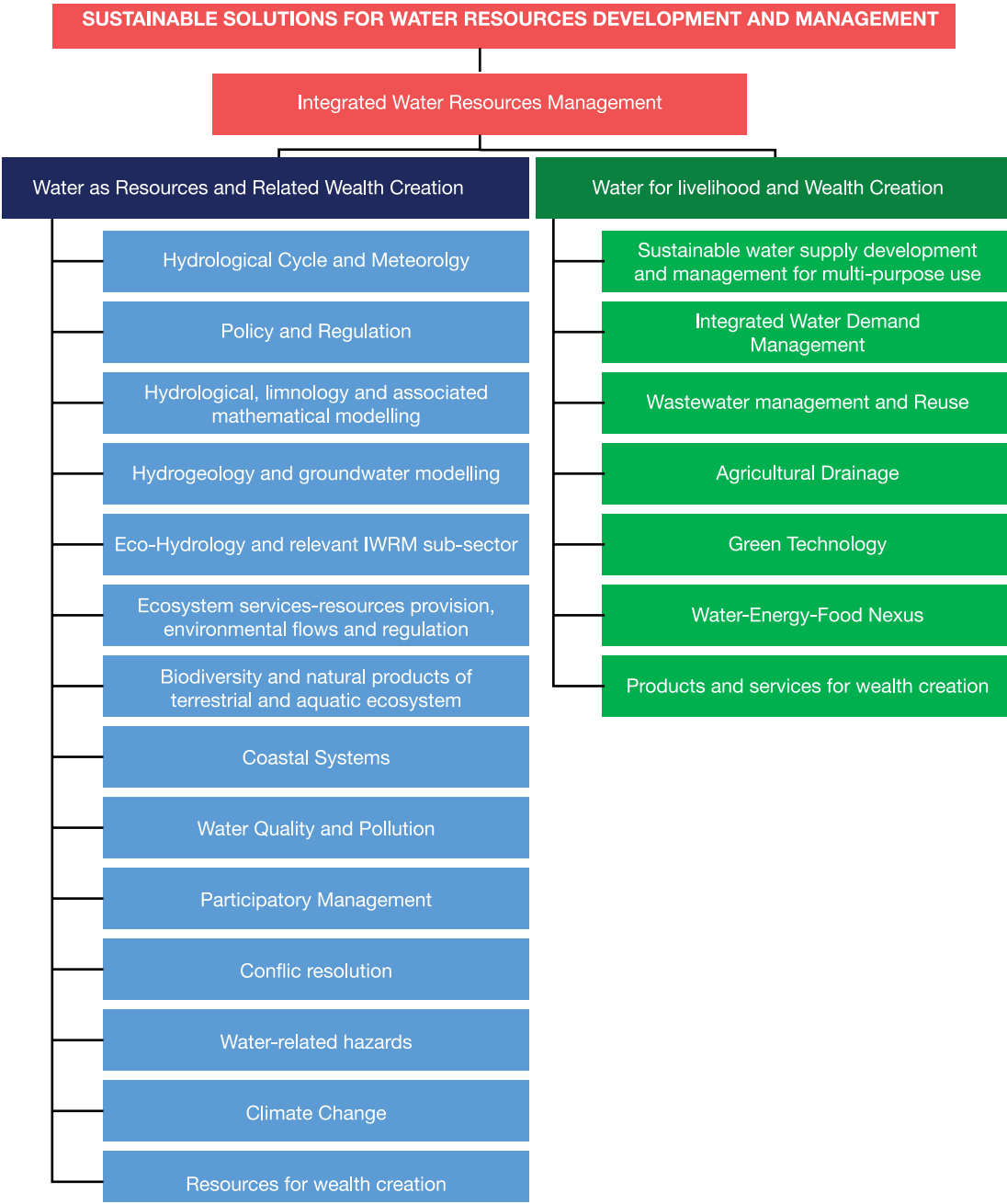
Going by the Ministerial Functions Schedule reinforced further by the launching of the NWRP in 2012, the NRE Ministry must be acknowledged as the custodian ministry for the country’s water resources. Hence, it would be incumbent on the NRE Ministry together with NAHRIM to spear-head the implementation of the national integrated water research agenda and working closely with other related ministries and the central agencies to ensure adequate human resources and funding are made available.

Strategies Implementation Road Map with Timelines and Relevant Lead Agencies

The ASM Advisory Report on *Setting a National Agenda for Integrated Water Research in Malaysia* was submitted to both MOSTI and NRE earlier this year. The report has since been tabled as a “*Kertas Pertimbangan*” and endorsed by MSAN 10 at its meeting on 15 October 2015. Through a joint workshop between ASM and NAHRIM, the Strategies Implementation Road Map was successfully developed with the relevant stakeholders. The road map is as follows:

- (i) Appendix 3.2.5.1 (Enabling Environment);
- (ii) Appendix 3.2.5.2 (Institutional Framework);
- (iii) Appendix 3.2.5.3 (Management Instruments); and
- (iv) Appendix 3.2.5.4 (Investments in Water Infrastructure).

Appendix 3.2.5 (a) National Agenda for Integrated Water Research in MalaysiaA



Note: Details of the R&D topics for each R&D theme are as in Appendices 6–1 and 6–2 given in this Advisory Report (Volume 1)

Appendix 3.2.5 (b) Research Themes for Water as a Resource and Related Wealth Creation

Water as a Resource and Related Wealth Creation (Research Themes 1 to 14)	
Research Theme	Research Topics
1. Hydrological Cycle and Meteorology	1. Hydrometeorology 2. Climate change and hydrologic cycle
2. Policy and Regulation	1. Policy and legislative issues 2. Risk assessment 3. Water security challenges and mitigation measures 4. Impacts of irrigation on environmental and health 5. Policy and legislative instruments 6. Energy and water efficient cities/township
3. Hydrology, limnology and associated mathematical modelling	1. Surface water hydrology 2. Rural hydrology 3. Urban hydrology 4. Water resource assessment and accounting 5. Alternative water resources (ground water, rain water harvesting, etc.) 6. Wetland modelling
4. Hydrogeology and groundwater modelling	1. Groundwater hydrology
5. Eco-Hydrology and relevant IWRM sub-sets	1. Eco-hydrology 2. River morphology 3. River rehabilitation 4. Catchment/river basin management 5. Integrated water resource management 6. Conservation and preservation of water resources 7. Sustainable and integrated watershed management 8. Eutrophication 9. Fresh water ecology 10. Wetlands and lakes restoration
6. Ecosystem services — resource provision, environmental flows and regulation	1. Environmental water requirements 2. Environmental flow versus climate change issue
7. Biodiversity and natural products of terrestrial and aquatic ecosystems	1. Environmental and indigenous people related issues 2. Marine biodiversity, conservation and management
8. Coastal Systems	1. Integrated coastal zone management 2. Coastal erosion 3. Coastal habitat management 4. Coastal ecology 5. Protected conservation areas in marine environment 6. Seawater and sediment chemistry 7. Marine ecology

Appendix 3.2.5 (b) Research Themes for Water as a Resource and Related Wealth Creation (continued)

Water as a Resource and Related Wealth Creation (Research Themes 1 to 14)	
Research Theme	Research Topics
9. Water Quality and Pollution	1. Water quality modelling 2. Terrestrial atmospheric pollution and water quality 3. Marine pollution 4. Ground water quality 5. Water quality Information management and modelling 6. Technologies for controlling and monitoring non-point source pollution
10. Participatory Management	1. Public participation in watershed management 2. Public awareness and participation in water resources conservation
11. Conflict resolution	1. Social and environmental costs of watershed degradation
12. Water-related hazards	1. Erosion and sedimentation 2. Flood management and mitigation 3. Stormwater management
13. Climate Change	1. Climate change and rainfall modelling 2. Impacts of climate change, increased population and changing human demographics on watersheds 3. Impacts of climate variability on wetlands ecosystem 4. Climate change and aquatic invasive species 5. Modelling climate-related water resource stressors 6. The adaptation of urban water supply to climate change
14. Resource for wealth creation	-

Appendix 3.2.5 (c) Research Themes for Water for Livelihood and Wealth Creation

Water for Livelihood and Wealth Creation (Research Themes 15 to 21)	
Research Theme	Research Topics
15. Sustainable water supply development and management for multi-purpose use	1. Advanced dam technology 2. Dam modelling construction 3. Electromechanical equipment 4. Assessment of water use and availability 5. Water-use efficiency 6. Water supply and demand for industry 7. Water supply and demand for livestock and agriculture 8. Sustainable water supply management in rural areas 9. Balancing water supply versus demand 10. Assessment of freshwater withdrawal 11. Drinking water quality standards 12. Advanced water treatment process 13. Drinking water quality versus public health 14. Improved and innovative irrigation technology (for water use reduction) 15. Micro drainage system for small-scale farming 16. Rainwater harvesting for irrigation purpose
16. Integrated Water Demand Management	1. Water demand projection and forecasting
17. Wastewater management and Reuse	1. Quality waters and wastewater reuse for irrigation 2. Water and sanitation hygiene in rural areas 3. Environmental and social impacts 4. Decentralised sanitation system 5. Integrated urban water management 6. Alternative unconventional urban sanitation systems 7. Low carbon and energy efficient treatment system 8. Nutrients removal and management 9. Phytoremediation/Bioremediation technology 10. Zero discharge technology 11. Advanced and innovative technology for industrial wastewater treatment 12. Policy and legislative instruments 13. Salt/sea water intrusion 14. Waterborne pathogens and microbial risks 15. Environmental impacts assessment of effluent discharge to environment 16. Technologies for monitoring, controlling and removing diffuse and point source pollution 17. Newly emerging water pollutants

Appendix 3.2.5 (c) Research Themes for Water for Livelihood and Wealth Creation (continued)

Water for Livelihood and Wealth Creation (Research Themes 15 to 21)	
Research Theme	Research Topics
18. Agricultural Drainage	1. Drainage, water logging and salinity control 2. Environmental effects of nutrients carried in drainage discharge 3. Development of best drainage design and practices that enable crops to use shallow groundwater efficiently, while reducing the use of agricultural chemicals and reduce flood flow 4. Drainage, and waterlogging and salinity control 5. Drainage for ecosystem and conservation
19. Green Technology	-
20. Water-Energy-Food Nexus	1. Water footprint 2. Consumer and corporate water footprint assessment 3. Carbon footprint of water and wastewater treatment system
21. Products and services for wealth creation	-

Appendix 3.2.4 (d) R&D Launching Grant to Kick Start the National Agenda for Integrated Water Research in Malaysia

RESEARCH THEME	ALLOCATIONS (million)
1. Hydrological Cycle and Meteorology	6.0
2. Water Quality and Pollution	5.0
3. Water-related hazards	6.0
4. Climate Change	8.0
5. Ecosystem services — resource provision, environmental flows and regulation	6.0
6. Coastal Systems	5.0
7. Water-Energy-Food Nexus	5.0
8. Hydrology, limnology and associated mathematical modelling	4.0
9. Hydrogeology and groundwater modelling	8.0
10. Biodiversity and natural products of terrestrial and aquatic ecosystems	5.0
11. Policy and Regulation	2.0
12. Conflict resolution	1.5
13. Eco-Hydrology and relevant IWRM sub-sets	3.0
14. Participatory Management	3.5
15. Sustainable water supply development and management for multi-purpose use	3.0
16. Integrated Water Demand Management	3.0
17. Wastewater management and Reuse	6.0
18. Agricultural Drainage	6.0
19. Green Technology	7.0
20. Resource for wealth creation	3.5
21. Product and Services for wealth creation	3.5
TOTAL	100.0

Appendix 3.2.5.1. NIWRM Strategy Plan and Implementation Road Map (NIWR): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion (11MP/12MP/13MP)	Remarks
Policy	National Water Resources Policy	National	NRE	NAHRIM / DID/ DOE / JMG / SWRCs	Policy Completed	Launched in 2012	NWRP Technical Working Groups are looking at water research-related action plans
Legislation	Pass appropriate legislation to strengthen the existing legal framework	National	NREF	NAHRIM / DID DOE / JMG / MET	Proposed	11MP	
		State	SWRCs	SWRCs	Proposed	12MP	
Regulations	Coordinate water research with the existing Water Resources and Water Services Guidelines	National	NRE KeTTHA MOA MOH MOSTI	NAHRIM / DID / DOE / SPAN / JBA / JMG / DOA / MET	Proposed	11MP	Prioritise water research themes that matches with the guidelines in all water-related Legislations and Policies: 1. WSIA (2006) 2. NWRP (2012) 3. NWR Bill (Draft)
		State	SWRCs	SWRCs	Proposed	12MP	
Finance	Provision of adequate financial resource (Launching Grant)	National	EPU	NRE KeTTHA MOA MOH MOSTI Stakeholders	-	11MP and beyond	Please refer to Appendix 3.2.5 (d) for the breakdown of the Launching Grant
	Provision of adequate human resource (Talent Management)	National	EPU	MOHE JPA	-		

Appendix 3.2.5.2. NIWRM Strategy Plan and Implementation Road Map (NIWR): Institutional Framework

Water as a Resource							
Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion (11MP/12MP/13MP)	Remarks
Establish Water Research Consortium (Interim Solution)	National	NRE NAHRIM	MOA, KeTTHA, MOH, MOSTI, IHLs, RIs and relevant agencies	To facilitate coordinated water related research to meet the multi-faceted needs of the water sector in Malaysia	NAHRIM has signed MoUs with almost all IHLs that have water-related research centres	11MP	
Establish Water R&D Centre (Long-term Solution)	National	NRE NAHRIM	IHLs, RIs	To act as a clearing house and one-stop centre to deal with all aspects of water R&D in the country To avoid duplication of research for optimisation of resources To develop capacity building programmes for stakeholders	-	11MP	Rebranding and restructuring of NAHRIM as the National Water R&D Centre is crucial because R&D does not only involve hydraulics.

Appendix 3.2.5.3. NIWRM Strategy Plan and Implementation Road Map (NIWR): Management Instruments

Water as a Resource						
Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
Research and Development	Implementation of National Integrated Water Research (NIWR) Agenda	NAHRIM	NRE, KeTTHA, MOA, MOSTI, related agencies, IHLs, RIs, NGOs	-	11MP and beyond	Please refer to ASM report on <i>Setting a National Agenda for Integrated Water Research</i>
	Blueprint for Water Research			-	11MP	

Appendix 3.2.5.4. NIWRM Strategy Plan and Implementation Road Map (NIWR): Investments in Water Infrastructure

Water as a Resource							
Item	Water R&D Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion (11MP/12MP/13MP)	Remarks
1	Water Research and Innovation Cluster	NAHRIM	IHLs, RIs	i. Set up dedicated Water Research Centre ii. Establish Water Data Centre iii. Develop Water Innovation and Industry Cluster iv. Develop Centres of Water Excellence in local Academia	RM250 million per MP	11MP 11MP 11MP/12MP 11MP	
2	Meetings, Incentives, Conferencing and Exhibitions (MICE) for Water Research and Development	NAHRIM	IHLs, RIs	i. Develop Malaysia as a Water Research Hub ii. Develop Malaysia as MICE for Water Sector/ Industry iii. Host global/regional/ national water events related to R&D	RM5 million per MP	11MP 11MP 12MP/13MP	
3	Funding in Water RDI activities	EPU	Ministries, NAHRIM and other related government agencies, RIs, IHLs	Water research based on 21 themes and 96 research topics	RM500 million per MP	Ongoing from 11MP–13MP	

Climate Change and Water

Summary Brief

Dr Salmah Zakaria FASc

Defining Climate Change Impacts on Water

Climate Change Impacts on Water (CCIW) have been well documented globally and summarised in many reports, specifically that from Intergovernmental Panel on Climate Change (IPCC) and other related publications. From decades of global observations, global warming as a result of climate change has been linked to changes in large-scale hydrological cycle, and therefore impacting global water systems. Both decreases and increases in precipitation have been recorded, depending on the location. Increased precipitation intensity and variability have been projected to increase the risks of flooding and droughts in many areas. Globally, the negative impacts of future climate change on fresh water are expected to outweigh the benefits. The changes in water quality and quantity due to climate change are expected to affect food availability, stability, access, and utilisation. The operating functions of existing water systems and infrastructure — including hydropower, flood defences, drainage, and irrigation — as well as water management practices will be affected. Climate Change will also challenge the traditional assumption of past hydrological information and experiences. Managing these changes is best done through both land and water management, specifically through appropriate management of the country's IWRM and IRBM and its subsets.

Review of Current Status and Needs Assessment

The Academy of Sciences (ASM) under its Sustainable Water Management Programme established the Task Force on Climate Change and Water Resources. This Task Force prepared a baseline *Study on the Status of Climate Change Impact on Water-related Issues*, 2010 and a subsequent Advisory Report, *Strategic Plan for Addressing the Impacts of Climate Change on Water-related Issues in Malaysia*, 2014. Both the *Study on the Status of CCIW Related Issues* (2010) and the *Strategic Advisory Report* (2014) were published before the latest IPCC report, the *Fifth Assessment Report – AR5* (2014). *The Stern Review* (2007), which provided an economic perspective to this global issue, was prepared around the same time as the Fourth Assessment Report - AR4 (2007).

AR5 Working Group 1 Summary for Policy Makers noted that changes in the global water cycle in response to the warming over the 21st century will not be uniform (IPCC 2013). The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions (see Figure SPM. 8). WG2AR5-

SPM, in which one of the drafting authors is our own Task Force Committee Member, Joy J. Pereira, summarised observed impacts, vulnerability and exposure, and adaptive responses (Figure 3.2.6.1). Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous

events and trends) with the vulnerability and exposure of human and natural systems. Changes in both the climate change (left) and socio-economic processes including adaptation and mitigation (right) are drivers of hazards, exposure, and vulnerability” (IPCC 2014).

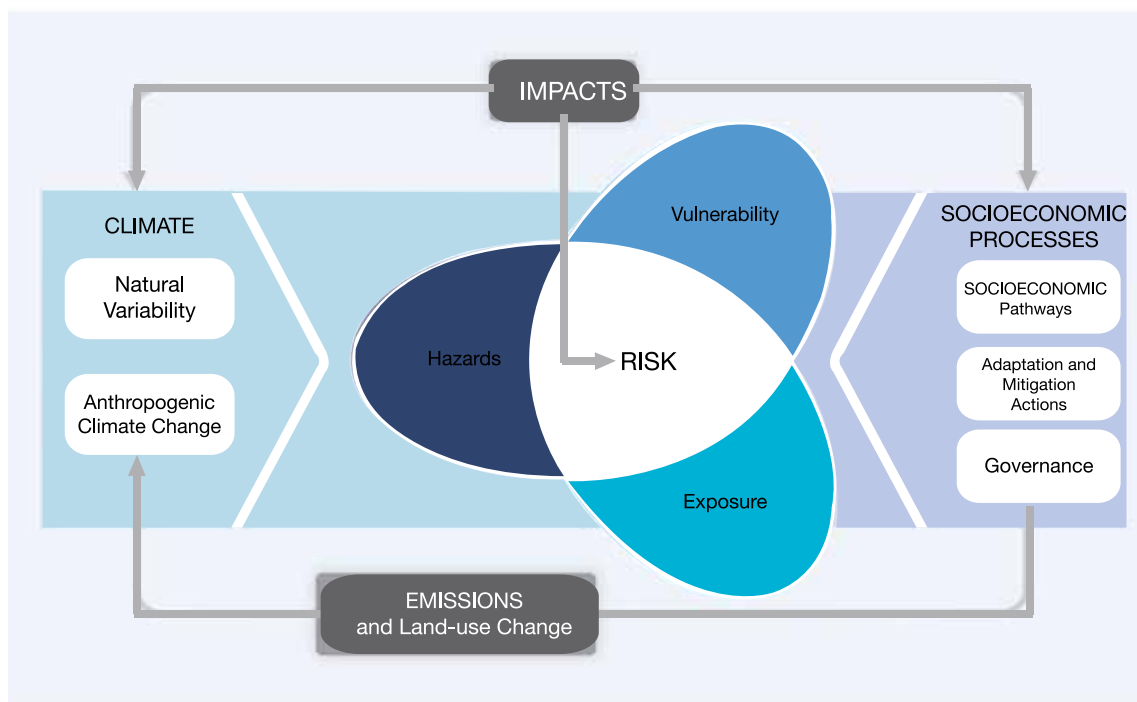


Figure 3.2.6.1. Illustration of the core concept of the WGII AR5.

Source: IPCC 2014.

The international political response to climate change began at the Rio Earth Summit in 1992, where the ‘Rio Convention’ included the adoption of the UN Framework on Climate Change Convention (UNFCCC). This convention set out a framework for action aimed at stabilising atmospheric concentrations of greenhouse gases (GHGs) to avoid “dangerous anthropogenic interference with the climate system.” The UNFCCC which entered into force on 21 March 1994, currently has a membership

of 195 parties. The main objective of the annual Conference of Parties (COP) is to review the Convention’s implementation. The first COP took place in Berlin in 1995 and significant meetings since then have included COP3 where the Kyoto Protocol was adopted, COP11 where the Montreal Action Plan was produced, COP15 in Copenhagen where an agreement to succeed the Kyoto Protocol was unfortunately not realised and COP17 in Durban where the Green Climate Fund was created.

Following the publication of AR5, discussions continue on climate change and its implication. In the COP21, 30 November to 11 December, also known as the 2015 Paris Climate Conference, although a legally binding and universal agreement on climate with the aim of keeping global warming below 2°C was agreed (Climate Council 2015 & UNFCCC 2007), there was, however, little discussions on water-related issues.

This “Component Strategy Plan — Summary Brief” looks at the works of ASM on CCIW thus far. The baseline study is a desktop study which focuses on the following:

- Review past and current initiatives and programmes undertaken within Malaysia and in areas within the same climatic zone with regards to impacts of climate change on water-related issues
- Extract, compile synthesise and summarise the findings and conclusions from such reports and proceedings; and
- Undertake gap analysis in relation to Item a. above, and to propose comprehensive recommendations pertaining to required adaptation to impacts of climate change on water-related issues in Malaysia.

The study was also in preparation for anticipated workshops to be organised, as a run up to an ASM advisory report on Climate Change.

This baseline study gave a brief introduction to climate change modelling and provided a description of the available climate projections relating to Malaysia. It also discussed how

these projections relate to each other, as well as to more regional and global projections. In addition, a synthesised overview of the subject of climate change impact, vulnerability and adaptation of the water sector was also given. A summary of the then current status of water management, addressing the impacts of climate change on water, together with key gaps and recommendations to address them, were given for seven thematic areas as follows:

- Governance and Institutional Capacity
- Climate Change Projections and R&D Capacity
- Information Management
- Stakeholder Awareness and Participation
- Water Bodies Management Capacity
- Water Use Management Capacity; and
- Water Management Capacity

To identify the desired set of strategic action plans for adaptation to the impacts of climate change for the various water sectors, a “National Conference on Water and Climate Change Adaptations” and workshops on each of the above thematic themes were recommended. The objective of the National Conference was to create awareness among all stakeholders on the key issues involved in water and climate change. The objectives of each of the seven thematic workshops were:

- To agree on the key issues to be addressed in each theme to adapt the impacts of climate change on water
- To clarify, prioritise and define the strategic action plans and develop

their list of activities to address each of the agreed issues; and

- To estimate the indicative costs, where possible, of each of the strategic action plan based on their list of activities.

The subsequent ASM Advisory Report 1/2014, *Strategic Plan for Addressing the Impacts of Climate Change on Water-related Issues in Malaysia* was based on the baseline report, outputs of the multi-stakeholders national forum and the seven follow-up thematic strategic stakeholder consultation workshops.

Global climate change has been a major concern of world leaders and scientists since the late 1980s when the hypothesis, “....that increased discharge of greenhouse gases into our atmosphere due to intensive human and industrial development activities over the past century have resulted in a trend towards a changed future global climate” was made.

Of certainty are the observed abnormal climate-related events in recent years, of increased variability and intensities of rainfall, resulting in historic floods and droughts, and of unusual climate-related events, in many places around the world.

The natural water cycle is an integral part of the global climate system. Climate changes impact significantly the water cycle and all water-related events and activities since 90% of climate impacts are water related. The climate projection models are continuously under development and testing, and thus, their projections have a lot of uncertainties. These models have projected the trend that climate change will result in increased rainfall intensities, resulting in larger floods with increase flood damages and loss of lives.

Thus, there are needs to mitigate against such losses. The large uncertainties associated with climate model projected flood risks, makes the choice of investing in costly, hard, structural flood mitigation projects potentially very hazardous, particularly the risk of investing in projects of low economic viability and utilising limited national financial resources. A better approach is to use the projections of climate change model to support the selection of “no regrets” projects that will yield benefits whether the climate change projections are accurate or not. In every five-year Malaysia Plan, multi-billion ringgit have been budgeted for water infrastructure in flood mitigation, irrigation and drainage, hydropower, water supply, transport/ tourism, etc.

Continuous investment in climate projection models will be required to increase the reliability of these projections to ensure retrofittings and new water infrastructure to be built will have better economic viability. It will also ensure sustainability and protect the economic gains that have been made. Possibly 0.1% of the total cost budgeted for water infrastructure development should be spent on research, including climate change projections.

The exposure of people and assets to hydro-meteorological hazards in Asia Pacific and Malaysia has grown over the past few decades. With economic growth and rapid urbanisation, changes in local environmental conditions and the location of more assets and people in hazardous areas such as flood plains and coastal low-land areas, the country will continue to be more exposed.

Climate change is anticipated to create extreme events, with some projections including increases in the frequency of years with above normal monsoon rainfall or extreme rainfall

deficient. An increase in rainfall extremes of landfall cyclones in South and East Asia have been projected in the IPCC's AR5, along with enhanced monsoon precipitation and increased drought in some areas over the long term.

While much work has been done by the government, much more is still needed to ensure national policies are implemented to provide social protection and to build resilience to the most vulnerable. There is a need towards better integrating disaster risk reduction into development initiatives in the five-year Malaysia plans in each and every agency. No agency located in a river basin is immune from climate change impacts and everyone lives in a river basin. The Malaysian landscape is one of short swift rivers flowing within each basin. Even before the concern on climate change emerged, Peninsular Malaysia (the size of the Chao Phraya River Basin of around 330,000 hectares — which was hit by the unprecedented great floods of 2011), had an estimated 29,000 hectares of flood-prone areas, that historically are susceptible to flooding.

The 2002 Institutional Study by Deloitte Kassim Chan for DID (unpublished) estimated an annual flood damage loss of close to RM3 billion, at the 2000 cost. The country, surrounded by more than 3500 km natural coastlines, will also be susceptible to any potential sea level rise.

Although the average annual rainfall in Malaysia is around 2500 to 3500 mm, there are differences in the temporal and spatial distribution of rainfall. This, therefore, requires management of the water resources in an integrated manner, managing each individual river basin holistically, to ensure equitable distribution over a sustainable period. For example, the 700 km²- Singapore Island is

managing water for a population of 5.3 million. Yet the 7.1 million population in Selangor State, although served by six major river systems (Rivers Bernam-3335 km², Tenggi-565 km², Selangor-1820 km², Buloh-560 km², Klang-1425 km² and Langat-1815 km²) is currently facing water crisis. The Inter-Basin Water Transfer Scheme from the Pahang River Basin to Selangor is expected to alleviate water supply problems only up to 2025, unless a new management instrument is identified. While the National IWRM, a generic national policy directive, specific river basin management should be implemented through a river basin master plan. As such, IRBM is a subset of IWRM. The need for a river basin master plan for each river has been accepted unanimously at the MSAN 02 meeting of July 2003.

In view of the large uncertainties in the various climate change model projections, a strategic plan is required to address the issue. The ASM Advisory Report proposes that the plan include adoption of the pragmatic approach described in the “Five Principles Framework” recommended by the APWF/ADB *Framework Document on Water and Climate Adaptation* (2012). Subsequently, APWF/ADB have published a sequel – *Meta-guidelines for Water and Climate Change For practitioners in Asia and the Pacific* in 2015. The strategic actions recommended in the plan were selected to address three key limiting factors which are grouped under three “guiding policies”. The thrusts of the “guiding policies” are:

- Invest in ‘no-regrets’ development projects to increase the resilience of the community to adapt to an uncertain future
- Invest in data collection, information management and R&D including continuous improvement of climate change model projections and

- Use of these climate change model projections in new and retrofitting investments in 'no-regrets' development projects to ensure optimum economic viability and to avoid "mal-investments/mal-adaptation"

Integrated Water Resources Management (IWRM) approach is "a no regret measure" in building up local resilience in climate change adaptation. IWRM is based on the understanding that all water resources are an integral part of the ecosystem; a natural resource; and a social and economic good; the three requirements for sustainable development. While the IWRM approach has been a Malaysian government policy since the 8th Malaysia Plan, there is a need to monitor its implementation, to ensure a coordinated development and management of water, land and related resources, to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystem and the environment.

Recommended Strategies

The Advisory Report recommended three specific key strategic actions for Malaysia as follows:

- (i) Adopt and implement the APWF five principles framework for Climate Change Adaptation as given below:
 - a) *Usable Knowledge*
 - Develop data infrastructure and networking for sharing data, information and knowledge to support decision-making and to raise public awareness

- Accelerate scientific efforts to improve the use of climate projections for countries, river basins, and cities as well as to quantify and reduce the related uncertainty
- b) *No-regret Investments*
 - Plan for incremental adaptation actions in tandem with improving climate projections
 - Use an appropriate mix of structural and non-structural measures
 - c) *Resilience*
 - Strengthen the adaptation capacities of water managers, communities and society as a whole
 - Improve community-based water risk management capacities
 - d) *Mitigation and Adaptation*
 - Promote IWRM in river basins as the appropriate process for planning and investments
 - Promote synergies in the planning and implementation of adaptation and mitigation measures
 - e) *Financing*
 - Conduct economic impact assessments for various adaptation options
 - Mobilise significant investments today (e.g. 1% of GDP) to prevent greater damages later (e.g. 5%) as advised by the Stern Report.

- (ii) 'Climate-proofing' and selection of 'no-regrets' projects, to increase the resilience of the Malaysian community and reduce its vulnerability. All development projects must be subjected to a climate proofing analysis, to ensure potential damages from the uncertainty of future Malaysian climate scenarios are taken into account in the evaluation. The selection of 'no-regrets' initiatives and options must be included in all future development projects.

Note: Thus, policy directives may be required by all government agencies and departments to develop and implement guidelines to 'climate-proof' their projects and to select the 'no-regrets' projects as the preferred option

- (iii) Key Climate Change adaptation actions are recommended in the management of water resources, services management, and water-related hazards capacities as detailed below:
- a) Water resources management capacity (such as in IWRM of water bodies of rivers, lakes and wetlands, groundwater and coastal area);
 - b) Water services management capacity (such as in agriculture/irrigation in the eight granary areas, potable water supply for domestic and industries including Water Demand Management especially for the anticipated floods and droughts, water for environment flow, etc.); and
 - c) Water-related hazards management capacity (floods, droughts and forest fires, especially peat forest fires).

Five other focus areas will be required to support the monitoring and assessing the current weaknesses and gaps of IWRM implementation as given below:

- a) Governance and institutional capacity — developing a checklist of relevant CC-related policies/plans and process of updating;
- b) Climate change projections and R&D capacity — to improve baseline data collation and collection, set up early warning systems and monitoring and to adopt a systematic approach to include the uncertainty of climate change impacts in current design methodologies and standards of WRE projects;
- c) Information management capacity — setting up a National Water and Climate Change Information Repository and enhancing our National Climate Service;
- d) Land use management capacity — IWRM is the coordinated development and management of water, land and related resources; and
- e) Stakeholder Awareness and Participation — create awareness and improve advocacy among all stakeholders: government agencies, disaster-relief agencies, and communities.

The implementation and monitoring of the recommended key strategic actions should be incorporated within all proposed projects that have their allocated budget. The retrofitting cost of existing projects/structures will need to be included in the allocation for operations and maintenance. The annual cost of floods for Malaysia before the year 2000 was estimated to be around RM3 billion. The allocated five-

year budget then, for floods was less than RM3 billion. The cost of damages is expected to increase with higher exposure of assets and properties as well as increasing occurrences of extreme events.

National CCIW Strategies Implementation Road Map

The strategies within the component plan study were re-casted into enabling environment, Institutional Framework, Management Instruments, and Investments to form the following, Strategies Implementation Road Map:

- (i) Appendix 3.2.6.1 (Enabling Environment);
- (ii) Appendix 3.2.6.2 (Institutional Framework);
- (iii) Appendix 3.2.6.3 (Management Instruments); and
- (iv) Appendix 3.2.3.4 (Investments in Water Infrastructure).

REFERENCE

IPCC, 2014, 'Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change', Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

IPCC, 2013, 'Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change', Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

APWF, 2012, 'Framework Document on Water and Climate Change Adaptation: For Leaders and Policy-makers in the Asia-Pacific Region', Philippines, <<http://www.apwf.org/doc/Framework.pdf>>.

APWF, ADB & GWP, 2015, 'Meta-guidelines for Water and Climate Change: For practitioners in Asia and the Pacific', <<http://www.adb.org/sites/default/files/publication/172958/meta-guidelines-water-climate-change.pdf>>.

Climate Council, 2015, 'Paris COP21: Key Issues for the New Climate Agreement: Climate Council Briefing Paper', Australia, <<https://www.climatecouncil.org.au/uploads/de494149f16b3b235d8fa74fb8a9c52d.pdf>>.

UNFCCC, 2007, 'Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries', Germany, <<https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>>.

Appendix 3.2.6.1. NIWRM Strategy Plan and Implementation Road Map (CCIW): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	National Water Resources Policy	National	MSAN / NRE	DID	Completed	Launched in March 2012	PTS15: Determine measures to aid adaptation of water resources to threats and emerging threats e.g. climate change and disasters
	Adoption of NWRP by states	State	NRE	UPEN	Mixed	11MP	Currently an RUU on Water Resources Management have been drafted by NRE and is making the round to all State Governments
	National Policy of Climate Change	National	NRE	NRE	Completed	Launched in November 2009	KA1 – ST1: Conduct systematic reviews and harmonise existing legislation, policies and plans, taking into account and proposing relevant balanced adaptation and mitigation measures, to address climate change-related sectors which include water. KA13 – ST4: Incorporate measures, including mobilising financing and technical assistance, into areas which include water KA25 – ST6: Integrate measures into policies, plans, programmes and projects in areas which include water KA28 – ST7: Establish and implement a national R&D agenda on climate change taking into account areas which include water security and services

Appendix 3.2.6.1. NIWRM Strategy Plan and Implementation Road Map (CCIW): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Legislation	Proposed RUU on Water Resources Management	National	MSAN/ NRE	NRE	Proposed	11MP	Expected requirements on climate change impact adaptation to be included in proposed RUU
Regulation	To be incorporated in future State Enactments, following the RUU or drafting of state level regulations based on proposed RUU	State	MSANG	UPEN	Proposed	11MP	Implementation on the ground is by state authority
Finance	Federal funding to be provided for: i. Economic impact assessments for various adaptation options ii. Pre-emptive entry projects as mitigation strategies	National	NRE	DID	In 10MP: - 34 hazard maps developed - 194 flood mitigation projects implemented - 24.4 KM of coastal areas rehabilitated - Heat and low water supply tolerant paddy variant launched	11MP and onwards	1% of GDP Investment to prevent greater damages later (e.g. 5%) as advised by the Stern Report Emphasis in the 11MP to strengthen Resilience against climate change: i) Enhancing adaptation measures ii) Strengthening disaster risk management

Appendix 3.2.6.2. NIWRM Strategy Plan and Implementation Road Map (CCIW): Institutional Framework

Water as a Resource							
Strategy	Hierarchical Level	Lead Authority	Composition	Functions	Current Status	Target Completion	Remarks
Identify and Empower a Lead Ministry/ Agency	National	NRE (lead ministry), DID (Lead agency)	KKR, MOA, KeTTHA, KPKT, KWP, Developing agencies, MSANG	To lead in the implementation of climate change impacts adaptation	Proposed	11MP	Can be a committee under MSAN, e.g. the CC Impact Adaptation Main Committee (CCIAMC)
Manage the large uncertainties in climate change projections through improved data collection and ensuing R&D Use the climate change projections judiciously and lobby for enough financing to improve uncertainties through research and development	National	NRE (lead ministry), NAHRIM (Lead agency)	MOSTI, KeTTHA, DID, MET, Relevant Universities, MSANG	To identify the required and appropriate climate change projections, for adaptation to the impacts of climate change	Ongoing	11MP and beyond	Can be a proposed sub-committee of CCIAMC (see remarks above) CC Projections will need to be on-going and will go beyond 13MP
Evaluate potential damages from climate change impact and support 'No-Regrets' development options	National	NRE (lead ministry), DID (Lead agency)	KKR, KeTTHA, MOA, MPIC, KPKT, KWP, MOSTI, NAHRIM, MET, Relevant Universities, MSANG	To evaluate the potential damages from the impacts of climate change. To recommend the level of protection	Proposed	11MP and beyond	Can be a proposed sub-committee of CCIAMC (see remarks above). 'No-regrets' measure include appropriate management of land-use and water in each river basin

Appendix 3.2.6.2. NIWRM Strategy Plan and Implementation Road Map (CCIW): Institutional Framework (continued)

Water as a Resource							
Strategy	Hierarchical Level	Lead Authority	Composition	Functions	Current Status	Target Completion	Remarks
Develop an integrated & coherent adaptation to climate change impacts in eight areas namely: 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 8. Stakeholder Awareness and Participation	National	NRE (lead ministry), DID (Lead agency)	KKR, KeTTHA, MOA, MPIC, KPKT, KWP, MOSTI, JPBD, NAHRIM, MET, Relevant Universities, MSANG	To develop an integrated & coherent adaptation strategy and implementation plans, suitable for implementation in eight areas	Proposed	11MP and beyond	Can be a proposed sub-committee of CCIAMC (see remarks above) Each of the eight areas can be within separate task forces, each headed by the relevant agencies
Identify and Empower a Lead Ministry/Agency	National	NRE (lead ministry), DID (Lead agency)	KKR, MOA, KeTTHA, KPKT, KWP, Developing agencies, MSANG	To lead in the implementation of climate change impacts adaptation	proposed	11MP	Can be a committee under MSAN, e.g. the CCIAMC

Appendix 3.2.6.3. NIWRM Strategy Plan and Implementation Road Map (CCIW): Management Instruments

Water as a Resource						
Category	Strategy	Lead Authority	Collaborating Partners	Current Status	Target Completion	Remarks
1. Information Management	Setting up of a National Water and Climate Change Information Repository and enhancing our National Climate Service	NRE	MET, DID, JKR, ARSM, NAHRIM and related agencies	Ongoing	11MP and beyond	
2. Planning and Development	Development of a checklist of relevant CC-related policies/ plans and process of updating	NRE	MET, DID, JKR, ARSM, NAHRIM and related agencies	Ongoing	11MP and beyond	
3. International Collaboration	Collaborate with UNHCCC, IPCC Further development on collaboration with ASEAN and other East Asian countries, particularly focusing on climate change projections and Climate Change Adaptations innovation	NRE	MET, DID, JKR, ARSM, NAHRIM & related agencies	Ongoing Proposed	11MP and beyond	

Appendix 3.2.6.4. NIWRM Strategy Plan and Implementation Road Map (CCIW): Investments in Water Infrastructure

Water as a Resource							
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
1	Climate Change Adaptation	NRE (lead ministry) DID (lead agency)	KeTTHA, MOA, MPIC, KPKT, KWP, DID, JKR, JMG, MET, ARSM, NAHRIM, other related agencies, MSANG and local communities	- Establish a Regional Water Hub for Climatic Change Adaptation - Weather and climatic change forecasting - Climatic change adaptation; and - Carbon sequestration/ financing	For new projects, cost for adaptation should be incorporated in the total project cost	11MP 11MP 12MP 12MP	NAHRIM has been identified as one of the Climate Change hub by ADB. This need to be activated with policy support and added resources. Climate change adaptation should be incorporated in all current and future projects
2	Climate Change Research	NRE (lead Ministry) NAHRIM (lead agency)	KeTTHA, MOA, MOSTI, MOHE, NAHRIM, Met, RIs, IHLs and related ministries/agencies	Climate change projections, innovations in adaptations in water infrastructures design and constructions, and new plant material	0.1% of the total cost budgeted for water infrastructure development	11MP and onwards	Federal support in the form of human and financial resources are needed
3	Community programme	NRE	Related ministries, IHLs, NGOs	- Strengthen the adaptation capacities of water managers, communities and society as a whole - Improve community-based water risk management capacities	-	11MP and onwards	-

Integrated River Basin Management

Summary Brief

Dato' Ir. Lim Chow Hock FASc and
Dato' Ir. Hanapi Mohamad Noor

Defining IRBM

Integrated River Basin Management (IRBM) is the process of coordinating conservation, management and development of water, land, and related resources across sectors within a river basin in order to maximise the economic and social benefits derived from water resources in an equitable manner while preserving and where necessary, restoring the freshwater ecosystems. IRBM is also a subset of the Integrated Water Resource Management (IWRM) regime, together with associated management instruments, such as Integrated Lake Basin Management, Integrated Flood Management (IFM), Integrated Coastal Zone Management and Integrated Aquifer System Management.

Review of Current Status and Needs Assessment

ASM's initiative in preparing the Strategic Plan for Integrated River Basin Management (IRBM) in Malaysia is to complement the National Water Resources Policy and Government efforts to address the challenges of managing river basins in an integrated way. Rivers have always

played a very important role in Malaysia's development as being the source of water for domestic, industrial and agricultural uses, navigation, power generation, recreation and the environment. However, due to the rapid pace of development over the last four decades, many of our country's river systems have degraded. Issues such as siltation, deterioration of river water quality and scarcity of potable water are becoming relatively more common.

The Advisory Report on IRBM which is to be submitted to the Government in 2016 is based on the outputs from an ASM's IRBM Position Paper study report entitled, *Study on the Status and Issues on Integrated River Basin Management (IRBM) in Malaysia* that was presented in 2014 and subsequently updated with feedbacks received from a Strategic Stakeholders Consultation Workshop. The current status and issues on IRBM in Malaysia are organised and presented in the Report under the following 13 thematic focus areas:

- Policy
- Legislation
- Institution
- Finance

- Water Assessment and Allocation
- Pollution Control
- Flood Management
- Drought Management
- River Basin and Land Use Planning
- River Basin Information System
- R&D on IRBM
- River Basin Monitoring; and
- Stakeholder Participation.

The Report has identified the following to be the key limiting factors to address the river basin management issues and IRBM challenges in Malaysia. The main findings of the Report regarding the current status and issues facing groundwater management are summarised below:

(i) Lack of a uniform water law to support IRBM implementation

From the review of the current status of the enabling environment to support IRBM implementation in the country and also the key IRBM functions it can be seen that most of the elements of IRBM implementation are already in place. What is lacking is a uniform national water law to bring all the components together to support IRBM implementation and to assist the States in enacting complementary State water enactments. For example, the States' water enactments are necessary to enable local authorities to enforce water resources management compliant land use laws that are essential for effective IRBM implementation.

(ii) Lack of institutional capacity to implement IRBM implementation

From the review of the current status of

the enabling environment to support IRBM implementation in the country and also the key IRBM functions, it was also found that there is very weak institutional capacity at the State level to implement IRBM. Since water resources management is under the jurisdiction of the State, there is a need to create a State Water Resources Agency to implement the provisions in the proposed State water resources enactment.

(iii) Lack of financial support to the States to implement IRBM

Since the States have limited revenue sources, the formation of the proposed State Water Resources Agency and also implementation of the proposed State water resources enactment will need additional funding support from the Federal Government, in addition to whatever revenues that the States may get from the extraction of its water resources.

Key Recommendations

The IRBM Report recommended the following strategies to address the above three limiting factors and river basin management issues for implementation which have been categorised under three broad headers, that is Enabling Environment, Institutional Setup and Management Instruments:

(i) Enabling Environment

a) *Implementation of the NWR Policy at State-level*

NRE shall conduct State-level dialogues and workshops to create awareness of the NWR Policy so as to identify and develop the specific

framework for Federal/State level partnerships to implement the NWR Policy in each State. Arising from such a developed Federal/State level partnership framework, the State can then develop its specific state-level water resources management policy that is compliant with the NWR Policy.

Thus, NRE shall implement the strategic actions for the three strategies identified in the NWR Policy's Strategic Targets 15 and 16 as listed below:

- Identify stakeholders and clarify roles as well as responsibilities
- Develop means and measures for consultation; and
- Determine means, measures and approaches for collaborative governance.

b) *National Legislature to enact the draft NWR Law*

As part of the 2012 NWR Study, a draft NWR Law has been prepared and is currently at the consultation stage with the relevant States and stakeholders. The various policies, legal and institutional elements to support the enactment of the draft NWR Law have already been piloted, refined and put in place at the national and state-level since 1998. They can be found in the formation of the National Water Resources Council in 1998 and the States WRE of Selangor, Sabah, and Kedah. Also, States such as Selangor and Sabah have more than a decade of experience in

implementing the Sabah Water Resources Enactment (SWRE) that they enacted in 1999 and 1998, respectively. Their numbers have been increased in 2008 when Kedah enacted and subsequently implemented the Kedah SWRE. Also, the NWR Policy has been formulated in 2012 and task forces have been setup to support its compliance.

What is lacking and required now is the integration of all the various elements together, with the benefits of the lessons learned from the implementation of the SWRE by Selangor and Sabah, via the enactment of the proposed draft NWR Law and the subsequent streamlining of the institutional framework to support its implementation.

c) *State Legislatures to adopt the draft NWR Law*

With the support of the NWR Council via its decision in its 8th Meeting in 2013 that DID shall be the Secretariat to all State Water Resources Council, NRE and DID Malaysia shall work via the respective state DID Departments and relevant state government agencies to get the proposed NWR Law adopted by the respective State Legislatures, thereby complementing existing legislation already enacted in Sabah, Selangor and Kedah.

- d) *Appropriation of adequate Federal Funds and support in Key Areas that are catalytical to the sound and sustainable management of river basins*

NWRP 2012 Policy Principles stress on Water Resources Security, Water Resources Sustainability and Collaborative Governance. A strong Federal-State alliance and commitment is vital for the sound management of river basins nationally noting that natural resources belong to the States. IRBM requires the development of basin management plans for each river basin and the deployment of competent managers and support personnel who have the necessary skills and knowledge relevant to sustainable and integrated river basin management. In addition, there needs to be in place a robust and continuing research programme nationally to provide sustainable solutions to resolve the many issues and challenges faced, harnessing the best of science, technology, and innovation. Hence, within the spirit of collaborative governance, the appropriation of adequate Federal funds to support the following critical areas is a vital prerequisite for the successful implementation of IRBM nationally.

- e) *Federal funding support to the States in enacting parallel water resources legislation and related institutional structures*

The Federal Government needs to provide additional funding to the States to encourage them to adopt and implement similar water

resources law as the proposed NWR Law. As highlighted above, the effective implementation of IRBM requires the agreement and support of the respective States to support the enactment of the proposed NWR Law as State law. This is because WRM involves land management, which is a state matter under the Federal Constitution. Thus, there is a need for the Federal Government to provide the States with adequate financial support to enact their respective SWRE, creation and subsequent financing of the State WR Departments.

- f) *Federal funding for the development of IRBM Plans*

There is a need for the Federal Government to provide financial allocations for the development of IRBM Plans, which have been estimated to cost RM1 million per IRBM Plan, to facilitate the implementation of IRBM in the 189 river basins in the country, in accordance to priority.

- g) *Federal funding for IRBM-related R&D and capacity building activities*

There is also a need for funding support for R&D related to IRBM topics and to complement the IRBM-related capacity building efforts carried out by both local and international organisations such as the Malaysian Water Partnership, Malaysian Capacity Development Network, Global Environment Centre, Global Water Partnership South-East-Asia (GWP-SEA), AguaJaring SEA Network, Network for River Basin Organisations, etc.

(ii) Institutional Setup

- a) *New Federal institutional structure for water governance (Federal WR Department and State WR Departments should be created)*

A Federal and State-level Water Resources (WR) Departments (except for Selangor and Kedah) should be created to implement the provisions of the proposed Draft NWR Law and State Water Resources Enactment when they are enacted by the Federal Parliament and the respective State Assemblies. They will then provide the required institutional capacity to implement IRBM in the respective States, except for Selangor, Sabah and Kedah.

Since the enactment of the proposed draft NWR Law requires the agreement of all the States, in view of the fact that Water Resources Management (WRM) is a state matter, there is a need to address the *issues related to the “legacy” state WRM institutional framework which are holding back the enactment of the draft NWR Law*. The major institutional issue for those States that have not enacted a SWRE is the designation of the State-level agency that shall be entrusted with the responsibility for WRM functions.

In the past, WRM-related functions are considered to be part of the responsibility of the state agency that is responsible for sourcing and treating the raw water for supply to the public. However, with the

enactment of the WSIA (2006), there is a clear separation of the responsibility and functions for WRM which is related to water source, and the treatment and distribution of the treated water to the public.

Thus, after 2006, there is a need for two State-level agencies/ departments to manage the two separate sets of functions related to water. They are:

- An agency/department (the existing Badan Kawal Selia Air) that manages all aspects of treated water and coordinates its work with the Federal agency, the National Water Services Commission, that have taken over all the regulatory functions of treated water in Malaysia; and
- An agency/department (the proposed state-level WR Department, with functions and responsibilities that are similar to LUAS, LUAK, and the Sabah DID WRM Section) that manages all aspects of WRM related to catchment areas, dams and rivers, including river and groundwater resources management and thus shall be responsible for implementing IRBM within the State. This State-level agency/department will be supported in its work by the proposed Federal-level National Water Resources Department that will be set-up upon the enactment of the draft NWR Law.

The NWR Study (2012) has recommended that the Federal and State DID be reorganised and renamed as the National and State Water Resources Department, except for Selangor and Kedah, in view of the fact that the existing water resources management functions of DID already covers more than 60% of the WRM functions of the proposed WR Department in the draft NWR Law. Thus, the enactment of the draft NWR Law and subsequent enactments of the State WRM Law (based on the template State WRM Law in the draft NWR Law) will provide DID or other similar WRM agencies (e.g. those that have been created in Selangor and Kedah) with the regulatory powers to implement all of the WRM functions.

The NWRC in its eighth meeting in 2013, has also recognised DID's existing key role in WRM when it decided to assign DID to be the Secretariat to all State Water Resources Council, except for Selangor and Kedah. Also, the Secretary-General of NRE is the Chair of the Committee for the Implementation of the NWR Policy and the Director-General of DID is the Chair of the NWR Policy Implementation Task Forces.

b) *Alignment of functions and responsibilities with the NWR Policy and proposed NWR Law*

Almost all of Malaysia's water supplies are derived from river sources. Thus, it is not possible to

achieve IWRM without IRBM. The NWR Study (2012) has identified six main WRM functions that the proposed NWR Department has to fulfil to implement IWRM and IRBM. They are:

- Water Resources Assessment
- Water Resources Sustainable Integrated Management
- Water Resources Allocation and Regulation
- Water Hazard Management
- Water Resources Technical and Scientific Support; and
- Intra- and International Technical Water Resources Services.

Thus, upon the enactment of the NWR Law, the existing WRM functions of DID shall be enhanced to cover all the six WRM functions listed above.

Management Instruments

a) *Water Assessment and Allocation*

- *Ad hoc Studies on Water Resources Assessment* — DID should implement a systematic programme of water resources assessment by river basins, and the DMG should also implement a systematic programme to assess the water resources available in the country's aquifers. This will ensure that the available water resources in a river basin and in the

aquifers can be known, and compared with the water demands placed on it by various water users to ensure sustainable water resources management by river basins and aquifers, respectively.

- *Fragmented and non-uniform State legislation governing water allocation* States should adopt the proposed NWR Law where relevant when it is enacted by the Federal Legislature so that there will be some relative uniformity between the States in the application of the water allocation rules and regulations.
- *Water allocation is not guided by IWRM principles* — Water allocation in a river basin shall be guided by a developed IRBM plan. The NRE, with the endorsement of the NWRC, should prepare IRBM plans for all important river basins in the country. They shall then be used by the states to guide their water allocation decision-making. The status on the development of IRBM plans for the 189 river basins in the country that has basin area of more 80 km² is given in Appendix 3.2.7.1.

b) *Uniform Pricing Model for Water Resources*

The 2010 NWR Study has recommended that a uniform pricing and tariff regime for the water services sector be adopted after taking into consideration the funding requirements for the management activities that are required to sustain water resources and the environment in river basins. Although different States have their own supply and service providers, an equitable uniform price and tariff structure for water supply will be much easier to enforce. Thus, the Study recommends a set of guiding principles for the water pricing that takes into consideration water resources and the environment.

c) *Implement Payment for Ecosystem Services (PES) Schemes*

Experiences from around the world show that there are two main approaches for sustainable freshwater governance: the traditional way of command and control, and the use of economic or market-based instruments. The traditional way of deterring environmental degradation is to enact a law coupled with sanctions for non-compliance. Such command and control policy may be effective in controlling pollution from well-defined point sources, e.g. factories or sewage treatment plants. However, they are less effective in regulating non-point sources of pollution, such as those occurring when numerous upstream landholders dedicate their land to intensive agricultural

or other non-sustainable activities. For such cases, the downstream water pollution (or scarcity) is the result of the combination of individual actions carried out by geographically spread out and heterogeneous upstream users. Therefore, economic mechanisms and incentives, especially, are promissory conservation approach and should be implemented.

d) *Pollution Control*

- *Control of pollution from sewage effluents* — SPAN should work with the relevant State authorities to increase the sewerage coverage areas covered by IWK. There is also a need for local authorities to control the discharge of raw sewage from squatters.
- *Control of pollution from SME Manufacturing industries* — The Ministry of Trade and Industries should provide financial and technical assistance to the SME industries to comply with the effluent discharge standards.
- *Control of Sullage (Grey-water)* — All Local Authorities are required to ensure that sullage water from households are treated before they are discharged into rivers through increased enforcement and conducting awareness programme among the public. There is also a need to control the creation of the sullage at source.
- *Control of livestock farming and aquaculture* — State authorities should designate specific areas for the livestock and pig farming industry to ensure proper control of their wastewater discharges and also for disease control.
- *Pollution control from non-sanitary landfill and open dumps* — State authorities should ensure that all landfills are designed as sanitary landfills and that all open rubbish dumps are closed.
- *Pollution control of sedimentation and siltation* — The DOE and DID have implemented the requirements of Erosion and Sediment Control Plan (ESCP) as part of land development submission. The enforcement and implementation of the ESCP plan requirements will mitigate the negative impacts from non-point sources of pollution.
- *Need for review of effluent discharge standards* — DOE should review the current effluent discharge standards so that it can be in line with current acceptable international standards and availability of treatment technology.
- *Need to develop specific river pollution loading capacity standards* — DOE should develop specific river pollution loading capacity standards. This is because the assimilative capacity of a river or water body to receive and absorb the pollution load from diffuse and point sources

should be measured and determined.

e) *Flood Management*

- *Implement the IFM Approach to address the increased incidences and cost of flood damages* — The State Authorities and Town and Country Planning Department should adopt the IFM approach to address the flood management issue since it is a total flood management approach that involves using both structural flood control measures (e.g. flood walls and bunds) with equal emphasis on non-structural flood management measures (e.g. land use zoning for flood detention storage). IFM requires a proactive management of risks due to flooding, where land use management plays a central role. Thus, it is recommended that the State authorities and other relevant agencies cooperate with DID to implement IFM principles to address the flood management issue.
- *To legislate and define designated flood protection zones to address the issue of uncontrolled development in flood-prone areas* — State authorities should designate the low-lying, undeveloped areas along a river corridor, that have been identified as flood detention zones in river basin Flood Mitigation

(FM) master plan, as flood protection zones. DID should prepare for every river basin an FM master plan that highlights the undeveloped low-lying flood-prone areas where development have to be controlled.

f) *Drought Management*

- *Management of dry spell (drought-like) conditions in a river basin* — All States should have a drought management plan ranging from water stress to water shortage (drought-like conditions) to extreme conditions of long periods of no rain (drought). Thus, there is a need for monitoring plans for drought-like conditions, such as for low river flow, low rainfall, low water supply reservoir levels and to develop water supply plans that are resilient against water shortages (seasonal dry periods).
- *Reprioritise water allocation in times of drought-like conditions* — All States should include in their respective State Water Resources Enactment, the power to reprioritise water allocations under drought conditions; example LUAS enactment Sec 72. General Drought Order.
- *Development of a climate change mitigation and adaptation plan for drought-like conditions* — All States should develop a plan to include the mitigation and

adaptation for climate-change-impact, such as the risk of climate variability of rain not falling at the desired catchment locations.

g) *River Basin and Land Use Planning*

- *Uncoordinated land use control at the local authority level* — All States that do not have any Water Resources Management (WRM) law should adopt the NWR Law for enforcement of land use control at the local level to support WRM objectives. For those States that already have WRM laws, such as Selangor, Sabah, and Kedah, they are recommended to start implementing and enforcing the provisions in their WRM laws.
- *Land use control at the local authority level is not guided by a river basin plan* — The NRE, with the support of the NWRC, should develop IRBM plans for all the 189 river basins in the country which are greater than 80 km², in accordance to priority. The implementation of each of the IRBM plan's strategies should then be monitored and coordinated by a proposed River Basin Management Committees (RBMC).
- *Inadequate technical capacity to monitor the implementation of IRBM master plans* — States should set up State Water Resources Agencies

(SWRA) to monitor the implementation of IRBM plans, and also to work with the proposed Federal National Water Resources Department (NWRD) to update the developed plans.

h) *River Basin Information System*

- *Too much information, lack of useful information products* — The proposed National Water Resources Department (NWRD) should create a River Basin Information Management Unit (RB-IMU) to manage and update the developed IRBM plans, and to carry out all the necessary information management functions to support IRBM implementation by the SWRA.
- *Selection and choice of Information Management (IM) tools* — The proposed NWRD should adopt appropriate guidelines for the selection of IM tools and standards for the proposed RB-IMU.

i) *R&D on IRBM and an IRBM Pilot Project*

The NRE, with the support of the NWRC, should provide funding support for R&D related to IRBM topics and the development of Best Management Practices in IRBM implementation via a pilot IRBM project involving partnerships between multiple stakeholders, such as Federal and State stakeholders, public and private organisations. In this regard, the "River of Life

(ROL)” project for the Klang River basin that began in 2010, with a total estimated cost of RM4 billion and duration of 10 years, can be chosen as the pilot IRBM project for R&D related to IRBM in Malaysia. The IRBM Taskforce also supports the specific IRBM-related recommendations of the ASM Water R&D Taskforce.

j) *River Basin Monitoring*

DID to prepare annual river basin monitoring reports — DID should start to compile and publish annual river basin monitoring reports for the important river basins in the country. This is in line with its function as proposed in the restructured NWRD when the proposed NWR Law is enacted.

k) *Stakeholder Participation*

Need to get more public participation in river basin management — NRE should provide additional funding to DID for IRBM capacity building activities so that DID can partner and complement the IRBM-related capacity building efforts that are being carried out by both local and international organisations.

National IRBM Strategies Implementation Road Map

A multi-stakeholder meeting was held to formulate the Strategies Implementation Road Map together with strategies related to the environment from the Water Demand Management component plan study. The National IRBM Strategies Implementation Road Map which comprises of four appendices is as follows:

- (i) Appendix 3.2.7.1 (Enabling Environment)
- (ii) Appendix 3.2.7.2 (Institutional Framework)
- (iii) Appendix 3.2.7.3 (Management Instruments); and
- (iv) Appendix 3.2.7.4 (Investments in Water Infrastructure).

Appendix 3.2.7.1. NIWRM Strategy Plan and Implementation Road Map (IRBM): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	Implementation of the NWR Policy at Federal and State-level	Federal / State	NRE / SWRC / BKSA	DID / JMG / DOE / BPSP / JPBD / JPSM / NAHRIM / FRIM / LUAS	Ongoing	11MP	NWRP completed in 2012 NWRP to be reviewed by 2020
Legislation	National Legislature to enact the draft NWR Law	National	NRE	DID / SWRA	Ongoing	11MP	Draft NWR Bill prepared. NRE is organising road shows in each of the states to get buy-in from the states
	State Legislatures to adopt the draft NWR Law	State	SWRC / BKSA	DID / SWRA	-	-	Decision for adoption subject to passing of the NWR Bill in Parliament
Finance	Appropriation of adequate Federal Funds and support in Key Areas that are catalytical to the sound and sustainable management of river basins 1. Resource Assessment 2. River Basin Management Plans 3. R&D 4. Advocacy, awareness and Capacity Building 5. Rehabilitation of ecosystem (terrestrial and aquatic)	National	EPU	NRE, KeTTHA, MOA and other related ministries and agencies	Ongoing	11MP onwards	

Appendix 3.2.7.2. NIWRM Strategy Plan and Implementation Road Map (IRBM): Institutional Framework

2. INSTITUTIONAL FRAMEWORK							
Strategy	Water as a Resource						
	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
MSAN	National	NRE / KeTTHA	All states, related ministries and agencies	Coordinate Water Resources Management between Federal & States (as a platform)	Ongoing	–	Meeting once a year
Rebranding of DID as the National WR Department	National	DID	–	Management of Water Resources	Ongoing	11MP	DID currently handling 60% of the functions responsible by WR Department
Establishment of Agriculture Water Services Department	National / State	BPSP	–	Manage Agriculture Water Services	–	11MP	
Establish State Water Resources Agencies (SWRAMSANG)	State	SWRA	Related water agencies	Managing Water Resources at State Level	Ongoing	11MP	Selangor has established MSANG
Establish River Basin Management Committees	Basin	SWRA	Stakeholders at basin level	Management of Water Resources at Basin Level	–	11MP	Selangor has established RBMC chaired by State Secretary

Appendix 3.2.7.3. NIWRM Strategy Plan and Implementation Road Map (IRBM): Management Instruments

Water as a Resource						
Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
1. Information Management	River Basin Information System based on appropriate guidelines for the selection of Information Management tools and standards	DID	Water-related Agencies	Ongoing	11MP	Approved under 11MP for a centralised Water Resources Information Hub (<i>Pengurusan Maklumat Sumber Air Negara</i>)
2. Planning and Development	Water Resources Assessment and Allocation (includes the development of IRBM Plan for each river basin)	DID	Water-related Agencies	Ongoing	11MP onwards	25 out of 189 River Basins were approved for IRBM Plan in 11MP LUAS has developed IRBM Plan for Sg. Selangor (2015–2020), IRBM Plan for Sg. Langat (2015–2020) and ongoing to prepare IRBM Plan for Sg. Klang (2016–2021)
	Implementation of Integrated Flood Management	DID	Water-related Agencies	Ongoing	11MP Onwards	
	Implementation of Integrated Drought Management	DID	Water-related Agencies	Ongoing	11MP Onwards	
	Development of a climate change mitigation and adaptation plan	NRE NAHRIM	Water-related Agencies	Ongoing	11MP onwards	Under Key Action 13, Strategy four of the National Policy on Climate Change, it was mentioned that measures, including mobilising financing and technical assistance to be incorporated into areas which include water
	Preparation of annual river basin monitoring reports	DID SWRA	Water-related Agencies	Ongoing	11MP onwards	LUAS started producing river basin monitoring report since 2006 (State of River Reports (SOR)) for Sg. Selangor. LUAS has replicate for SOR Sg. Langat and Sg. Klang (2008, 2011) and for all major four river basin including Sg. Bernam (2015)

Appendix 3.2.7.3. NIWRM Strategy Plan and Implementation Road Map (IRBM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
2. Planning and Development (continued)	Increase sewerage coverage areas covered by IWK	JPP SWRA	SPAN, IWK	60.46% Coverage	To achieve 80% coverage in 11MP	
	Include land use planning to designate livestock farming, aquaculture and non-sanitary landfill	SWRA	JPV,DOF	Ongoing	11MP onwards	
3. Economic and Financial Instruments	Implement Payment for Ecosystem Services Schemes	NRE SWRA	JPSM, SWRA	Ongoing	11MP onwards	Implemented by JPSM in Kedah since 1 March 2016 LUAS Implemented PES for seven categories (aquaculture, ask from LUAS)
	Adoption of polluter pays principles	NRE KeTTHA	DOE SWRA	Ongoing	11MP onwards	Under Environmental Quality Act (EQA), DOE can only act on point source polluters only LUAS implemented the Emission or Pollutant Discharge Regulation (Selangor) 2012 for seven categories. Its include fresh water aquaculture, marine prawn aquaculture, development/earthworks, non-pig farming, pig farming, pets, mining related activities
4. Legal (Licences and Penalties)	Gazette of: a) Designated flood protection zones b) Protection of catchment areas including lakes and reservoirs c) River reserves, buffer zones d) Licensing arrangements e) Fines and penalties	NRE SWRA	JPSM, DOE, SWRA	Ongoing	11MP onwards	

Appendix 3.2.7.3. NIWRM Strategy Plan and Implementation Road Map (IRBM): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
5. Participatory Management	Formation of community groups addressing various parts of the river basin	DID BPSP SWRA	IADA, NGOs	Ongoing	11MP onwards	LUAS has implemented River Basin (Selangor, Langat , Klang) River Basin Task Force Meeting for four times/ year to discuss issues in river basin including water resources pollution
6. Research and Development	R&D on IRBM	NAHRIM HTC DID	RIs, IHLs	Ongoing	11MP onwards	
	IRBM Pilot Projects	DID	DID SWRA	Ongoing	11MP onwards	
7. Awareness, Advocacy and Capacity Building	Awareness programmes on IRBM	NRE DID SWRA	DID SWRA IHLs	Ongoing	11MP onwards	LUAS has implemented Qua-Qua programme for river water quality monitoring using physical, chemical and biological (bio-indicator) which involve students, NGO, stakeholders
8. International Collaboration	Networking and International Collaboration	NRE MOA	DID, BPSP	Ongoing	11MP onwards	ASEAN Working Group on Environment, NARBO, UNESCO, ICID and other NGOs

Appendix 3.2.7.4. NIWRM Strategy Plan and Implementation Road Map (IRBM): Investments in Water Infrastructure

Water as a Resource						
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion
1	Integrated River Basin Management	DID	SWRA, NRE, KeTTHA, MOA, related Ministries and Agencies	- Set up IRBM Training Centres - Setup River Basin Organisations for all major river basins - Watershed management/restoration programmes - Develop IRBM Plans - Develop trans-boundary water resources management		RM54 M (11MP) +RM13.3 M(12MP) for IRBM Plans LUAS has developed the IRBM Plan for Sg. Selangor, Sg. Langat and in progress to prepare the Sg. Klang IRBM Plan Discussion and workshop has been conducted with UPEN Perak to prepare the Sg. Bernam IRBM Plan and SOR
2	Flood/Drought Mitigations	DID	NRE, SWRA	- Develop and improve flood forecasting centre and technology - Structural and non-structural flood mitigation works - Develop flood sensitive designs/ solutions for commercialisation - Improve flood relief, response and recovery mechanism/ institutions - Develop drought infrastructure and alternative water sources - Develop catastrophe insurance industry		Flood Mitigation Holistic Solution (Total: RM24.5 B for 11MP, 12MP, 13MP): 11MP – RM7.62 B LUAS has implemented to use alternative water resources as ponds at Bestari Jaya to supplement the Sg. Selangor river yield

Appendix 3.2.7.4. NIWRM Strategy Plan and Implementation Road Map (IRBM): Investments in Water Infrastructure
(continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
3	Ecosystem Services	DID	NRE, relevant agencies, SWRA	• PES framework and mechanism for Malaysia • Watershed rehabilitation and management of river basins and resources • Lake brief and management plans for Malaysian lakes • Wetland restoration and management • Mangrove replanting and coastal protection		11MP 11MP 11MP 12MP 12MP	LUAS implemented integrated coastal management for coastal area in Selangor and actively organise and participate in mangrove planting programme.
4	Water Pollution Monitoring and Rehabilitation	DOE	NRE, SWRA	• River Basin Pollution Management Programme • Superfund for clean-up of polluted rivers in Malaysia • Modernising water quality monitoring network • Develop water quality modelling tools and infrastructure • Community river management programmes • Pollution control at source		11MP 11MP 11MP 12MP 12MP 11MP	Living River Project (Sg. Kelantan, Sg. Kuantan, Sg. Perak) : Total RM223.2 M LUAS ingoing to prepare the TMDL Study For Sg. Langat, River Sand Mining Impact to the River Morphology, Development for Sg. Buloh Action Plan

Appendix 3.2.7.4. NIWRM Strategy Plan and Implementation Road Map (IRBM): Investments in Water Infrastructure
(continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
5	Waterfront and Water-Sensitive City	DID	NRE, KPKT, KWP, related agencies	- Develop integrated urban water resource management - Improve stormwater management - Rainwater harvesting - Water efficient design/buildings - River of Life		11MP 11MP 11MP/12MP 12MP 11MP/12MP	River of Life (RM4.17 B): - RM3.17 B for river cleaning - RM1 B for river beautification Holistic Stormwater Management Solution (Total RM11.18 B): 11MP: RM966.7 M
6	Research Development and Innovation	NAHRIM	IHLs, RIs	- River Basin related R&D i) Research on managing water quantity, security and sustainability ii) Research on Impact of Climate Change on Water Resources for Malaysia iii) Research Programme on Hydraulic Product for Water Resources Industries		11MP onwards	RDI Funding for NAHRIM in 11MP: RM76.208 M

Agriculture Water Services for Agribusiness

Summary Brief

Datuk Ir. Mohd Adnan Mohd Nor FASc

Defining Agriculture Water Services

Agriculture Water Services (AWS) in Malaysia is widely known as “Irrigation and Drainage” for historical reasons. The introduction of a systematic approach to AWS was, in fact, the strategy in line with policies on food security and rural poverty eradication introduced in the early 1930s. These policies were in response to frequent and at times severe food shortages incidences and widespread extreme poverty in the rural areas in the late 1920s. The strategy was to form a dedicated department, the Department of Drainage and Irrigation (DID) in 1932 to plan, develop and manage drainage schemes and paddy irrigation schemes. Over the years and by the 1990s, the DID developed and provided a wide range of AWS activities covering agricultural land reclamation, agriculture drainage, irrigation, water resources development, river management, coastal protection works and flood management for the Agriculture Sector. Completing the spectrum of AWS are operations and maintenance of the systems, hydrological data and information services, applied research and capacity building for system managers and farmers. The AWS policy has always been for the Government to provide for infrastructure and services

that are beyond the capacity of the farmers or in situations that require intervention for a balanced and harmonious water management at local and regional levels. This is in the form of providing infrastructure for managing large volumes of water on an extensive scale. Farmers remain responsible for on-farm water management and support for this is provided as part of the agriculture extension services by the Department of Agriculture.

Review of Current Status and Needs Assessment

The Agriculture Sector had the privilege of a wide spectrum of AWS for over 70 years until the 2004 restructuring of water management related Government organisations that saw the move of the DID and NAHRIM from the MOA to the NRE. The net impacts in the succeeding years are concerns on the gaps and capacities of AWS for all sub-sectors of the Agriculture Sector. These include staffing capacity reduction (at Federal and State levels) for planning, design and systems operations and maintenance, training facilities and programmes for system managers and farmers, applied research in large volume water management. The gradual erosion of knowledge, skills, and

experience due to non-permanent staffing arrangements (seconded staffs from DID) at the Irrigation and Agriculture Drainage Division (responsible for AWS) is also of concern. The exception to this is the MADA and KADA Granaries that continue to have a dedicated AWS team.

Based on past experience, the need for consistent AWS level is not only for establishing yield and production increases but confidence building for farmers to sustain planting and continue investing in their farms. This at the same time have allowed for the establishment of new agriculture-based business opportunities such as agriculture service providers for farm operations and subsequently consistency of farm produce supply to the agriculture downstream industries.

Apart from the continuous food security objective, AWS has supported the changing national development objectives over the years. This began with poverty eradication followed by income generation and increases.

As the country progresses towards achieving a developed nation status, agriculture policy objective is now for wealth creation. This is reflected by the agriculture development theme that “Agriculture is a Business” and not merely agriculture as an occupation. Propelling this change is the ETP with the theme “Transiting from Agriculture of Agribusiness”.

Agriculture is one of the water sensitive industries both in terms of water needs (irrigation) and drainage. As a business then, water management needs is one of the highest risk management factors to ensure returns on investments and sustainability in agriculture. Thus a higher AWS level would be a prerequisite.

At the local, regional and even national levels, AWS would be an important component for the total water resources security management of the country for the future. 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 (Figure 3.2.8.1). With water demand management, the potential for water savings here is estimated to be 1,067 MCM or 2,927 MLD (Table 3.2.8.1), a substantial relief for the Water Supply Sector. Comparatively, water demands for non-paddy agriculture (non-paddy crops, livestock, and fishery) is relatively small but is projected to increase by 84% between 2010 and 2050 (Figure 3.2.8.2). When consolidated in a large contiguous area, the impact on water resources sustainability can be significant as in the case of the vegetable and flower industry in the Cameron Highlands. Traditionally rain-fed crops too may 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 (Table 3.2.8.2).

Whilst regional flood management, hydrological services, coastal protection works and river management would be under the purview of DID, drainage and water table management as well as farmer/agribusiness participation in water management at the agriculture scheme levels would have to be part of the AWS role.

With agriculture long being one of the suspects for non-point watercourse pollution sources, AWS would also have to be responsible for improving agriculture water discharges. This is part of the water demand management strategy for water reuse, ecosystem management, groundwater quality protection and ultimately water resources security management.

Extending the AWS range of services would be to implement climate change mitigation and adaptation measures particularly in the applications of the 3Rs (Reduce, Reuse, and Recycle). Technologies to implement these are emerging such as use of biofuels by the livestock industry, zero-discharge in the oil palm industry and water recycling by the rubber industry, water reuse in paddy irrigation and micro-irrigation for horticulture.

Overall, a strong and formal AWS institutional structure is necessary to ensure the development and sustainability of agriculture as a business as well as for national food security. At the same time, AWS will need to interact affirmatively with all other water sectors for national water security.

Approaches to Develop AWS for Agribusiness

There are four key approaches to developing agriculture water services for agribusiness for sustainability of the business itself and the industry as a whole as well as from the perspectives of water resources security and for water, energy and food security. These are the service-oriented management (SOM) approach, the risk management approach, the Integrated Water Resources Management (IWRM) approach and the Water-Energy-Food (WEF) Security approach.

The agribusiness would also have to be managed on a risk management approach that requires the business to assess and share the risks with the Government. With Agriculture, as the biggest user of water as well as returning the used water back to the system, will need to be as responsible as the other water sectors to ensure the security of water resources. This can only be achieved by the IWRM approach.

Overall, the three key elements for sustainable development of a nation are water, energy and food securities and that are interlinked and with water resources as the common denominator. Considering this is the Water-Energy-Food (WEF) Nexus approach from the perspective of water resources sustainability and security.

(i) **The Service-oriented Management Approach**

The SOM (Box 3.2.8.1) approach is based on an agreed level of service between the Supplier (Government or private entity) and the user (the business entity or farmers). This is a shift from the traditional top-down rigid approach (FAO MASSCOTTE) to one that allows for higher operational flexibility for the supplier and the user.

Investments in the systems and the service facilities can be either by the Government or the private sector or both. The Service Provider provides and delivers the service to the Users based on the agreement as to where, when, how and how much (Refer Figure 3.2.8.1.3). The User then remunerates the Service Provider. This is similar to that of the Water Supply and the Energy Sector services. The system should have some level of flexibility for the user to specify demands in relation to seasonal needs. Remuneration for AWS remains a contentious issue but this is actually already practised under the Irrigation Areas Act (1953) and Drainage Works Act (1954). Unlike the Water Supply Sector, the measurement unit is based on operating area and not on volume of water used.

Remuneration by user may not be implemented within the near future but at least there should be a system of measurement and value assessment for the AWS. The agribusiness, as in any other business and in the long-term, would have to appreciate the need to pay for services and AWS is one of them. The idea would be to prepare the business to be ready to remunerate for AWS in the future.

(ii) The Risk Management Approach

A good understanding and appreciation of risk in Agribusiness are important for system planners, managers and investors in Agribusiness. Risk is the probability (or chances) of damage or loss when vulnerable and exposed to a hazard (Figure 3.2.8.1.4). Hazard is any event that can cause damage or losses. Vulnerability is the degree of susceptibility and resilience to cope and recover when exposed to the hazard. Exposure is the presence or the position of the business when a hazard occurs.

As a business, the damage or loss is not only physical and financial terms. It could also be subjective especially in terms of loss of confidence and reputation of the business that could ultimately extend to the industry and ultimately the nation.

Agriculture is vulnerable to water hazards (e.g. floods, droughts, water logging) and exposed to the vagaries of weather (e.g. rainfall pattern, duration, and intensity). The risks involved are not only on the success of planting the crops but also on the production system as a whole such as land preparation, crop husbandry, harvesting, and transportation. Managing water hazard is, therefore, one

of the most important strategies in the risk management for agriculture. This is one of the reasons for installing an extensive primary and secondary agriculture water management facilities and networks including services in the Northern Corridor Economic Region (NCER) covering the States of Perlis, Kedah, Pulau Pinang and northern Perak (Figure 3.2.8.1.4). The density of 30 m per ha of canals, drains, and farm roads at tertiary levels have been proven to be adequate thus far.

The intensive drainage networks for tree crops and other non-paddy crops in the coastal plains were also installed for the same reason.

Exposure is managed by defining limits of the system capacity and often expressed in terms of Average Return Interval (ARI) of rainfall event. At present, the ARI for paddy irrigation is 1:5 years and drainage at 1:20 years with allowances for floods retention in the fields from 24 to 48 hours. For tree crops, the ARI applied is for 1:20 year's event with allowances for a seven-day on-farm flood retention.

Risk management is not only by structural measures but non-structural measures too. Systems vulnerability (and exposure) is managed through operations and maintenance activities, flood and drought warning systems, planting schedules (for paddy) and standard operating procedures for disaster management and recovery. Even capacity building programmes are considered as part of the non-structural measures. In addition, there are also, on a case-by-case basis, cash compensation

for relief and recovery from severe incidences leading to income losses such as due crop diseases and floods. In the 2015 flood event for example, affected farmers in the MADA granary were awarded cash relief by the Government at RM1,009.00 per ha and totalling RM100.89 million (Table 3.2.8.3).

Following the above, agribusiness need to understand the limitations of the water management systems also take on the responsibility for risk sharing and management with the system managers. In fact, the idea for transiting towards agribusiness is for the private sector to accept and able to manage higher risk levels in relation to the Government limits of investment in system infrastructure and management. In other words, the agribusiness would also need to invest in water infrastructure, participate in water management activities, plan for options for recovery such insurances and cash reserves and consider payment for higher agriculture water service levels for improved risk management.

Apart from risk management for water requirements, agribusiness also needs be responsible for environmental impacts on water resources security and the environment. This also requires risk assessment and the impact on the business. This concern is not only on local impact but also international impacts. With pressures on business and trade increasingly used by some international organisations to induce conformance to environmental conservation and protection, the agribusiness need to be aware and seen to care for the environment.

The present risk management levels now need to be reviewed to account for agriculture as a business, for wealth creation and for food security. The process will also have to account for expected return on investments in the business and the economy, climate change mitigation, impact, and adaptation, increasing limitations to available water resources for all sectors and environmental impacts on water resources.

The quantum of targets of the respective agricultural policies and especially the NKEAs and the respective EPPs (including location) would provide some general guide to risk assessment and risk management strategies for water hazards in relation to exposure and vulnerabilities.

(iii) **The Integrated Water Resources Management Approach**

Water resources and water development has always been sectoral and is now well entrenched in this country. There are a number of reasons for this. One is the different needs of sectors namely agriculture, energy, water supply and floods in terms of the timing of development phases and needs and the locality of these needs. The other is that the land and water availability far exceeded the demand when the country was at development phase. The development and management of these facilities were assigned to the respective sectoral organisations and institutions established by the Government, each with its own mandate to ensure the success of its own sector.

At development stage, the objective was to provide the quantity and accessibility to end-users. This is usually referred to as Supply Management. The main characteristics of supply development are water resources development (e.g. dams, barrages, water treatment plants) and installation of water delivery and distribution infrastructures.

At development stage, the sectoral boundaries of influence on each other were far apart, not infringing and with little impact on land and water resources. The focus was also more on quantity for use more than the quantity and quality of water returned to the system. There was also low consideration on inter-sector needs and water needs of the environment have been almost completely overlooked.

As the country develops, the sectoral development intensities increased and their boundaries expanded and began to infringe on each other. The consequences now include increasing pressures on each sector to source for common resources namely land and water to further intensify their facilities to meet their respective sectoral increasing demands. This is increasing difficult. Land and water resources are increasingly limited and present development plans are constraint by social and environmental factors. This situation is gradually increasing pressures on sectors to impose upon each other's existing resources. Defending individual boundaries is almost an instinctive reaction by sectoral institutions. However, the increasing pressure has already caused some of the sectoral boundaries to be breached. The Kerian granary irrigation system that was

almost exclusively installed for the paddy sub-sector of the Agriculture Sector, for example, has now increasingly serving the Water Supply Sector, the Tourism Sector as well as for aquaculture. Similar situation has also occurred in the MADA granary that now also serves the Water Supply and Energy (IPP) sectors.

Such pressures are typical of countries rapidly progressing toward developed status. The need is now for a systematic approach to water resources management for the sustainable sector development. This is the transformation from the Sectoral Approach to the IWRM (Box 3.2.8.2: IWRM Definition, Figure 3.2.8.6: IWRM). Within this is the need to shift from emphasis on Supply Management to Water Demand Management (Figure 3.2.8.7).

The Agriculture Sector has already acquired a long experience and knowledge in IWRM approach and practices for its water resources development and water services. Agriculture development and management has always been on a consultative and participative approach between institutions (DID, DOA, LPP) involving not only multi-disciplines but also the end-user i.e. the farmers. The Drainage Works Act (1954) has provision for the formation of a Drainage Board comprising Government representatives as well as the private sector. The IWRM approach is also reflected on the ground by institutions such as MADA, KADA and the IADAs for paddy and non-paddy crops with all of them integrating the various service and professional components under a single organisation dedicated. Since the 1980s, Water

User Groups comprising farmers were formed. This is in recognition that the success of water demand management is highly dependent on their support and active participation at planning, design, construction, capacity building and on-farm water management in harmony with systems water management. Beyond the sector, the breach of agriculture water boundaries as in the MADA granary and the Kerian granary should be accepted positively as an affirmative response of this sector for IWRM approach with other sectors.

The IWRM approach is in fact supported by the National Blue Ocean Strategy (NBOS) introduced in 2009 (Box 3.2.8.2: NBOS) for sharing of resources for development. Overall, the IWRM approach is needed as part of the strategy for National Water Resources Security that is one of the key foundations for Water, Energy and Food securities for sustainable development of a nation. The NBOS also encourages new approaches to financing investments. Extending this concept is the possibility of cross-sector financing such as Water Supply Sector investments in Agriculture Sector to increase water savings and conversion to multiuse systems in paddy irrigation that would relieve water resources for the Water Supply Sector. This could defer the need for the Water Supply sector to develop new dams for example. Another possibility is for the Agriculture and Water Supply Sectors (and even for flood management) to jointly and proportionately invest in the “investment attractive” Energy Sector development of new dams for renewable energy production but for multi-purpose use.

(iv) **The Water-Energy-Food Nexus approach**

That Malaysia has achieved a comfortable food self-sufficiency levels (SSL) is indeed commendable. However, SSL is by no means a representative indicator for food security levels. SSL refers mainly to production in the country whilst the attributes for security cover elements that include physical and economic accessibility for dietary needs and preferences. The Water-Energy-Food Security Nexus (WEF) approach is gaining interests of policy-makers and sector managers. There are several approaches to analyse these three key inter-related elements of security for sustainable development. The FAO concept for the WEF Nexus management (Refer Figure 3.2.8.8) is based on fundamental drivers and pressures that influence the impact on the WEF elements and consequential responses. An example (International Trade) is the food price crisis in 2007/2008 (Box 3.2.8.3). The impact on Malaysia was a rice supply shortage incidence in 2008. Although for only a short period (less than a month) and localised (in central Peninsular), the policy response was swift and significant. The SSL for paddy was revised to be more than 70%, four new Granaries were added to the existing eight matured granaries, and investments in paddy irrigation were increased and included for active non-granary irrigation schemes with considerations that these be added to the nearest granary.

For AWS development, the fundamental drivers and pressures of the WEF Nexus would be the Resource Security, specifically, Water Resources Security.

The conceptual model for AWS in relation to managing the WEF Security Nexus and Water Resources security is shown in Figure 3.2.8.9. In the long term, the AWS would have to be established based on similar models for the Water and Energy Sectors with defined Governance structure. The interactions between the respective sector services and Governance should be the basis for IWRM and ultimately for achieving the desired levels of Water, Energy, Food and Water Resources security.

Models to analyse these have yet to be developed for Malaysia. However, from the aspect of water resources and water management and quantity as the primary indicator for these three sectors, and from the perspective of the Agriculture Sector, there are already examples of significant issues of the Nexus at regional and local levels that require urgent attention.

One is the Northern Corridor Economic Region covering the States of Perlis, Kedah, Pulau Pinang and the northern region of Perak. This region is host to three of the 12 granaries namely MADA granary, IADA Pulau Pinang granary and IADA Kerian granary. The irrigation facilities for these are increasingly under pressure to service the water supply and the energy sector (an IPP in Kedah). Another is the Perak River basin where the Energy Sector (hydropower) is under pressure to release more of its waters for agriculture and water supply needs downstream. The case of informal (private sector initiative) irrigation for vegetable and flower industry in the Cameron Highlands is indicating severe impacts on the water supply and energy (hydropower) sectors as well as the water

resources security here and even on the agriculture sector itself.

For the drainage schemes, the drivers and pressures would be mainly from urbanisation. In many of these schemes, the expanding urban settlements have resulted in the drainage systems that were designed and operated for agriculture, have now to also service for urban drainage and flood management. The operational requirements for these are often in conflict with agriculture which requires higher levels of water table control.

A detailed consideration of these drivers and pressures could be the initial basis towards developing practical approaches and strategies for future AWS in managing the WEF Nexus.

Recommended Strategies

The ASM Report recommended the following strategies for implementation which have been categorised under three broad headers following IWRM General Framework format and guidelines:

(i) Enabling Environment

- a) *Strategy 1 — Formulate an affirmative AWS policy for agribusiness for all sub-sectors of the Agriculture Sector*

The present policies related to agriculture are silent on agriculture water services. A distinct and dedicated AWS policy would encourage a systematic approach to support the development and sustaining agribusiness. The AWS

policy is also necessary to ensure adequate water resources and water management needs for agriculture in relation to other sectors and for the WEF Nexus management and Water Security.

b) *Strategy 2 — Promulgate law, rules and regulations for AWS*

An AWS law is necessary to ensure compliance as well as to increase the sense of responsibility of agriculture water users for sustainable development. The law should incorporate governance measures as well as allowances for private sector participation in water management. It should also incorporate the possibility for Public-Private Partnership in investments and operations.

or forums for interaction with Government and private AWS providers and that these platforms are linked to the Federal and State Water Resource Councils

The success of sustainable AWS and efforts for sustainable development is ultimately dependent on the mutual support and understanding between the AWS providers and end-users. A formal platform would strengthen this relationship.

c) *Strategy 5 — Replicate the granary model for all other key production areas and commodities of each of the agriculture sub-sectors*

This model allows for efficient and effective management of resources, higher chances for returns on investments and long-term development of business opportunities related to the main agribusiness.

(ii) Institutional Framework

a) *Strategy 3 — Form a dedicated government institution for AWS with adequate capacity to support agribusiness and allow for private sector involvement as AWS Providers or Operators*

AWS development by a dedicated institution has been proven to be one of the key success factors for agriculture development. For the future, private sector involvement in AWS would allow for higher and consistent service levels for agribusiness. This is now the approach for the water supply sector and transportation sector.

b) *Strategy 4 — Formalise the formation of agriculture water user groups with special platforms*

(iii) Management Instruments

- a) *Strategy 6 — Develop agriculture water accounting and auditing tools that is harmonised with other water sectors*

The present water accounting system is too simplified and inadequate for higher levels of water management necessary for the present and future situations. There also no auditing tools for water management. For effective IWRM, a standard and harmonised water accounting and auditing tools are necessary. This is an inter-sector effort and the development process would also be a strategic effort to establish the IWRM approach and inter-sector protocols.

- b) *Strategy 7 — Develop Water-Energy-Food Security Nexus and Water Security Management Tools*

This is another inter-sector effort and towards establishing a standard procedure for water, energy, food and water resources security policy responses to prevailing and anticipated drivers and pressures.

the MOA with participation of all the EPP lead agencies and key private sector representatives from all the agriculture sub-sectors. There should also be active participation from lead agencies and key private sector representatives from the Water Supply (including sewerage), Energy and Water Resources sectors. The initiative should begin immediately so that by 2020 they are in a high-level state of readiness and that by 2025 all are ready for full implementation (Table 3.2.8.4).

The strategies from the component plan study were extracted together with the strategies from Water Demand Management into the four appendices below to form the Strategies Implementation Road Map:

- (i) Appendix 3.2.8.1 (Enabling Environment);
- (ii) Appendix 3.2.8.2 (Institutional Framework);
- (iii) Appendix 3.2.8.3 (Management Instruments); and
- (iv) Appendix 3.2.8.4 (Investments in Water Infrastructure).

Strategies Implementation Road Map with Timelines and Relevant Lead Agencies

The timeline for the agriculture EPPs under the ETP to achieve the respective objectives is by 2020. After this, the idea is for the EPPs to be sustained and with an expanded scope. They can be replicated elsewhere but be private-sector driven. Thus, implementing those strategies should be in tandem with the EPP timelines and the anticipated expansion and replications. The lead agency for implementation should be the BPSP under

REVIEW OF CURRENT STATUS AND NEEDS ASSESSMENT

Water Demand		MCM/year		%		Increase/Decrease(2010-2050)		
		2010	2050	2010	2050	MCM/year	%MCM	%(+/-)
A	Potable Water	5,277	9,291	35.7	50.9	4,014	76	15.2
B	Agriculture (a+b+c)	9,512	8,959	64.3		(55.3)	(6)	(15.2)
	a. Paddy(Irrigation)	8,266	7,205	55.9	39.5	(1,061)	(13)	(16.4)
	b. Non-paddy Crops	1,117	1,176	7.6	6.4	59		
	c. Livestock	129	578	0.9	3.2	450	349	2.3
Total Water Demand(A+B)		14,789	18,250	100.0	100.0	3,461		
	d. Fisheries*	1,287	2,898	8.7	15.9	1611	125	7.2

*Considered as Non-consumptive Demand

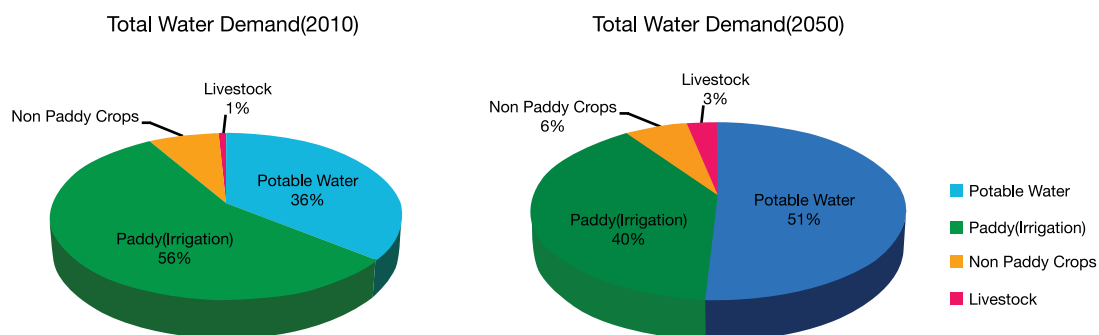


Figure 3.2.8.1. Total Water Demand for the Year of 2010 and 2050

Source: Review of National Water Resources Study (2012)

State	Unit	Year				
		2010	2020	2030	2040	2050
Total National Water Demand	MCM	14,788	17,211	17,102	17,699	18,250
Portable Water	MCM	5,277	6,796	7,663	8,529	9,291
Irrigation Paddy Cultivation	MCM	8,266	9,112	8,049	7,641	7,205
Non-paddy Crops	MCM	1,117	1,123	1,133	1,150	1,176
Livestocks	MCM	129	180	256	379	578
Total Agriculture Water Demand	MCM	9,511	10,415	9,438	9,169	8,959
Fisheries (Non-consumptive)	MCM	1,287	1,593	1,923	2,390	2,898

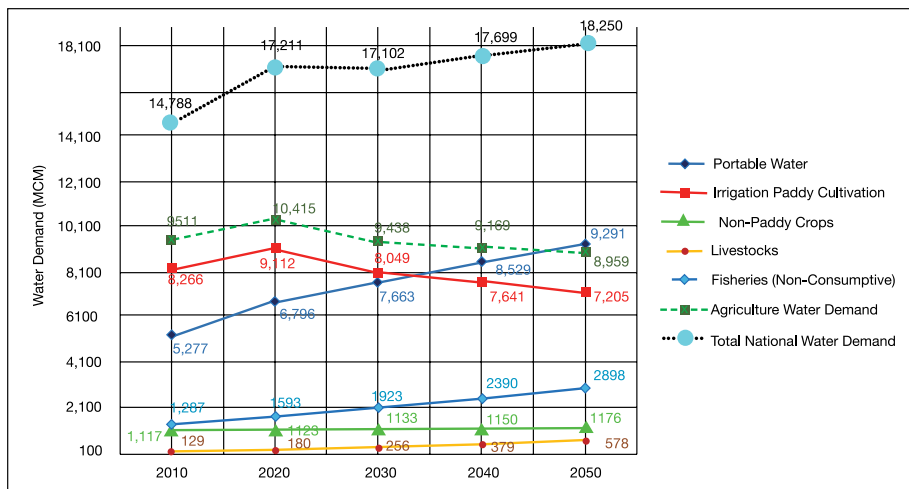


Figure 3.2.8.2. Total Water Demand for all Sectors

Source: Review of National Water Resources Study (2012)

Table 3.2.8.1. Potential Irrigation Water Savings in the Granaries

No	Granary	Basin (RBMU)	Area (Ha)	Present Efficiency %	Irrigation Water Use (MCM/year)	Target Efficiency (%)	Target Irrigation Water Use (MCM/year)	Irrigation Demand Reduction (Savings) (MCM/year)	Equivalent (MLD)	Notes
Existing Eight Granaries										
1	MADA	Kedah - Muda	96,558	70	1589	75	1483	106	291	
2	KADA	Kelantan	31,464	55	659	75	483	176	482	
3	a. Kerian IADA	Kerian	22,170	50	511	75	341	170	467	

	b. Sg. Man- ik IADA	Perak	6,278	50	145	75	96	48	132	
4	North West Selangor IADA	Bernam	19,701	50	454	75	303	151	415	
5	Pulau Pinang IADA	Muda	10,138	50	234	75	156	78	214	
6	Seberang Perak IADA	Perak	8,529	50	197	75	131	66	180	
7	Kemasin Semerak IADA	Kemasin/ Semerak	5,560	50	128	75	85	43	117	
8	KETARA (Besut) IADA	Besut	5,110	50	118	75	78	39	108	
	Total (8) granaries		205,508		4,033		3,157	877	2,405	
New four Granaries										
9	Pekan IADA	Pahang	10,937	50	252	75	168	84	230	
10	Rompin IADA	Rompin	6,173	50	142	75	95	47	130	
11	Batang Lupar IADA	Lupar	4,300	50	99	75	66	33	91	
12	Kota Belud IADA	Bongan	3,357	50	77	75	52	26	71	
	Total (4) Granaries		24,767		571		380	190	522	
	Total (12) granaries		230,275		4,604		3,537	1,067	2,927	

Source : RPM Engineers, 2015

Notes :

- Figures on water use reduction are potentials only.
- Calculation based on MADA Granary Data (Box No. 1)
- "Efficiency" refers to canal delivery efficiency and therefore not the total effectiveness (water productivity) of water use.
- The effectiveness of water use is also dependent on the efficiency of water use at the on-farm levels and includes adherence to schedules as well as effective use of rainfall.
- Present efficiency are estimates (except for MADA Granary) and derived from selected Performance Evaluation Studies ([MOA, FAO, MANCID (2013)])
- The four granaries are still at development stage and 50% efficiency assumed at start.

Table 3.2.8.2. FFB Yield in Malaysia

SITUATION	FFB Yield (T/ha/year)
Malaysian National Yield (1957-2010)	18.94
MPOB (DG's plot)	32
FELDA (Irrigated)	46
FELDA (Lysimetric with maximum inputs of fertilisers and water)	60
India (Irrigated)	32
India (Non-irrigated)	8

Source: Yusof Basiron 2014, ASM, SC2 Water and Agriculture

APPROACHES TO DEVELOP AWS FOR AGRIBUSINESS

a. The Service-oriented Management Approach

A Definition of Service-oriented Management

In the business sector, Service-oriented Management (SOM) is the operational management of service delivery within a Service-oriented Architecture (SOA). The primary objective of SOM is to provide a differentiated service delivery capability during operation, using business objectives to drive system behaviour. An SOM solution supervises and controls the delivery of a service from a service provider to a service requester. (It can also be seen as supervising and controlling the consumption of services by a requestor from a number of providers.) An SOM solution should be able to manage any service from any technology without requiring code changes, special deployment, or special development environments. SOM solutions are runtime solutions rather than development or deployment solutions.

Box 3.2.8.1. A Definition of Service-oriented Management

Source: FAO irrigation and Drainage Paper, 63

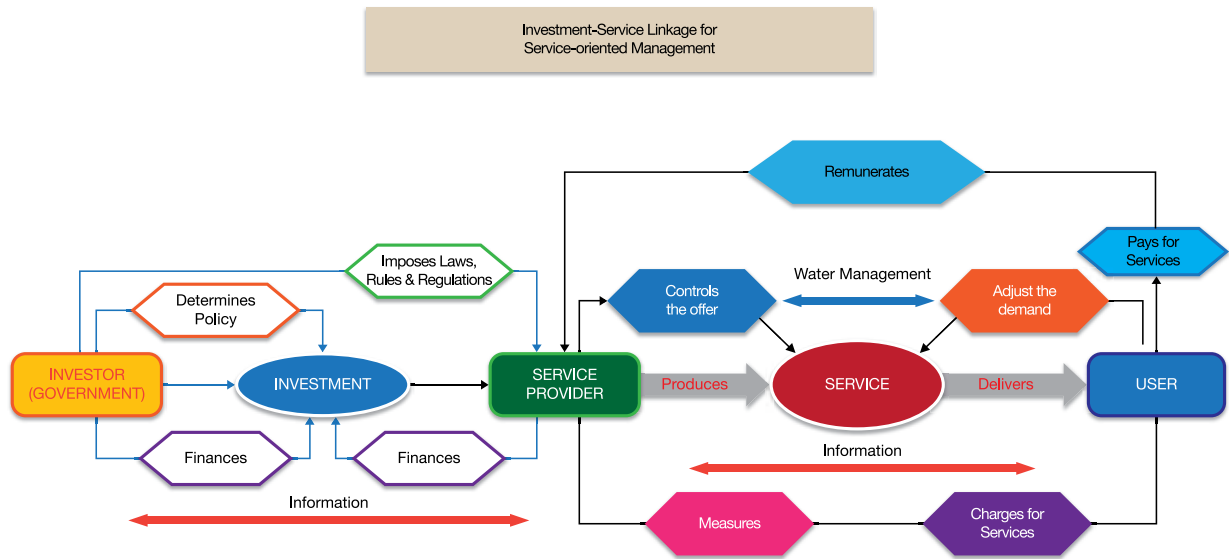
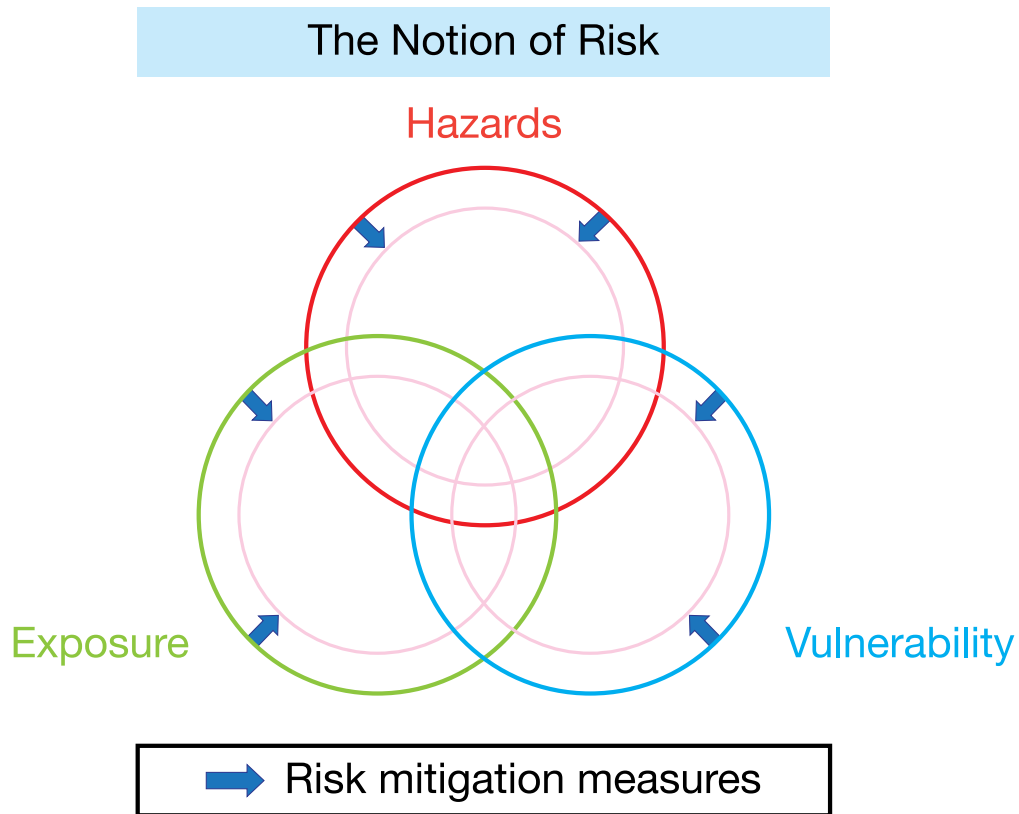


Figure 3.2.8.3. Investment-Service Linkages for Service-oriented Management (SOM)

Source: Adapted from Multiple Uses of Water Services in Large Irrigation System, Food and Agriculture Organization

b. The Risk Management Approach**Figure 3.2.8.4. Risk Mitigation Measures**

Source: Integrated Flood Management Tools Series, AFPM, ISSUE 25 (2016)

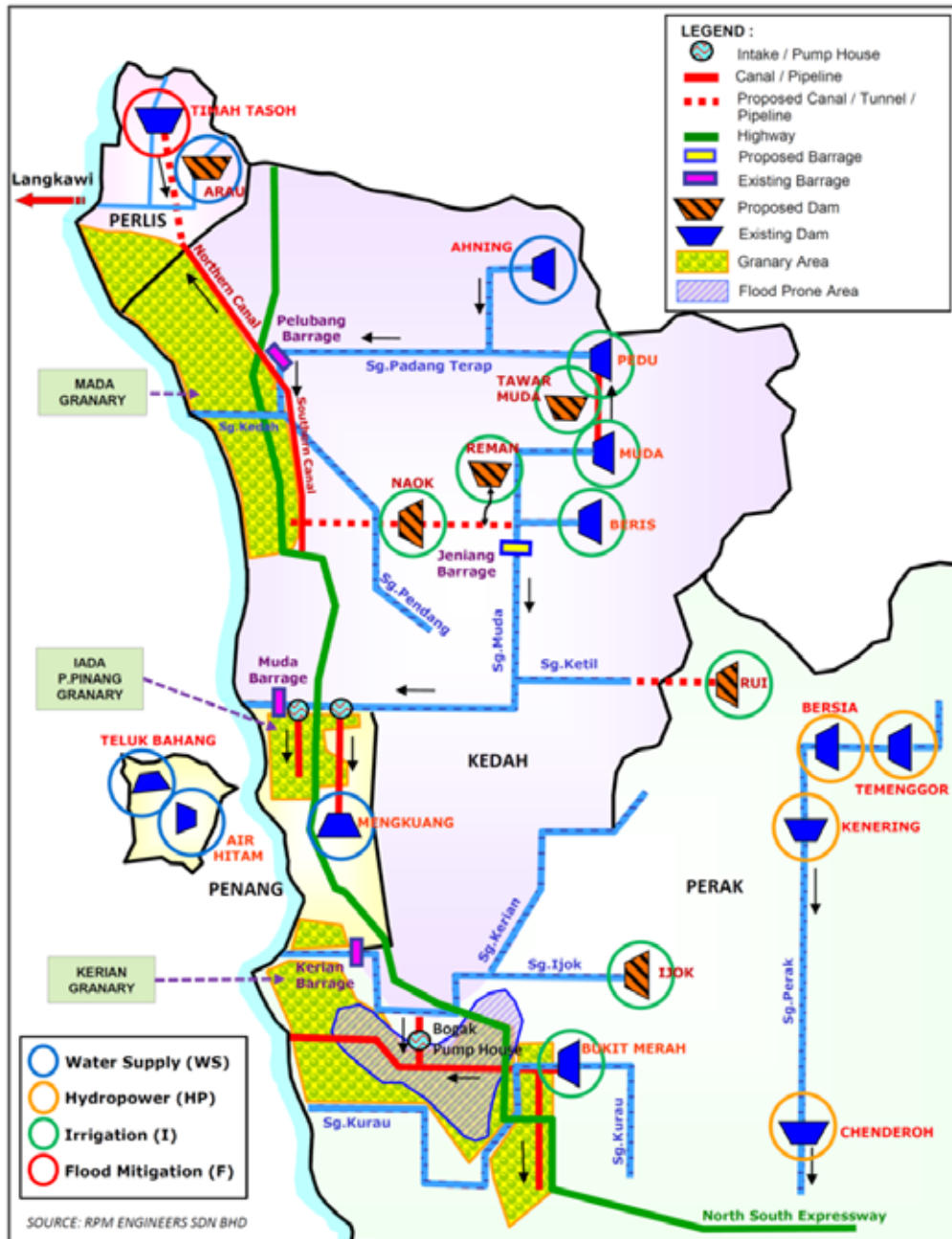


Figure 3.2.8.5. Northern Corridor Economic Region

Source: RPM Engineers (2014)

Table 3.2.8.3. Crop Damaged and Flood Aid in MADA Granary

Period	Year	Month	Frequency	Area Flooded	Impact		
					Crop Damaged	Government Aid	Average Government Aid
				(Hectare)	(Hectare)	(RM Million)	(RM/Hectare)
1970 – 1979	—	—	—	—	—	—	—
1980 – 1989 (1 times)	1988	November	1	19,449	9,857	—	—
1990 – 1999 (3 times)	1997	August	1	10,158	258	—	—
	1998	November	1	6,447	1,556	0.48	309
	1999	October	1	3,667	3,676	0.99	269
2000 – 2009 (11 times)	2000	November	1	4,111	747	0.40	535
	2003	October	1	10,445	9,295	5.37	578
	2005	December	1	19,185	18,246	39.35	2,157
	2006	October	1	9,792	8,304	4.76	573
	2007	Sept/Oct/Dec	3	6,948	5,099	5.85	1,147
	2008	Sept/Oct	2	22,366	10,119	6.78	670
	2009	Sept/Nov	2	7,345	5,256	4.51	858
2010 – 2015 (12 times)	2010	Jun/Sept/ Nov	3	37,424	26,972	23.86	885
	2011	Mar/Aug/ Sept	3	685	520	0.94	1,807
	2012	September	1	827	789	1.42	1,800
	2013	October	2	2,989	1,134	1.75	1,543
	2014	November	1	3,496	2,416	1.96	811
	2015	July/September	2	2,341	2,074	2.47	1,191
1988 – 2015 (27 times)	TOTAL	-	27	167,675	106,317	100.89	
(Avg. 1:1 year)				(Avg. 6210)	(Avg. 3938)	(Avg. RM3.74)	(Avg. RM1,009)

Source : Based on data from MADA

c. The Integrated Water Resources Management Approach

What is IWRM?



Integrated Water Resources Management is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP 2000).

Box 3.2.8.2. Integrated Water Resources Management

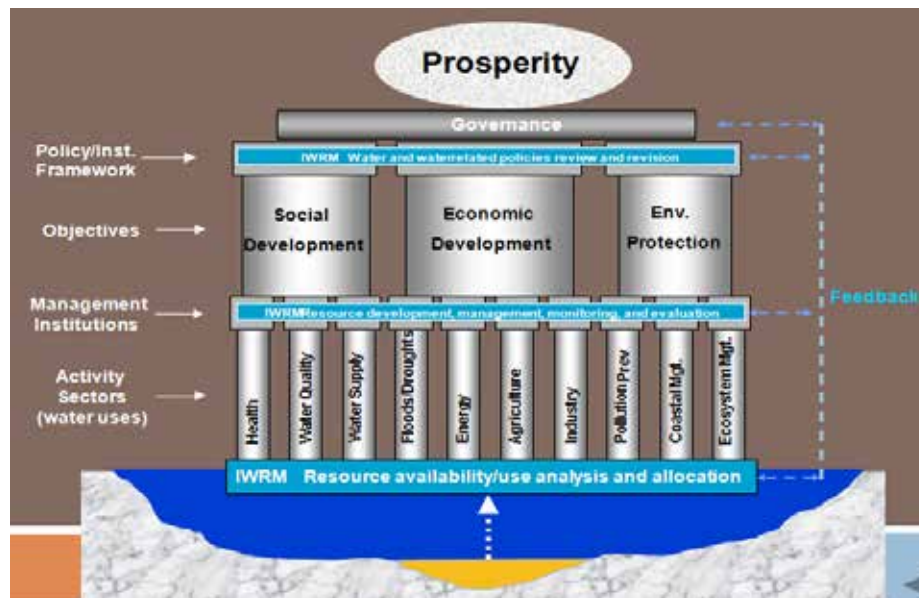


Figure 3.2.8.6. Integrated Water Resources Management Framework

Source: GWP

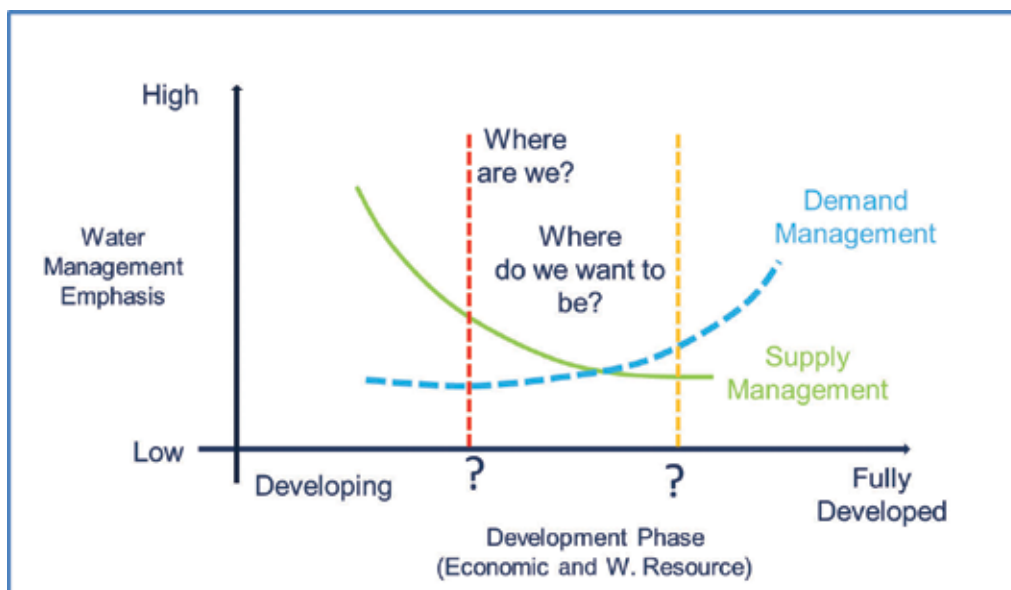


Figure 3.2.8.7. Supply Management to Water Demand Management

Source: ASM, Water Demand Management (2015)

Box 3c: What Is NBOS

The Vision of a Country with High Income and Greater Public Well-being

Malaysia is successfully moving towards achieving its goal of becoming an advanced nation by 2020, however, the nation's aspirations go beyond just achieving high-income status. Malaysia wants to be a truly advanced country where people enjoy high income along with a greater level of public well-being. To achieve this, the Malaysian Government is applying the Blue Ocean Strategy principles of high impact, low cost and rapid execution to national development through National Blue Ocean Strategy (NBOS).

The Malaysian National Development Strategy (MyNDS)

NBOS serves as the basis for the Malaysian National Development Strategy (MyNDS) which will guide the 11th Malaysia Plan from 2016 until 2020. MyNDS focuses on rapidly delivering high impact on both the capital and people economies at low cost to the government. The capital economy is about GDP growth, big businesses, large investment projects and financial markets, while the people economy is concerned with what matters most to the people, including jobs, small businesses, the cost of living, family well-being and social inclusion.

Under MyNDS, strategy formulation is being driven by creativity and innovation, and strategy execution follows the principles of fair process. By reconstructing the conventional boundaries that exist across public and private organisations, the government is creatively unlocking and multiplying national resources, while higher value is delivered to people by creatively deploying those resources to hot spots. This enables the simultaneous pursuit of high income and greater public well-being while keeping taxes low.

National Blue Ocean Strategy: Simultaneously Pursuing High Income and Greater Public Well-being

NBOS is formulated and executed through the NBOS Summit, a unique and dynamic national strategy platform which brings together ministries, agencies, all levels of government and the private sector on a voluntary basis to develop initiatives that are high impact, low cost and rapidly executed. The Summit which was launched in 2009, breaks down bureaucratic silos through fair process and is driven by the creativity of ideas, while participants receive full credit and recognition. To date more than 60 NBOS initiatives have been successfully implemented to address a wide range of economic and social issues. Through the series of NBOS initiatives implemented since 2009, the government is fulfilling the aspirations of all the Malaysians and making progress towards realising the vision of Malaysia as a country with high income and greater public well-being a reality.

Box 3.2.8.3. National Blue Ocean Strategy

d. The Water-Energy-Food Nexus approach

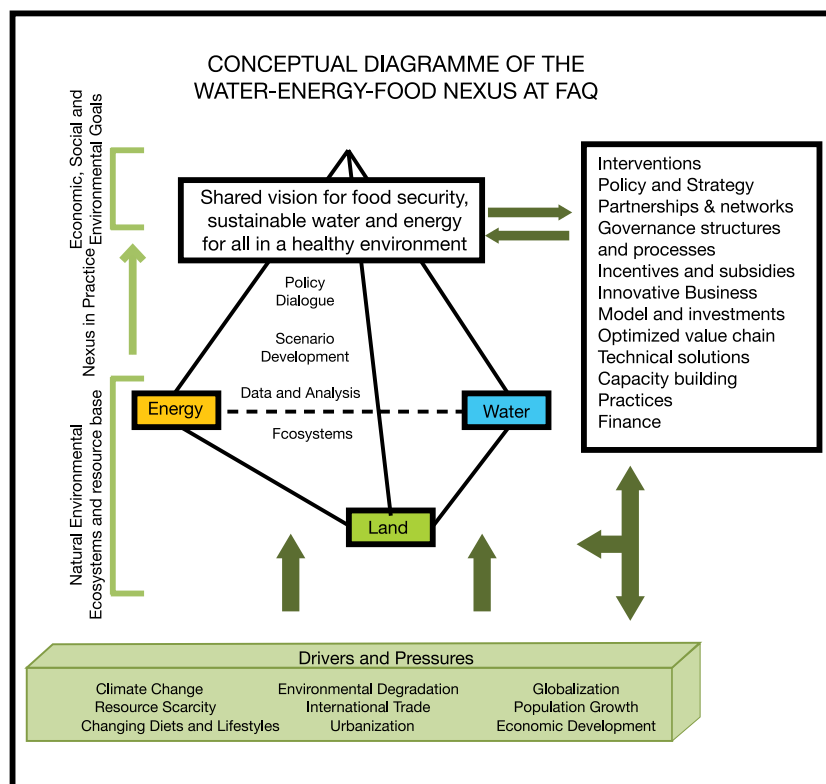


Figure 3.2.8.8. Conceptual Diagram of the Water-Energy-Food Nexus

Source: UN-FAO, World Water Forum 7 (2015)

The Water-Energy-Food Nexus

The food price crisis of 2007-2008 highlighted both the coupling of food and energy markets due to demand for biofuels and prices of fertilizers and transportation and the impact of droughts and food events on food supply and demand. The awareness of the inter-connected risks related to water, energy and food focused the attention of decision-makers on the Water-Energy-Food Nexus. In the Asia Pacific, Nexus issues are not new and indeed have long dominated water and food security issues.

Box 3.2.8.4. The Water-Energy-Food Nexus

Source: UN-FAO, World Water Forum 7 (2015)

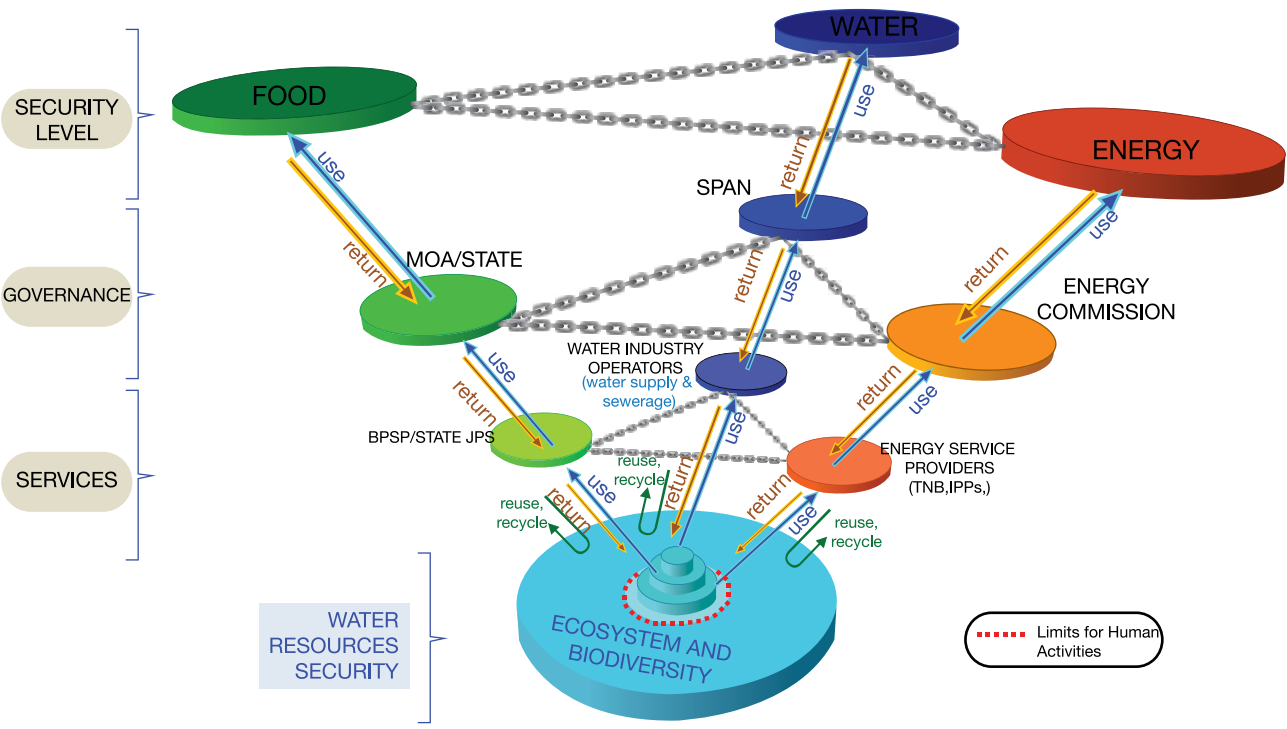


Figure 3.2.8.9. WEF Security Nexus and Water Resources Security

Source: RPM Engineers (2016)

Table 3.2.8.4. Strategies for W&A Implementation

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
A	Governance	Strategy 1	Form a dedicated Agriculture Water Services Governance Structure	Individual and commercial agriculture would require a formal Agriculture Water Services Governance system for sustainable water and agriculture development
		Strategy 2	Develop and instal a comprehensive agriculture Water Accounting, Water Auditing and Feedback System	- This is the basis of all efforts for governance, transparency, integrity in efforts to improve sustainable water management - To harmonise technical terms and definitions with all other Water Sectors (Water Supply, Sewerage and Environment) for Integrated Water Resources Management - Regular and systematic water services performance assessment is necessary
B	Policy	Strategy 3	To incorporate Agriculture Water Services Policy in Agriculture Policy and key development plans	The National Water Resources Policy covers a broad area of sectors, uses and users. A specific policy for the agriculture sector level is still necessary to ensure adequacy of water and water management to meet agriculture needs and development objectives and at the same time instil commitment for water savings and water quality management with IWRM approach for inter-sector harmonisation
		Strategy 4	All Agriculture and Agriculture Water Services development shall be based on the principals of Integrated River Basin Management approach	
		Strategy 5	To designate focused production areas and for all sub-sectors (non-paddy food crops, industrial and commodity crops, aquaculture and livestock)	- This is replicating the Granary Policy for paddy production. It allows for focused and efficient resource management and long-term confidence building with agriculture investors and producers for sustainable development and production of specific National agriculture target output - Also in line with the National Blue Ocean Strategy (NBOS) - To develop non-granary irrigation schemes designated for diversified use
		Strategy 6	Develop and apply the WEF Nexus Approach for medium and long-term decision making in relation to Agriculture Water Services and water resources needs for agriculture development	Long term WEF Nexus management would require negotiation and agreement for water resources trade-offs to balance security levels of the Nexus elements. This trade-offs can be between states, within sector and between sectors e.g. within Agriculture is accommodating aquaculture in Kerian Granary trading off water for rice; Agriculture may need to reduce irrigation areas by accelerating non-Granary areas conversion to other crops to release more water for Water Supply; Energy Sector could reduce output from hydropower dams to release more for Agriculture and Water Supply sectors and substitute energy production from other sources or locations; Agriculture could increase use of grey water and reduce freshwater use that would relief Water Supply needs

Table 3.2.8.4. Strategies for W&A Implementation (continued)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
C	Laws, Rules and Regulations			- To develop small reservoirs to increase agriculture water security - This approach would also allow for possible development of cross-sector financing models for infrastructure investments and management - This approach could also be a tool to resolve transboundary issues (as in the NCER inter-State interests and vis-à-vis National wealth and security interests) - Also in line with the National Blue Ocean Strategy (NBOS)
		Strategy 7	All Science, Technology and Innovation (STI) development for agriculture water services to be towards National ownership of the technology	- Support STI policies for increased water productivity - Wealth creation
		Strategy 8	Promulgate an Agriculture Water Services Act	- To ensure focused and high-level water services for commercial agriculture - To protect Government investments in agriculture water services infrastructure and ensure long-term commitment to production in line with Government Policies - To instil discipline of end-users to care and protect the system, practice water savings and water quality management through rules and regulations that include penalties for non-compliance - To provide for the need to form Water User Group organisations and platform for end user participation and communication - Should include the review and update of the principles and provisions of the Irrigation Areas Act and the Drainage Works Act. These Acts to be repealed subsequently - To allow and facilitate for Public-Private Partnership (PPP) financing and management approach for Agriculture Water Services such as provision for Agriculture Water Services Operators similar to that of the Water Supply Services Industry and Energy Services - To consider for the formation of the Agriculture Water Services Commission with allowance for private sector end-user representation - Should provide for the registration of all Farm Investors (Farmers) and Agriculture Services Providers and related rules and regulations for providing the services (e.g. mechanisation services, fertiliser and pesticide application services, water management services)

Table 3.2.8.4. Strategies for W&A Implementation (continued)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
D	Institution	Strategy 9	Form a dedicated Department for Agriculture Water Services to develop and manage large-scale irrigation and drainage areas for all crops (food, industrial and commodity crops) and, aquaculture and livestock. Able to implement the Governance system	- Dedicated water services Department and related institutions have proven necessary for long-term performance reliability and confidence building with investors and producers, allowed for specialist knowledge and technology acquisitions and innovations in the field as well as attract and retain talents - The role should include implementing the Governance process and procedure - The structure should also allow for private sector AWS providers - The structure should include a special climate change management unit
		Strategy 10	Establish a Centre of Excellence for Agriculture Water Services for all Crops for applied research on water and agriculture and including training and capacity programs for farmers and managers	
		Strategy 11	Establish Water User Group Dialogue Platform, Water User – Water Manager Integrated Dialogue Platform and extend this to all areas with Agriculture Water Services and establish formal linkages with the MOA and other Ministries and with State and National Water Resources Councils	Long-term relationship between Policy Makers, Water Managers and End-Users inculcates better understanding, appreciation and support in addressing current and future water issues
E	Operations and Maintenance Service Levels and Performance Assessments	Strategy 12	Develop Operations and Maintenance system based on service level delivery for end-users that include measurement indicators for cost of service with a view of remunerations for water services in the future	- Commercial farming needs reliable water service delivery as part of the management of risks in investments - Water services, as with other service such as energy and water supply, is an integral component of cost of business
F	Data and Information	Strategy 13	Integrate data and information collection and sharing system with all other Water Sector managers and end-users	- All sector water managers require common set of data for planning, design and management such as hydrology, water resources, river flow, water quality - Integrating and sharing data and information can be a cost efficient management of resources - To support the Governance system

Table 3.2.8.4. Strategies for W&A Implementation (continued)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
G	Science, Technology and Innovations (STI)	Strategy 14	Develop agriculture water accounting, water auditing and performance feedback tools and systems	- Technology ownership is one of the most important characteristics of a developed high income Nation - This should also be part of a broader strategy to create an environment that nurtures advance STI ownership for the country - Green technology is an important characteristic of Green Growth Economy - Applications of Reduce, Reuse, Recycle and Water Demand Management approaches for sustainable water management
		Strategy 15	Develop agriculture water development and management sustainability tools	
		Strategy 16	Develop advance software for agriculture water services planning, design and management tools	
		Strategy 17	Develop and instal water quantity and quality measurement and control devices for all sub-sectors of agriculture	Agriculture practices could impact non-point sources of pollution
		Strategy 18	Develop Water-Energy-Food (WEF) Nexus assessment tools	The WEF Nexus approach for sustainable water resources and water management is necessary to develop strategies for a balanced and sustainable growth at local and regional levels that ultimately contribute to National objectives and visions
		Strategy 19	Develop Water Footprint Tools for all agricultural sectors to support the WEF Nexus Assessment tools	Water use policies of the future will need to be based on precise categorisation of water – Green, Blue, Grey; to allocate water sources, water use and water quality 3R specifications for each sector. This is one of the tools for the WEF Nexus approach
		Strategy 20	Redesign existing and new Granary Irrigation Systems and components to strengthen the gravity system and to incorporate climate change adaptation needs	Existing large-scale irrigation (paddy) and drainage system (non-paddy) were not designed for Green Growth Economy and climate change management criteria
		Strategy 21	Develop planning and design criteria for non-paddy crops, livestock and aquaculture to increase yields, stabilise production, flood resilience and sustainable development	- As part of risk management in commercial farming - Climate change mitigation and adaptation measures
		Strategy 22	Develop irrigation and drainage planning and design criteria for large-scale agricultural services system for oil palm, rubber, fruits and other food crops, industrial and commodity crops, livestock and aquaculture	- Non-paddy agriculture is mainly rain-fed. For commercial enterprises, water management facilities and services are necessary for increased and stable production (risk management) - On-farm irrigation and drainage system development and installation of new irrigation technology are now on the initiatives of individual investors. There is a need of systematic agricultural services to integrate these individual systems for sustainability

Table 3.2.8.4. Strategies for W&A Implementation (continued)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
		Strategy 23	Development of Waste-to-Energy plants in the Oil Palm, Rubber and Livestock industry	- Green Technology for Green Growth Economy - For climate change mitigation and adaptation - For higher yields and environmental management - To increase water availability to within agriculture sector and other sectors
		Strategy 24	Development of Zero Discharge technologies for the Oil Palm, Rubber and Livestock industries	
		Strategy 25	Development of Water Recycling Plants in the Paddy Granaries and Rubber Industry	
		Strategy 26	Development of surface water – groundwater conjunctive use of water technologies for agriculture water management	
		Strategy 27	Develop existing Granary irrigation and drainage system network for multi-use to service all sectors and ultimately plan for this as a regional and national water management grid. All new agricultural water services system should also be planned for this	- For efficient use of existing facilities and cost as well as resource savings for new infrastructures - In line with the National Blue Ocean Strategy - To ensure stability of supply over a wider region
		Strategy 28	Develop planning and design criteria for agriculture area to be part of the local, regional and national integrated flood system	
	H	Strategy 29	Develop and implement Public-Private Partnership financing models for Agricultural Water Infrastructure and Services	- There are already Malaysian financial models in other sectors e.g. the Water Supply Services Industry, Highways, Flood Mitigation, Federal Road Maintenance, Federal Building Maintenance - PPP in Agriculture Water Services models are also in France and certain developing countries - The World Bank has developed principles and frameworks for Governance and risk sharing for PPPs
		Strategy 30	Develop cross-sector Financing Models as part of the WEF Nexus management and multi-use of existing and new infrastructure	- Water saving efforts by the Agriculture Sector are for the benefit of the Water Supply Sector else the Water Supply Sector would have to develop new resources. Thus, the cost of improved irrigation system could be finance by the Water Supply Sector - New sectorial infrastructure investments including dams and adjustments to existing infrastructure would need to account or accommodate the needs by other sector water requirements (including flood management), thus, the benefiting sectors could also contribute to the financing (e.g. multi-purpose dams) - This is also in line with the National Blue Ocean Strategy

Table 3.2.8.4. Strategies for W&A Implementation (continued)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
I	Wealth Creation	Strategy 31	Facilitate Water User Groups to increase non-farm income sources within and outside of the Agriculture Water Service Areas	- To ensure certain categories of farmers are not marginalise in economic growth - To increase GNI and job opportunities - To retain talent in Agriculture Water Services and Agriculture as a whole
		Strategy 32	Identify and encourage the development of Agriculture Water Services Providers industry and new business opportunities	
		Strategy 33	Export Agriculture Water Services industry to cooperate with countries still in the development stages of large-scale irrigation and drainage system for paddy and other non-paddy agriculture activities	One of the characteristics of a developed nation is to share knowledge and technology with other nations to support wealth creation and improve wealth creation opportunities including increasing food, energy and water security levels in developing nations
J	Public Participation	Strategy 34	Encourage the formation of Water User Groups in Agriculture Water Services Areas with formal linkages to Policy Makers and Water Managers	- Higher levels of public participation is a characteristic of developed nations and civil society for good governance - For support in addressing water issues - For development of self-governance by end-users - To prepare end-users to share cost and management of agriculture water services and facilities - Facilitate Capacity Building Programs
		Strategy 35	Planned handover of tertiary systems operations and management to WUGs	
K	Capacity Building	Strategy 36	Develop comprehensive capacity building programs for agriculture water managers and agriculture water services providers	- Capacity including skills and knowledge are critical for sustainable water management - To include integrity and transparency advocacy
		Strategy 37	Develop comprehensive capacity building programs for Water User Groups and Service Providers related or have impact on agriculture water management	Unregulated agricultural service providers could impact AWS and soil
L	International Participation and Collaboration	Strategy 38	Long-term membership and active participation in Internationally renowned organisation	- Participation in Internationally renowned organisations (e.g. ICID, FAO, IWMI) has proven mutually beneficial, to other nations & organisations and the country as a whole - Local experts have gained international recognition and reputation through active and long-term international participation and collaboration and therefore ready to export services worldwide

Appendix 3.2.8.1. NIWRM Strategy Plan and Implementation Road Map (AWS): Enabling Environment

Water for Livelihoods							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	Strategy 1 – Formulate an affirmative AWS policy for agribusiness for all sub-sectors of the Agriculture Sector	National	MOA	BPSP	Proposed	11MP	
Legislation	Strategy 2 – Promulgate law, rules and regulations for AWS	National	MOA	BPSP	Proposed	11MP	
Regulations		State	State Governments	State Secretaries	Proposed	11MP	
Finance	Strategy 3 – Develop and implement Public-Private Partnership (PPP) models for AWS	National	MOA	BPSP	Proposed	11MP	
		State	State Governments	State Secretaries	Proposed	11MP	
	Strategy 4 – Develop and Implement Service-oriented Management (SOM) system including consideration for term contracts for Operation and Maintenance.	National	State Governments	BPSP	Proposed	11MP	
		State	State Governments	State Secretaries	Proposed	11MP	
	Strategy 5 – Implement AWS projects that are integrated with projects of other sectors (namely water supply, sewerage, energy (hydroelectric) in line with the National Blue Ocean Strategy	National	MOA/ KeTTHA	BPSP/TNB/ JBA	Proposed	11MP	
		State	State Governments	State Secretaries	Proposed	11MP	

Appendix 3.2.8.2. NIWRM Strategy Plan and Implementation Road Map (AWS): Institutional Framework

Water for Livelihood							
Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Strategy 6 — Form a dedicated government institution for AWS with adequate capacity	National	BPSP	Line agencies	To support agribusiness and allow for private sector involvement as AWS Providers or Operators	Proposed	11MP	
Strategy 7 — Establish a Centre of Excellence for AWS	State	State Govern-ments	State line agencies and water operators	To undertake research and capacity building development	Proposed	11MP	
Strategy 8 — Formalise the formation of agriculture water user groups with special platforms or forums that are linked to the Federal and State Water Resource Councils	National/ State	Federal and State Govern-ments	Line agencies, local communities, NGOs	For interaction with Government and private AWS providers	Proposed	11MP and beyond	
Strategy 9 — Replicate the granary (Management) model for all other key production areas and commodities of each of the agriculture sub-sectors.	National/ State	BPSP, State Governments	MPIC, line agencies, water operators	For effective management of resources	Proposed	11MP and beyond	

Appendix 3.2.8.3. NIWRM Strategy Plan and Implementation Road Map (AWS): Management Instruments

Water for Livelihood						
Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
Planning and Development	Strategy 10 – Develop agriculture water accounting and auditing tools that is harmonised with other water sectors	BPSP	Line agencies	Proposed	11MP and beyond	
Operations and Maintenance	Strategy 11 – Develop Water-Energy-Food Security Nexus and Agriculture Water Security Management Tools	Inter-Ministry, State Governments	Line agencies, water operators, private sectors	Proposed	11MP and beyond	

Appendix 3.2.8.4. NIWRM Strategy Plan and Implementation Road Map (AWS): Investments in Water Infrastructure

Water for Livelihood						
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion
1	Agricultural Water Management	BPSP	DID, DOA, Agriculture development authorities	- Water accounting and auditing tools - Redesign of irrigation schemes for 3R and climate change 3R and climate change related projects for all agriculture sub-sectors - Water-Energy-Food Nexus tools	To be estimated by MOA	11MP – 12MP 11MP 11MP 11MP 12MP 12MP
2	Research, Development and Innovation	MOA	MOSTI, RIs, IHLs, Industry	3R and climate change management project		11MP – 12MP
3	Awareness, Advocacy and Capacity Building	MOA	NRE, KeTTHA, Agriculture development authorities, relevant line agencies	Capacity building module and programmes for water users		11MP – 12MP

National Key Priority Area (NKPA) on Water

Summary Brief

Dr Low Kwai Sim FASc

The Academy of Sciences Malaysia (ASM), an independent think tank providing strategic advice to Government on Science, Technology, and Innovation matters, has since 2008, been undertaking studies pertaining to the water sector considered strategic for the country's economic development. The studies have been overseen by a dedicated ASM Water Committee. Adopting IWRM as the central thrust and noting that Integrated Water Resources Management (IWRM) *per se* is a rather abstract concept, the Committee has for practical application in the Malaysian context, broken down IWRM into discrete subsets or sub-themes. Each of these subsets or sub-themes is then subjected to in-depth studies culminating in the preparation of a strategy plan or advisory report for consideration and adoption by the relevant authority or agency responsible for their implementation. The studies also undergo a process of strategic consultations with relevant institutional, community and private sector stakeholders.

This Advisory Paper is prepared to underpin the Malaysian Water Vision and the Malaysian Water Resources Policy to realise the crucial role of water for life, national security and the economy. On account of the importance of water as a resource and for livelihood supporting all sectors of the economy, the ASM Water Committee while taking into consideration feedback from the Performance Management Delivery Unit and other relevant stakeholders from the Ministries felt strongly that there is a compelling need to explore the concept and rationale of incepting water as a National Key Priority Area (NKPA) even though it is too late (short cut-off by 2020) to consider it for a National Key Economic Area (NKEA), as a way forward for a water secure economy in the country.

The main objective in this Advisory Paper is to develop a rationale for the water economy (resource and livelihood functions of water) as a NKPA associated with the critical complementary objectives for:

- (i) **Water security in the country:** Water is life and therefore it is necessary to ensure that there is sufficient water

for everyone, the economy and the environment. Water has to be regarded as an integral resource along the lines as for forests, fisheries and minerals with great potentials to contribute to man, the economy and societal development. Undeniably, the vagaries of climate in the form of severe droughts and floods have caused tremendous miseries to too many people in the country for which water and water security have to be re-examined more strategically and convincingly for the common good within the boundaries of federal and state legislations and the related institutional structures in the country.

- (ii) **Water economic opportunities:** There is a need to unlock the vast potential investment opportunities through more efficient use of water and promoting scientific, technological and environmental solutions for water management amongst the multi- and inter-disciplinary water sector uses in the country, as propounded through the NKPA, with least disruptions to the environment.

So far, water *per se* is not valued as an important natural resource or its economic value according to the Ministerial Stakeholders interviewed. There is a perception that water is readily available because the country has abundant rainfall and therefore, the rivers would presumably be able to provide all the water needed for livelihood and for everyone to use. Strategic planning is now needed more than ever, not only to dispel such implausible profound thinking but more importantly, to being prepared and resilient to all hazardous events due to climate change. There is a need for water resources to be managed professionally and holistically for the common good.

This Advisory Paper advocates for a new paradigm approach necessary to promote water as a NKPA, to give credence to the role of water and to enable strong scientific and technological contributions from the scientific and industrial community; and collectively that they be part of the overall Economic Transformation Programmes (ETPs) to enlarge the water economy for the benefit of the country. For a start, the Advisory Paper has provided a list of 15 large water programmes and 72 Entry Projects (EP) to underline the importance of a water NKPA.

Transformation Road Map

The transformation road map is geared to the precise objective of contributing to a need for a Water NKPA as a strategic way forward in the new paradigm approach. It recommends a number of wide-ranging Entry Point Projects, committed through appropriate policies and investments for a more water-energy-food secure nation. The 72 EPs are by no means exhaustive, but they represent a slew of diversified products for investments, and programmes for the scientific and business community to consider (see Table 3.2.9.1).

The future of water, in terms of quantity and quality, is highly uncertain, and some of this uncertainty is due to the vagaries of climatic conditions. However, the most critical factors are the key drivers of the water economy; these being escalating population growth, uncontrollable urbanisation and industrial expansion, low investments in water resources projects, indistinct allocation of water to various users, impasse reforms in water management, and nominal scientific and technological innovations, all of which impede an efficient water future.

Water can and should be developed to get more from each drop. Water underpins food and energy security, and environmental sustainability. It is integrally linked to the health and survival of ecosystems, which helps to regulate the quantity and quality of water. A sustainable water scenario will dramatically increase the amount of water that can be allocated for environmental uses, connect all households to quality piped water, achieve lower per capita domestic water consumption, and sustain food and energy production, thereby achieving greater social equity and environmental protection.

The road map is divided into 15 water sector programmes, each with their Entry Point projects (EP) (altogether 72 of them). Inserted in column 4 of Table 3.2.9.1 is the timeframe to show that some EPs can be taken up immediately (1 to 3 years) if the water agenda of having a NKPA is adopted, while others may take longer; mid-term (5 to 9 years) and long term (10 years) by the public and private sectors.

The Way Forward

There is no alternative to water resources, unlike energy, which has alternative sources. Presently, the country relies almost entirely on surface water (97%) and this situation is obviously untenable in the long run for water security reasons. At least five States are already facing water deficits that will require development of groundwater, but this source of water has yet to be developed although we have approximately 5,000 billion cubic metre (BCM) of groundwater compared to 973 BCM of annual rainfall in the country. The following are some of the steps forward:

- (i) **Place water as a national water agenda:**
A NKPA will definitively place water on

the national water agenda, imperative for economic growth and development in the country. We have already experienced both flooding and drought conditions that have ramifications on food prices, disrupt energy, constrain trade, undermine the work of authorities and even create a lot of temporary water refugees at the schools and community halls, and straining the resources of hospitals to cope with water-borne diseases. From a local flooding problem, it has escalated into a national issue and has become a major challenge in the country as shown in the December 2014 floods. Water shortage also causes a lot of hardships to a lot of people and negative impacts on tourism industry and tainting the good image of the country as experienced in the April 2014 drought. Thus, from the perspective of a sustainable water future, we need to have a national water agenda to determine all aspects of water management for the country.

- (ii) **Promote Scientific and Research Agenda on Water:** In ASM's *Mega Science 1.0 Study*, 10 recommendations were put forward for wealth creation, which can easily be taken further through the 72 EPs proposed in the table below. The *Mega Science 2.0 Study* on the Environment Sector also advocated a new thinking on water management. A separate and detailed Advisory Report entitled *Setting a National Agenda for Integrated Water Research* has also been produced by ASM to emphasise the development of a water R&D framework. However, what is more important is to ensure that our water security and water sufficiency is intact for all beneficial uses. In line with the above strategic thinking, there is also a need to achieve significant

improvements in the ecological health of rivers, lakes, floodplains, wetlands and estuaries so that the many water sources and services they provide are maintained for the present and future use. It is increasingly difficult to argue for a business as usual scenario when the stakes are so high, and yet the responses to the water management issues around resource scarcity and the environment are so low and hardly equal to the size of the problem.

food production is getting more and more expensive. Water not in the right place at the right time needed for agricultural and energy production will only increase the cost of production and hardships to the people. Added to this is the cost of energy production which drives the economy; and unfortunately, the cost of energy is also rising at the expense of the consumers. All these means that we have to strike a balance between the three legs of the nexus tripod. Water will be needed as a NKPA for the future survival of the country.

(iii) **Develop Water Benefits:** The industrial sectors will have to move beyond public relation benefits to give water sustainability a seat at the table. They are realising that the inter-related problems of food, energy and water threaten their own industrial sustainability and production and that there is business opportunity in increasing efficiency and reducing wastes in the environment. The National Water Resources Policy of 2012 is a tipping point in amplifying the need for actions to a whole new generation of water resources development programmes for securing water resources on short-, medium- and long-term horizons. There are policy directions for four core areas, namely, water resource security; water resource sustainability; partnerships; and capacity building and awareness; with a total of nine thrust areas and 69 strategic action plans, to move the water agenda forward for a water secured future.

(iv) **Water-Energy-Food Nexus:** Towards the end, we have to tie in more closely with the Water-Energy-Food Nexus. Presently, the agricultural sector is producing food at a rate that is not commensurate with population growth (we have to import more than we produce) and the cost of

Table 3.2.9.1. Summary of Entry Points for a Water NKPA

Item	Water Sectors	Entry Point Projects	Uptake
WATER AS A RESOURCE			
1	Flood/ Drought Mitigations	• Develop and improve flood forecasting centre and technology. • Structural and non-structural flood mitigation works. • Develop flood sensitive designs/ solutions for commercialisation. • Improve flood relief, response and recovery mechanism/ institutions. • Develop drought infrastructure and alternative water sources. • Develop catastrophe insurance industry.	• Immediate • Immediate • Immediate to mid-term • Immediate • Mid- to long-term • immediate
2	Integrated Water Resources Management	• Set up IWRM Training Centres. • Setup RBOs for all major river basins. • Watershed management/ restoration programmes. • Develop ILBM and IRBM • Develop trans-boundary water resources management.	• Immediate • Immediate • Immediate to mid-term • Immediate • Mid-term
3	Water Research and Innovation Cluster	• Set up a dedicated Water Research Centre. • Establish a Water Data Centre. • Developed Water Innovation and Industry Clusters. • Develop Centres of Water Excellence in Local Academia.	• Immediate • Immediate • Immediate to Mid-term • Immediate

Table 3.2.9.1. Summary of Entry Points for a Water NKPA (continued)

Item	Water Sectors	Entry Point Projects	Uptake
4	Ecosystem Services	• PES framework and mechanism for Malaysia. • Watershed rehabilitation and management of river basins and resources. • Lake brief and management plans for Malaysian lakes. • Wetland restoration and management. • Mangrove replanting and coastal protection.	• Immediate • Immediate • Immediate • Mid-term • Mid-term
5	Climatic Change Adaptation	• Establish a Regional Water Hub for Climatic Change Adaptation. • Weather and climatic change forecasting and modelling. • Climatic change adaptation. • Carbon sequestration/ financing.	• Immediate • Immediate • Mid-term • Mid-term
6	Water Pollution Monitoring and Rehabilitation	• River Basin Pollution Management Programme. • Superfund for clean-up of polluted rivers in Malaysia. • Modernising water quality monitoring network • Develop water quality modelling tools and infrastructure. • Community river management programmes. • Pollution control at source	• Immediate • Immediate • Immediate • Mid-term • Mid-term
7	Integrated Coastal Zone Management	• ICZM/ Integrated Shoreline Management Plan (ISMP) Network for all Malaysian States. • Coastal Erosion Monitoring and Rehabilitation Programme. • Estuarine and Marine Fishery Management. • Offshore Sand Mining, Reclamation and Dredging Industry. • Coral Triangle Initiative. • Trans-boundary Pollution Monitoring.	• Mid- to long- term • Mid-term • Immediate • Immediate • Mid-to long-term • Mid-term

Table 3.2.9.1. Summary of Entry Points for a Water NKPA (continued)

Item	Water Sectors	Entry Point Projects	Uptake
8	Meetings, Incentives, Conference and Exhibition (MICE)	• Develop Malaysia as Water Hub. • Develop Malaysia as MICE for water sector/ industry. • Host global/ regional/ national water events.	• Immediate • Immediate • Mid-term
9	Water-based Recreation and Tourism	• Water tourism products. • Conservation of high-value tourism areas. • Hosting of water-related events, competitions and festivals.	• Mid-term • Immediate • Immediate to Mid-term
10	Waterfront and Water-sensitive City	• Develop integrated urban water resource management. • Improve stormwater management. • Rainwater harvesting. • Water efficient design/ buildings. • River of Life.	• Immediate • Immediate • Immediate to mid-term • Mid-term • Immediate to mid-term

Table 3.2.9.1. Summary of Entry Points for a Water NKPA (continued)

Item	Water Sectors	Entry Point Projects	Uptake
WATER AS A UTILITY			
1	Water Supply Sector	• Privatisation/ corporatisation of water supply sector. • Smart water network monitoring systems for non-revenue water reduction. • Improve urban and rural water supply infrastructure. • Develop water demand management initiatives. • Inter-basin water transfer schemes. • Commercialisation of technology and expertise.	• Mid-to long-term • Immediate to mid-term • Immediate • Immediate to mid-term • Mid- to long-term • Mid to long-term
2	Water, Wastewater and Energy Sector	• Expand sewerage infrastructure and regionalisation of sewerage networks. • Waste to wealth – bio-effluent, bio-solids and biogas industry. • Potable and non-potable wastewater recycling. • Tertiary treatment for sewage to reduce eutrophication in public waters • Develop industrial wastewater treatment systems. • Zero-discharge and zero-energy for wastewater facilities. • Hydropower development. • Improving efficiency of water use in thermal power plants.	• Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term
3	Groundwater Development	• Groundwater mapping and abstraction. • Groundwater metering and licensing. • Groundwater recharge technology. • Groundwater infrastructure and service sector development.	• Immediate • Mid- to long-term • Long-term • Immediate to mid-term

Table 3.2.9.1. Summary of Entry Points for a Water NKPA (continued)

Item	Water Sectors	Entry Point Projects	Uptake
4	Agricultural Water Management	• Water metering for irrigation areas. • Improve productivity of agriculture water. • Reuse of wastewater for irrigation. • Recycling systems for aquaculture industry • Livestock waste treatment systems. • Urban Farming.	• Immediate to mid-term • Immediate • Immediate • Immediate • Mid-term • Mid-term
5	Commercial water to Shipping	• Water supply for shipping. • Navigational channel and port dredging. • Ballast water monitoring, management and treatment systems. • Urban water transport.	• Immediate • Immediate • Immediate • Immediate

ASM Mega Science Study: Water Sector

Summary Brief

P. Loganathan

Defining the Mega Science Framework Agenda — The Water Sector

The Mega Science Framework Agenda was initiated by the Academy of Sciences Malaysia in the year 2010 as a comprehensive vehicle to drive the use of science, technology, and innovation to contribute towards economic growth. Mega essentially means big, therefore the discipline of mega science implies a pervasive (broad-based), intensive (in-depth), and extensive (long period of engagement) use of science or knowledge to produce technologies, products, and services for all sectors of the economy to drive economic growth and development. It also calls for extensive investment in research activities to enhance the knowledge base for the targeted sectors. Since knowledge in marketing and finance is equally important in promoting the success of a commercial venture as compared to technical needs, it is envisaged that the mega science approach will require research to be conducted both in non-technical sectors and in traditional scientific sectors.

The mega science approach emphasises the need to strengthen R&D and strategic studies to be undertaken in the non-traditional sectors.

For example, to enhance the development of the tourism industry (service sector), dedicated R&D and strategic studies should be undertaken to generate new knowledge that will lead to the delivery of new tourism products, services and innovative strategies which will improve competitiveness of the industry. Similarly, research studies, market surveys, and financial models are proposed especially for the service sectors as the knowledge created will fulfil a need or solve a problem which eventually will generate revenue and contribute to economic growth. The mega science approach, therefore, identifies R&D and strategic studies as the key enablers to economic growth in all targeted sectors of the economy.

The Water Sector was one of five sectors targeted for the first phase of the Mega Science Framework Study (the other sectors being energy, health, agriculture and biodiversity). *The Mega Science Study for Sustained National Development in the Water Sector (2011–2050)* is a STI foresight study looking at the short-term (five years), medium-term (6–15 years) and long-term (more than 15 years) targets of growth opportunities in the sector which will contribute to the national GDP in the coming years.

The scope of the Water Study is as follows:

- To identify sources of future growth opportunities in the various areas in the water sector;
- To identify the current gaps in STI knowledge in the water (and medical) sector and how (and the areas in which) science and technology can assist in the economic growth in the water sector;
- To undertake comparative studies with other developed countries that will allow the local water sector to grow, including the identification and/or development of the policies necessary to sustain this growth;
- To identify and propose appropriate measures in the research needs in the water sector that can contribute to sustained economic growth;
- To conduct a review on international best practices of STI policies and plans for sustained national development in the water sector;
- To review and analyse Government's various policies, strategies and plans towards identifying educational (capacity building), technological, and scientific and governance (institutional framework) gaps in the Water Sector;
- To identify gaps and propose appropriate measures in the research needs in the water sector as growth potential;
- To propose an action plan for implementation; and
- To propose a roll-out plan of a water sector road-map for implementation of the Action Plan.

Review of Current Status and Needs Assessment

The data and information given in this Summary Brief is extracted from the *Mega Science Water Sector Report (2010)*.

Globally, about two-thirds of the world population will live in water-stressed catchments by 2025. However, Malaysia has abundant water resources with annual mean rainfall for Peninsular Malaysia is 2400 mm, Sabah 2360 mm and Sarawak 3830 mm. This rainfall is equivalent to 990 billion m³ volumetrically, of which 566 billion m³ becomes surface run-off and 64 billion m³ ground water, with the remainder returning to the atmosphere through evapotranspiration. This translates into an annual average water availability of about 28,400 m³ per capita. The sources of raw water for domestic, industrial and irrigation are almost entirely from surface run-off, comprising 98% of the total supply. The remaining source is from groundwater.

Water supply has been a priority issue in the development agenda for Malaysia. The budget spent for water development has risen considerably in the recent years. In the Ninth Malaysia Plan (9MP) between 2006 and 2010, the government allocated USD2.5 billion. This value is more than double than the total spent in the 8MP. Currently, there are 47 single-purpose and 16 multipurpose dams with a total storage capacity of 25 billion m³. In 2008 the water supply coverage for the urban and rural populations was 97.8% and 91.0%, respectively.

The present total water consumption in Malaysia is about 12.5 billion m³ per year or less than 3% of the available run-off. The demand is expected to increase at about 12% per year due to rapid population increase and

industrial growth. The estimated total demand for the whole country is projected to increase to 60 billion m³ per year by 2040 and 120 billion m³ per year by 2060. Irrigation will continue to be the largest consumer but its share is expected to decline as demands for domestic and industrial consumption are growing at a higher rate.

Malaysia's aquatic environmental assets are similarly abundant. About 12 % of the total 330,000 km² land area can be categorised as aquatic ecosystems. The surface freshwater ecosystems in Malaysia include the highland forests, forested wetlands and water bodies such as river systems, lakes, and reservoirs. These ecosystems provide various kinds of services such as natural resources, biodiversity, habitats for flora and fauna, water purification and flood control. There are currently six Ramsar-recognised wetlands in Malaysia.

Malaysia has more than 9,000 km of coastline with 98% of the total population living within 100 km from the coast. Malaysia has a strong potential to realise economic opportunities in marine and coastal ecosystems and has an area of continental shelf of about 336,000 km². Malaysian territorial sea (up to 12 nautical miles) is 152,000 km² with Claimed Exclusive Economic Zone of 198,000 km. Malaysia has about 1650 km² of mangrove forests that harbour 36 mangrove species and nine seagrass species. A total of 36 mangrove species can be found in the Malaysian coastal mangrove forest that covers 1,659 km² and 7% of which is protected. The total fisheries production in the year 2007 was 1.65 million tonnes of food fish with valued RM6, 467 million which comprised marine capture and aquaculture. Malaysia also produced 558 million pieces of ornamental fish valued at RM647 million.

Malaysia's water sector is not without its challenges. Some of the well-recognised issues include:

- Rapidly increasing demand on water supply to 2050 and beyond, particularly in the domestic and industry sectors;
- Localised water shortages particularly during drought periods;
- Low irrigation water use efficiency;
- Pollution affecting more than half of Malaysia's rivers;
- High rate of non-revenue water;
- Climate change increasing temperatures and rising sea-levels, as well as exacerbating climate variability and extreme events; and
- Institutional and regulatory complexity and inconsistency.

However, compared to other countries, Malaysia is likely to be exceedingly well off, resulting in increasing competitive advantage and economic development opportunities. All these opportunities will require science, technology and innovation to improve feasibility and reduce costs.

The opportunities were prioritised and a list prepared and evaluated in more detail. The prioritisation was undertaken to assess the 'potential significance of the STI opportunity to Malaysia'. The importance of each opportunity was rated very high, high, medium and low. At the same time, the long list of opportunities was separated into two categories, 'creating new wealth' and 'sustaining the resource'.

Recommendations

Based on a Risk-Return Assessment of the opportunities (Figure 3.2.10.1 and Table 3.2.10.1), the Mega Science Water Sector Report recommended the following list of opportunities for creating new wealth:

- Eco-tourism around high ecological value sites;
- Urban water-based tourism;
- Market and export high-quality water;
- Clean water for aquaculture Industry;
- Malaysian brand for domestic water purification unit;
- World leading tropical aquatic research and education;
- Knowledge export;
- Downstream water tapping;
- Rainwater harvesting; and
- Zero pollutant discharge.

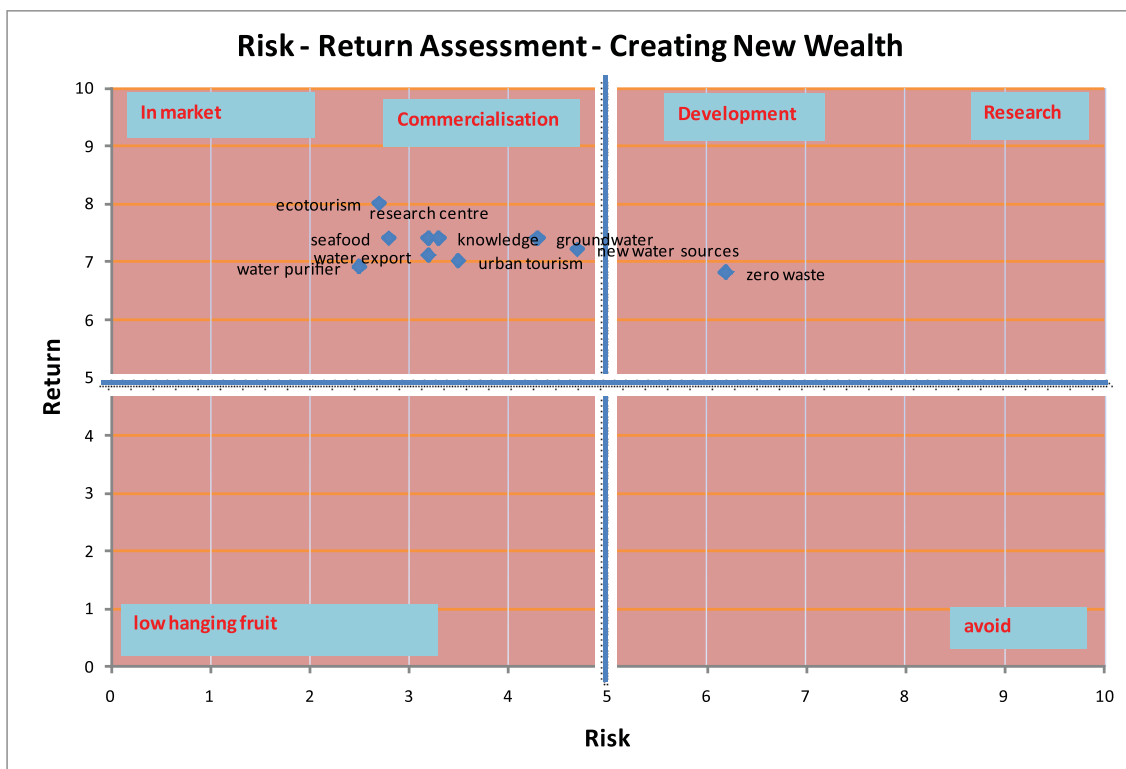


Figure 3.2.10.1. Risk-Return Assessment for Opportunities for Creating New Wealth

Table 3.2.10.1. Risk-Return Assessment for Opportunities for Creating New Wealth

Opportunity	Return	Risk	Combined risk-return and rank
Eco-tourism around high ecological value sites	8	2.7	117
Urban water-based tourism	8.4	3.5	113
Market and export high-quality water	8.1	3.3	111
Clean water for aquaculture Industry	7.4	2.8	107
Malaysian brand for domestic water purification unit	6.9	2.5	104
World leading tropical aquatic research and education	7.4	3.2	101
Knowledge export	7.4	3.3	100
Downstream Water Tapping	7.7	4.2	93
Rainwater harvesting	7.4	4.3	87
Zero pollutant discharge	6.8	6.2	61

Based on a similar Risk-Return Assessment of the opportunities (Figure 3.2.10.2 and Table 3.2.10.2), the Mega Science Water Sector Report recommended the following list of opportunities for sustaining the resource:

- Exploit groundwater further as a resource and drought protection;
- Improve flood forecasting and mitigation
- Reform Water Education Approach;
- Improve ecosystem protection from point and non-point pollution;
- Clean-up and rehabilitate waterways in highly visible locations to improve aesthetics and ecological functioning;
- Irrigation water use efficiency;
- Community (including decision-makers, planners, and politicians) values ecosystem services for Malaysia;
- Advanced water and wastewater treatment;
- Wetland ecosystem repair; and
- Water management planning to improve resilience with uncertain climate future.

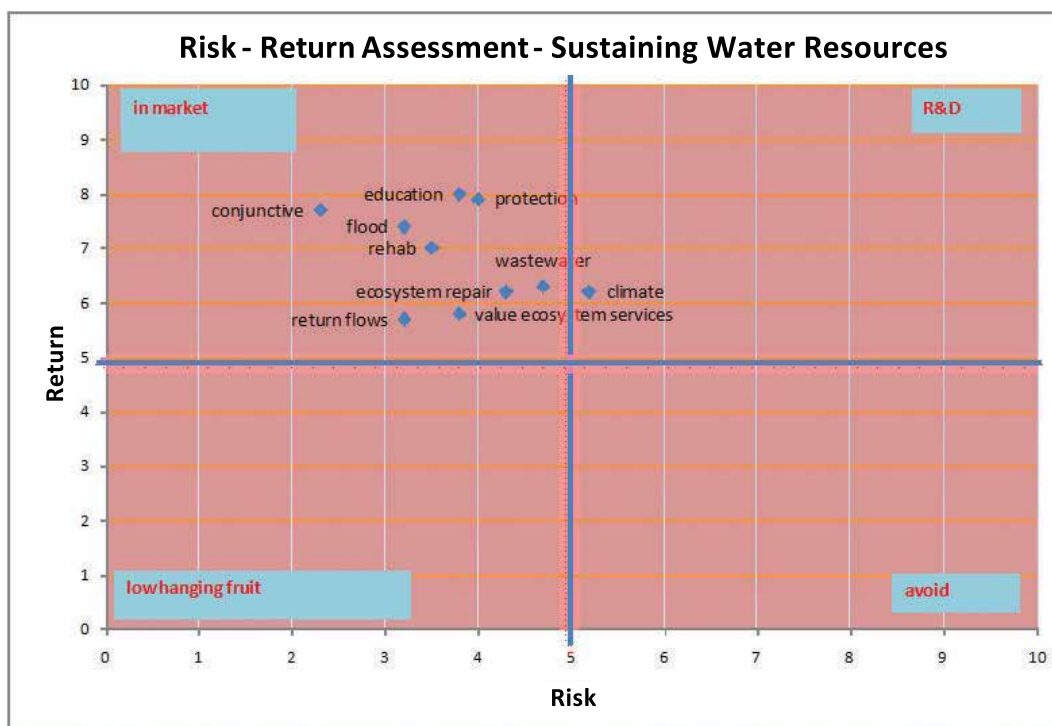


Figure 3.2.10.2. Risk-Return Matrix for Sustaining the Resource Opportunities

Table 3.2.10.2. Risk-Return Assessment for Opportunities for Sustaining the Resource

Opportunity	Return	Risk	Combined risk-return and rank
Exploit groundwater further as a resource and drought protection	7.7	2.3	119
Improve flood forecasting and mitigation	7.7	2.3	119
Reform Water Education Approach	8	3.8	102
Improve ecosystem protection from point and non-point pollution	7.9	4	98
Clean-up and rehabilitate waterways in highly visible locations to improve aesthetics and ecological functioning	7	3.5	91
Irrigation water use efficiency	5.7	3.2	79
Community (including decision-makers, planners, and politicians) values ecosystem services for Malaysia	5.8	3.8	72
Advanced water and wastewater treatment	6.3	4.7	68

Wetland ecosystem repair	6.2	4.8	65
Water management planning to improve resilience with uncertain climate future	6.2	5.2	62

Note: The details of each of the opportunities are given in the Mega Science Water Sector Report

Implementation Road Map with Timelines and Relevant Lead Agencies

This assessment is strategic in nature and additional more detailed assessments, including benefit-cost analyses, should be conducted prior to investment.

The prioritisation of the twenty STI opportunities has been based on a Risk-Return paradigm. The Malaysian government may well have other reasons for according higher priority to specific opportunities, for example, to meet social objectives.

Some of the opportunities that have a high return but a high risk are ranked lower when both return and risk are taken into

account. High return – low risk projects may be taken up or partially supported (e.g. in a joint venture) by the private sector, whereas the high return – high risk opportunities may attract greater attention from government which is willing to invest (e.g. in R&D) to reduce the risk.

It is now up to the various Ministries concerned to study the Mega Science Water Sector Report and to develop the road map and respective timelines for implementing the opportunities identified.

The opportunities identified for “Creating New Wealth” require a multi-Ministry approach with the Ministries involved as shown in Table 3.2.10.3.

Table 3.2.10.3: Ministries Responsible for Implementing “Opportunities for Wealth Creation”

No.	Opportunity	Ministry Responsible	
1.	Eco-tourism around high ecological value sites	(i)	Ministry of Natural Resources and
		(ii)	Ministry of Tourism and Culture
2.	Urban water-based tourism	(i)	Ministry of Tourism and Culture
		(ii)	Ministry of Housing and Local Government
3.	Market and export high quality water	(i)	Ministry of Natural Resources
		(ii)	Ministry of International Trade and Industry
4.	Clean water for aquaculture Industry	(i)	Ministry of Agriculture and Agro-Based Industries
5.	Malaysian brand for domestic water purification unit	(i)	Ministry of Domestic Trade and Industry
		(ii)	Ministry of Energy, Green Technology and Water

6.	World leading tropical aquatic research and education	(i)	Ministry of Science, Technology and Innovation
		(ii)	Ministry of Education
		(iii)	Ministry of Higher Education
		(iv)	Ministry of Natural Resources and Environment
7.	Knowledge export	(i)	Ministry of Higher Education
		(ii)	Ministry of Foreign Affairs
8.	Downstream Water Tapping	(i)	Ministry of Energy, Green Technology and Water
		(ii)	Ministry of Natural Resources and Environment
9.	Rainwater harvesting	(i)	Ministry of Housing and Local Government
		(ii)	Ministry of Natural Resources and Environment
10.	Zero pollutant discharge	(i)	Ministry of Natural Resources and Environment
		(ii)	Ministry of Housing and Local Government

The opportunities identified for “Sustaining the Resource” also require a multi-

Ministry approach with the Ministries involved as shown in Table 3.2.10.4.

Table 3.2.10.4. Ministries Responsible for Implementing Opportunities for “Sustaining the Resource”

No.	Opportunity	Ministry Responsible	
1.	Exploit groundwater further as a resource and drought protection	(a)	Ministry of Natural Resources
		(b)	State Governments
2.	Improve flood forecasting and mitigation	(c)	Ministry of Natural Resources and Environment
		(d)	Ministry Science, Technology and Innovation
3.	Reform Water Education Approach	(i)	Ministry of Higher Education

4.	Improve ecosystem protection from point and non-point pollution	(i) Ministry of Natural Resources and Environment (ii) Ministry of Housing and Local Government
5.	Clean-up and rehabilitate waterways in highly visible locations to improve aesthetics and ecological functioning	(i) Ministry of Housing and Local Government (ii) Ministry of Natural Resources and Environment (iii) State Governments
6.	Irrigation water use efficiency	(i) Ministry of Agriculture and Agro-Based Industries
7.	Community (including decision-makers, planners, and politicians) values ecosystem services for Malaysia	(i) Ministry of Natural Resources and Environment (ii) State Governments
8.	Advanced water and wastewater treatment	(i) Ministry of Energy, Green Technology and Water
9.	Wetland ecosystem repair	(i) Ministry of Natural Resources and Environment
10.	Water management planning to improve resilience with uncertain climate future	(i) Ministry of Natural Resources and Environment (ii) Ministry of Energy, Green Technology and Water



Appendices to Chapter 4.
Complementary Component Plan
Studies – Summary Briefs and Reports
/ Expert Reviews

Integrated Flood Management

Summary Brief

Dato' Ir. Hanapi Mohamad Noor

Defining Integrated Flood Management (IFM)

IFM is an integrated approach for an effective and efficient flood management for achieving sustainable development aiming at balancing development needs and flood risks. IFM is also a subset of the Integrated Water Resource Management (IWRM) regime, together with associated management instruments, such as Integrated River Basin Management (IRBM) and Integrated Lake Basin Management. This synthesis, with overall catchment health, is embedded in what is referred to as Integrated Flood Management (IFM).

Review of Current Status and Needs Assessment

In August 2009, DID Malaysia organised a two-day National Seminar on IFM carrying the theme "Challenges in Flood Management in Malaysia and the Way Forward".

The main findings and issues presented and discussed at the seminar and current updated data related to IFM are summarised below:

- (i) 9% or 29,800 km² of the total area of Malaysia lies in flood-prone areas where 22% of the country's total population live.
- (ii) Flood events in Malaysia varies each year with the worst ever flood hitting the east coast States of Kelantan, Terengganu, and Pahang in December 2014 forcing more than 400,000 people to be evacuated.
- (iii) Current practices in flood management is fragmented, pursued by DID for the implementation of flood mitigation projects involving rivers and main drainage system, by local authorities for the implementation of local drainage system particularly in addressing flash floods and by Agensi Pengurusan Bencana Negara (APBN), newly formed in 2015 with the responsibility of managing assistance to disaster victims. The main current practices are as follows:
 - a) **Structural measures:** Implementing flood mitigation works through the construction of river bund, flood wall, river improvement,

river diversion, pump houses, detention ponds, barrages and dams.

- b) **Flood forecasting and warning systems:** DID at the federal and state levels manage flood forecasting and warning systems for the main rivers with hydrological data inputs provided from the on-line telemetric rainfall and river water level stations. The objective is to provide early warning to the public for forecasted flood events to assist in early preparation, thus reducing loss to properties and lives.
- c) **Stormwater guidelines:** DID Malaysia has published the Storm Water Management Manual (MSMA) which was approved by the Cabinet in 2001, MSMA is a technical guide designed to assist regulators, planners, designers, developers, the public and other stakeholders towards addressing sustainable stormwater development. In May 2012, DID Malaysia launched the MSMA 2nd Edition, a simplified and updated version of the guideline.
- d) **Flood Hazard Maps:** Up to 2015, DID Malaysia has completed 33 Flood Hazard Maps designed to increase awareness of the likelihood of flooding and facilitate the identification of areas of risks of flooding and also helps prioritise mitigation and response efforts. In the 11th Malaysia Plan (2016-2020), DID has committed to carry out another six more Flood Hazard Maps at river basin level.

e) **Flood Disaster Aids Machinery:**

In 2015, the Government has established a new organisation, APBN under the Prime Minister's Department with the primary objectives of coordinating and managing aids and relief efforts to disaster victims, taking over the function.

- (iv) Major issues facing flood management are:
 - a) Fragmented policy, legal and governance framework;
 - b) Pollution;
 - c) Increase in flood mitigation cost;
 - d) Increase in flood damages and losses;
 - e) Effect of global climate change;
 - f) Inadequacy of rainfall and river water level station network for real-time data; and
 - g) Public awareness and stakeholder participation.

Recommended Strategies

The National Seminar on IFM and subsequent stakeholders' consultations recommended the following strategies for implementation which have been categorised under three broad headers following IWRM standard format and guidelines:

(i) Enabling Environment

- a) Since IFM is a subset of IWRM, it is essential that the proposed National Water Resources Act also include clauses related to flood management to ensure issues related to flood be addressed in a holistic and integrated approach. Actions to expedite the passing of the proposed Act and subsequent adoption by the States should be taken seriously.
- b) The implementation of the National Water Resources Policy which also has strategies related to hazard management should be given focus by the relevant authorities especially implementation at the State level.

(ii) Institutional Framework

- a) Similarly, in undertaking flood management on a holistic basis, the Government would have to strengthen DID which is currently given the responsibility of planning and implementing flood mitigation projects and flood Early Warning and Forecasting systems. Appropriate manpower and financial resources would have to be provided to DID to ensure effective planning and implementation of projects related to floods, both structural and non-structural approaches.
- b) At the State level, a more workable mechanism should be set up to ensure effective coordination and enforcement especially with regards to land use planning and land development affecting the implementation of IFM.

(iii) Management Instruments

- a) Future IRBM studies need to take into consideration the inclusion of IFM components. Land use plans and water management have to be combined in a synthesised plan through coordination between land management and water management authorities. Both technical and/or management solutions and remedies on floods should be put in place as action plans for the short, medium and long term.
- b) Flood Mitigation Master Plans that have been prepared very much earlier without taking into consideration the holistic and integrated approach need to be reviewed.
- c) Apart from the 33 completed Flood Hazards Maps, Action Plans for the preparation of Flood Hazard and Flood Risks Maps for the remaining river basins in flood-prone areas should be prepared by DID/NRE.
- d) Flood Warning and Forecasting Systems in flood-prone river basins should be upgraded to allow for more lead time in providing early warnings to the public considering the advancement in radar, satellite and communication technology. More on-line telemetric river water level stations and rainfall stations should be built to provide up-to-date data for flood monitoring and as inputs for flood forecasting models.

Integrated Drought Management

Summary Brief

Dato' Ir. Hanapi Mohamad Noor

Defining Integrated Drought Management (IDM)

IDM is an integrated approach for an effective and efficient drought management taking into account the risks associated with drought in all water user sectors. IDM is also a subset of the Integrated Water Resource Management (IWRM) regime, together with associated management instruments, such as Integrated River Basin Management, Integrated Flood Management and Integrated Lake Basin Management. The major output building upon this initiative shall be a coordinated national framework for drought monitoring, early warning, prediction and management, accompanied by a set of guidelines and tools for the development of drought policies and plans at federal and state levels.

Review of Current Status and Needs Assessment

In June 2003, NAHRIM organised a workshop on drought management with the following objectives:

- (i) To have a better understanding of the nature of drought and the impacts on the

country and its management in the short and long term; and

- (ii) Effecting better management of droughts in Malaysia through mitigation actions in the form of policies, activities, plans, and programmes.

The main findings and issues presented and discussed at the workshop and current updated data obtained from follow-up seminars, forums, and consultation related to IDM are summarised below:

- (i) An effect of the El Nino phenomena is the shifting of rainfall patterns over different regions of the world leading to much of South-East Asia experience dry and drought conditions in many areas from time to time.
- (ii) In 1997, 1998, 2014 and 2016, low rainfalls and hot temperature associated to El Nino event affected some parts of Malaysia such as Kuala Lumpur, Selangor, Malacca, Johor, Penang, Kedah, and Perlis.
- (iii) The low river flows and critical storage of water in several dams in 2014 coupled with increasing water demand prompted

the Selangor and Johor State Government to impose water rationing in several areas affecting more than 5 million people.

- (iv) The memorable drought events underscore the needs for a national understanding of droughts, its prediction, implication, risks and management to minimise adverse impacts to Malaysia's socio-economic activities.
- (v) Drought management tools such as the following need to be explored and implemented where appropriate:
 - a) Legislation and public policy;
 - b) Assessment programmes;
 - c) Water use conflict resolution;
 - d) Water supply augmentation;
 - e) Drought contingency plans;
 - f) Emergency response plans;
 - g) Demand reduction/water conservation programmes; and
 - h) Public awareness/education programmes.
- (vi) Major issues facing drought management are:
 - a) Fragmented policy, legal, and governance framework;
 - b) Effect of global climate change;
 - c) Increase in water demands for all sectors;
 - d) Demand management not given priority;
 - e) Inadequacy of rainfall and river-water level station network for real-time data; and
 - f) Public awareness and stakeholder participation.

Recommended Strategies

The national workshop on drought management and subsequent stakeholders' consultations recommended the following strategies for implementation which have been categorised under three broad headers following IWRM standard format and guidelines:

(i) Enabling Environment

- a) Since IDM is a subset of IWRM, it is essential that the proposed National Water Resources Act also include clauses related to flood management to ensure issues related to drought be addressed in a holistic and integrated approach. Actions to expedite the passing of the proposed act and subsequent adoption by the States should be taken seriously.
- b) The implementation of the National Water Resources Policy which also has strategies related to hazard management including drought should be given focus by the relevant authorities especially implementation at the State level.
- c) Both the Federal and State governments need to develop and agree on policy and planning for drought preparedness and mitigation across sectors.

(ii) Institutional Framework

- a) There is an urgent need to set up a new organisation or strengthen existing organisation at both Federal and State levels such as DID to play the role of supporting stakeholders by providing policy and management guidance and by sharing scientific

information, knowledge, and best practices for IDM.

- b) The organisation empowered to carry out drought management should focus on the following principles :

- To shift the focus from reactive (crisis management) to proactive measures through drought mitigation, vulnerability reduction, and preparedness;
- To integrate the vertical planning and decision-making processes at national, state, and community levels into a multi-stakeholder approach including key sectors especially domestic, industrial, agriculture and energy;
- To promote the evolution of the draught knowledge base and to establish a mechanism for sharing knowledge and providing services to stakeholders across sectors at all levels; and
- To build the capacity of various stakeholders at different levels.

- b) Need to address inadequate density and data quality of meteorological and hydrological networks.
- c) Need to develop early warning system models, with drought prediction and drought monitoring tools.
- d) Develop and implement education and awareness programmes.
- e) Need for greater focus on programmes related to water demand management and water conservation.

(iii) Management Instruments

- a) A National Master Plan on IDM needs to be developed which will include components such as assessment of water supply and demand at river basin levels, drought risk assessment, emergency response, monitoring tools, inventory resources, and identification of areas and groups at risk.

Water Quality Management

Summary Brief

Dato' Halimah Hassan

Dr Saim Suratman

Water is the essence of life. The water crisis is often associated with water quantity issues, however, water quality issues are increasingly recognised as an important contributing factor in a water crisis. In the Klang Valley for instance, during prolonged dry weather and low river flows, the water supply was frequently disrupted when water treatment plants were forced to shut down due to river pollution. There were instances when the concentration of ammoniacal nitrogen especially from untreated or partially treated sewage, and other industrial and non-industrial sources exceeded the treatment capability of existing water treatment plants.

Apart from rivers, lakes and reservoirs are also important water bodies, contributing various ecosystem services including water supply, hydropower generation, and recreational and tourism benefits. Ongoing lake issues such as eutrophication, sedimentation, and governance fragmentation also require in-depth studies on the respective lakes to identify an effective mechanism and action plan for sustainable management of the water bodies (Sharip *et al.* 2014).

Effective water quality management is vital for sustainable development. Since water is a finite and a vulnerable resource, clean water is essential to sustain life and its beneficial uses. In the framework of IWRM, Water quality management covers two main aspects namely the water quality monitoring network to ascertain the status of the water quality and detect its changes for appropriate policy interventions, and secondly to address sources of water pollution both from the point and non-point sources including wastewater management and control.

Global Trends in Water Quality

The last decades saw an improvement of surface water quality in many parts of the developed country but the opposite trend is observed in many parts of the developing world (The Global Water Quality Challenge — UNEP, 2016). This is due to pressing needs for development as the population grows, industrial and agricultural activities expanded. New factors are also threatening water quality such as increasing discharge of endocrine disruptors and dangerous chemicals.

UN-Water Annual Report (2011) stated that the major sources of water pollution are from human settlements and industrial and agricultural activities. These include unhygienic disposal and inadequate human and livestock waste, deficient management and treatment of industrial residues, inappropriate agricultural practices, and unsafe solid waste discharge. Over 80% of sewage in developing countries is discharged untreated and 300-400 million tonnes of heavy metals, solvents, toxic sludge and other waste are dumped into waters from industries.

Water Quality Monitoring Network

The Department of Environment (DOE) continuously monitors the river water, marine and groundwater quality, and reports the state of the water quality annually. River water quality stations are categorised as ambient, impact and background stations. National Water Quality Standards for Malaysia (NWQS) was established and the Water Quality Index (WQI) is used to indicate the level of pollution and the corresponding water classes and uses compared to the NWQS. Marine water quality monitoring stations are categorised into coastal, estuary and islands monitoring stations. A Marine Water Quality Index was also established.

The river WQI takes into consideration only six parameters namely dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen ($\text{NH}_3\text{-N}$), suspended solids (SS) and pH.

Based on the NWQS, the Water Classes and Uses are classed from Class I to Class V. Class I is for conservation of natural environment where practically no treatment is necessary

for water supply, Class IIA where conventional treatment is required, Class IIB for recreational use for body contact, Class III where extensive treatment is required for water supply, Class IV for Irrigation to Class V with no beneficial use at all.

There are limitations with the existing WQI calculations. Only six parameters are used in its derivation. A number of important pollutants that has an impact on health and the ecosystem such as heavy metals, herbicides, pesticides, coliform, carcinogens, and toxic elements are not addressed in the WQI formula. It is less sensitive to the changes in pollutants and is bias towards organic pollutants. The upper and lower limits of the WQI determining parameters need to be reviewed and set appropriately considering the requirement of the effluent standards, raw water quality criteria and other specific requirements. A review of the WQI method is needed to identify the main and most frequent detected pollutants to be included in its formulation and to better assess the state of the river water quality for policy intervention and informed decision making. The emerging Endocrine Disrupting Chemicals (EDCs) and potential EDCs such as pesticides, metals, additives or contaminants in food, and personal care products are known to be found in our waters and need to be looked into at the same time.

The existing DOE's concession for water quality monitoring is expiring and for the new concession, it is opportune to review and enhance the water quality monitoring network to improve inputs for informed decision making. It is also appropriate to establish an interactive Data Centre within the DOE, to enhance its readiness to analyse data in terms of on-line and real-time relay including providing trigger points and early warning system to support the IWRM approach.

Current State of Water Quality in Malaysia

Based on the *Environmental Quality Report 2014*, out of 473 rivers monitored, 244 (52%) were found to be clean, 186 rivers (39%) slightly polluted and 43 rivers (9%) polluted. This shows that the river water quality has declined in 2014 compared to 2013, where the percentage of clean rivers were 58%, slightly polluted rivers at 37% and polluted rivers at 5%.

Consistent with the trend as in previous years, the BOD and $\text{NH}_3\text{-N}$ remained to be significant pollutants in terms of river pollution and both the trend of its sub-index over the last four years had deteriorated and is worrying. Utilising NWQS, out of the 43 polluted rivers, 25 rivers are classified as Class III, 18 rivers as Class IV. In terms of BOD sub index, 10 rivers were classified as Class IV and 33 rivers as Class V. Where else in terms of $\text{NH}_3\text{-N}$ sub index, 14 rivers are classified as Class IV and 24 as Class V.

In terms of SS sub-index, the number of clean rivers has increased from 351 rivers in 2013 to 367 rivers in 2014. The trend in the improvement of the SS sub-index can be attributed to continuous efforts particularly from DOE and Drainage and Irrigation Department (DID) in the control of earthworks and land clearing. The DOE had introduced an EIA-ESC Improvement package in 2011 (*Bahagian Penilaian, Jabatan Alam Sekitar 2011*). Measures included guidance documents for addressing erosion and sediment control aspects in environmental impact assessments (EIA), environmental management plans and soil erosion and sediment control plans (ESCP). DOE also puts a requirement for certification and competency and engineers designing ESCP must be a certified professional in erosion and sediment control. In addition,

developers must engage environmental officers and a third party environmental auditors who are certified erosion, sediment and stormwater inspectors. This requirement is only for the EIA projects whose earthworks are under the jurisdiction of the DOE. Non-EIA projects at present are not subjected to the requirement for a competency and certification programme, and are recommended to be so.

Source of Pollution

The sources of water pollution can be categorised into point and non-point sources. In 2014, based on DOE's inventory, 1,488,848 water pollution point sources were identified. These include 3,355 manufacturing industries, 10,795 sewage treatment plants, 1,276,195 individual septic tanks, 3,628 communal septic tank, 755 animal farms (pig farming), 531 agro-based industries, 879 wet markets, and 192,710 food services establishments.

The estimated BOD_5 load in 2014 from point sources is 762 tonnes per day, a 0.5% increase compared to 758 tonnes per day in 2013. Sewage remained the largest contributor with a total load of 278 tonnes/day followed by the animal farm (pig farming) at 215 tonnes per day. The estimated total of ammonical nitrogen load in 2014 is 238 tonnes per day, sewage being the largest contributor with a total load of 184 tonnes per day (77%) followed by animal farm (pig farms), (11%) agro-based industries (7%), food services establishments (3%), and wet markets (0.14%). The estimate of SS from point sources in 2014 is 1,170 tonnes per day with animal farming (pig farming) being the largest contributor (38%), followed by sewage (30%), food establishments (21%), agro-based industries 4%, and wet markets (1%).

In DOE's inventory of sources, non-point sources namely from land clearing and earthworks, agricultural activities, sand mining, sullage, commercial areas, quarries, forestry, transport and others are not estimated. In earthworks related activities, ESCPs are either non-existence or not effective and in most instances, the Best Management Practices for erosion and sediment control are not in place. Uncontrolled agricultural activities especially in highlands and areas with a steep slope as in Lojing, Kelantan, and Cameron Highlands, Pahang contributed to the high content of SS in waterways. Riparian reserves and buffers should be preserved and restored.

A huge contribution from non-industrial sources including household sullage, wastewater from food services establishment, restaurants, and wet markets which at present is under the jurisdiction of the local authorities need to be addressed effectively. Analysis showed that the deterioration of river water quality was mainly due to the discharge of sewage and domestic wastewater, animal farming, land clearing and earth works agricultural activities and manufacturing industries (Rosnani & Lee 2004). However, domestic wastewater, surface runoff from urban areas, discharges from restaurants, wet markets and food courts, pollution from agricultural and land clearing activities, suspended solids and silt from earth works and sand mining which are considered as non-point sources and comprised the major contribution to river pollution are currently not subject to the Environmental Quality Act 1974.

Findings from various river rehabilitation studies conducted by DOE under the River Pollution Prevention and Water Quality Improvement Programmes namely Sg. Sepetang, Sg. Merbok and Sg. Linggi estimated that about 38.8 to 88% of BOD load were

contributed by non-point sources. As for the Sg. Langat, Sg. Segget, Sg. Tebrau, Sg. Linggi, Sg. Sepetang and Sg. Merbok, the contribution from industries, which are regarded as point sources made up of only 10–26 % out of the total number of pollution sources (Zulkifli *et al.* 2012). This means that the pollution sources currently regulated by DOE, i.e. industries, are not the major contributor to the river pollution in most of the river basins. Thus, some means of control need to be instituted in order to address pollution from the major pollution sources currently not subject to the Environmental Quality Act, 1974 both non-point sources and point sources from non-industrial activities.

The Sg. Linggi studies, 2007 also showed that food services establishments (FSEs) and wet markets posed significant contribution towards river pollution due to its highly concentrated organics in discharges. *E. coli* were also found to be high in discharges from food courts. These sources used to be categorised as non-point sources are in fact point sources and can be controlled at source through installation and maintenance with an efficient fat, oil, and grease (FOG) trap. Unlike in developed countries, such discharges may not have pre-treatment using FOG traps for FSEs and effluent treatment plants for the wet markets, instead their discharges are directed into drains and watercourses. These discharges should instead be channelled into sewerage systems.

A survey conducted by DOE with Majlis Bandaraya Ipoh and Chemistry Department in 2012 (Zulkifli *et al.* 2012) also shows that most FSEs used a simple often undersized FOG trap. The FOG traps are often not functioning due to lack of maintenance.

Enforcement of Pollution Source

The three-tiered federal, state and local government system posed a considerable challenge to an effective enforcement of pollution sources. Based on Schedule 9 of the Federal Constitution the state governments has jurisdiction over natural resources including water, land, forest and mines. The exploitation of these natural resources is an important source of much-needed financial revenue. Sometimes environmental sensitive areas are opened or insufficient buffers are provided for the much-needed infrastructure and development projects. A coordinated action within and between the three-tiered governments and the agencies involved is crucial. The exploitation of natural resources needed to be regulated and pollution control in place. The key point is not to prohibit but to regulate these activities with BMPs in place. Pollution from the bauxite mining in Kuantan, Pahang is an example where pollution control and BMPs are totally absent. It is also the case where many agencies at the federal, states, and local government are involved but not coordinated.

In order to manage the water quality from these various point and non-point sources, not only all these relevant agencies need to be coordinated, pollution needs to be controlled at source under each of their jurisdiction. The project proponents must bear the cost of pollution control in line with the Polluters Pay Principle. The responsibility and pollution control cost will then be distributed. The cost for pollution prevention will certainly be less than the cost for rehabilitation and clean up. The cost for rehabilitation and cleanup will end up with the government. Existing uniform effluent discharge standards may need to be reviewed to include measures to control the pollution load allowed for designated water bodies and the

total maximum daily load (TMDL) assigned to ascertain beneficial uses of any stretch of water bodies. The need to develop effluent discharge standards, according to the carrying capacity of the river or stream is certainly very challenging but needs to be done.

TMDL is a regulatory term describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards and is directly associated with designated beneficial use. TMDLs have been used extensively by the United States Environmental Protection Agency (EPA) and state environmental agencies in implementing the Clean Water Act by establishing maximum pollution limits for industrial wastewater dischargers. It is a challenging but much-needed approach to address pollution within a watershed. TMDL will not only address sources subject to Environmental Quality Act (EQA) 1974 but will address all pollution sources. Controlling pollution load discharged into waterways can be a right direction towards toward TMDL.

The need of a coordinating body or council at the state level can be established or formalised to implement and monitor actions from all relevant enforcement agencies. It is needed to effectively implement the decisions of the National Water Council.

Recommendations

The existing framework and implementation of water quality management were reviewed and recommendations made encompassing the enabling environment, institutional framework and managing instruments within the IWRM framework.

(i) Enabling Environment

a) *Amendment of the EQA 1974 and its related regulations to address of water pollution*

There are various laws and regulations that controls and addresses sources of pollution that fall within the jurisdiction of the federal, state and local government. Regardless of jurisdiction at federal, state, or local level, for various activities, there is a need for an encompassing law at the federal level within an agency under the Ministry of Natural Resources and Environment to enable punitive action to be taken should severe pollution occurs that affects public health and safety e.g. the bauxite mine in Pahang and pollution affecting water catchment areas.

The EQA 1974, an act relating to the prevention, abatement, control of pollution and enhancement of the environment, and for the purposes connected therewith should be able to provide for actions to be taken even if the activity or pollution source does not fall within the jurisdiction of DOE. The EQA 1974 need to be amended for this purpose. The intent is not to have jurisdiction over the activity itself but to have the provision to take action should pollution occurs. This is recommended on the premise that “pollutant” is introduced that had resulted in the pollution of the water resources regardless of the constitutional rights that natural resource is a state matter. Its exploitation needs to be regulated so as to protect the water resources.

b) *Enhancing Self-regulation and Competent Persons*

The element of self-regulation and competent persons need to be introduced and enhanced within all agencies responsible for the addressing the quality of water resources including the control of both point and nonpoint pollution sources not subject to the EQA 1974. DOE had already implemented this approach in all its regulations introduced since 2009. At present for sources subject to the EQA 1974, elements of self-regulation and competence, amongst others include the element of notification, a legal requirement for a certified competent person, performance monitoring, records keeping and reporting, and personnel training. On-line and real-time monitoring of effluent discharged from major sources including an effective Information Management System of Environmental Pollution Sources is needed. DOE had required a submission of a Monthly Discharge Monitoring Report from point sources under the EQA.

It is recommended that the element of self-regulation including certified competent person and a third-party environmental audit need to be extended to the control of all pollution sources both point sources and non-point sources enforced by other agencies at the federal, state, and local level. The efforts can be implemented in stages starting with the major pollution sources.

To address non-point sources particularly sediments from earthworks, it is also recommended that all persons designing ESCPs should be a certified and competent persons in Erosion and Sediment Control, and that person be made responsible and accountable for the ESCP they had designed. This will reduce the burden of the resourced constraint DID and the local authorities. It will also contain the element of self-regulation.

The jurisdiction of enforcement for non-point sources needs to be defined and coordinated. Illegal activities such as illegal land clearing, logging or mining needed to be monitored effectively using remote sensing technologies and drones.

A Regulation under the EQA 1974 to control SS from earthworks need to be introduced with the element of self-monitoring and self-regulation. Large scale projects with earthworks involving 10 ha or more (in line with MASMA) will need an ESCP designed by a certified competent person in ESC and smaller projects will be regulated by the issuance of guidance documents with clear specifications of BMPs to be installed.

In addition to the review of legislation to control pollution sources, it is also important to have clear policies on the requirement for riparian reserves and buffers. Riparian reserves and buffers should be preserved and restored.

- c) *Strengthening Research and Enhancing Capacity Building*
Research needs to be intensified based on disciplinary and spatial focuses in areas related to water quality management. There is a need to integrate multi-disciplinary research towards achieving the common aims. Collaborative research needs to be built up between research institutes and universities to orientate fundamental research towards real applications that solve problems. Common barriers that constrain interdisciplinary research such as the natural science–social science divide, which has been reinforced in schools in many countries, including Malaysia, need to be reflected upon and eradicated. There is also a need also for continuous information exchanges between all stakeholders and scientists to bridge the fragmentation of knowledge and action.

(ii) Institutional Framework

- a) *To establish a Committee at the State Level to coordinate IWRM*
To address the challenges of the three-tiered federal, state, and the local government system, a coordinated approach by all relevant agencies is crucial. At the federal level, the National Water Council can be the platform. A committee at the state level to monitor and coordinate efforts by relevant agencies need to be established. It is recommended that this committee coordinate all action needed to address IWRM including the enforcement.

This committee will need to play a crucial role in addressing matters under the state and local governments particularly pollution sources from non-industrial point sources and non-point sources.

The Committee can also address and assigned beneficial uses of water bodies in line with the National Physical Plan, State Structure Plans, and Local Plans approved and gazette and set water quality objectives and targets for designated water bodies.

(iii) Management Instruments

a) *Enhancement of the Water Quality Monitoring Network and Information Management with Data Centre*

The scope of the existing water quality monitoring is recommended to be enhanced, not only with additional water quality stations and automatic stations but with an establishment of a data centre as well. The data centre will collate, manage, process, and relay water quality data online and real time for DOE and related agencies for related decision-making both planning and operations including enforcement. The data centre will also need to incorporate alert and early warning systems to enable action plan to be triggered for pollution control and to avoid the shutting down of water treatment systems that may cause unnecessarily prolonged water shortages for consumers including industries from incidences such as oil spills, chemical, and toxic

chemical spills, and high $\text{NH}_3\text{-N}$ during low flow. The automatic stations can be placed strategically for these purposes. To implement pollution load control and TMDL based on the assimilative capacity of the water bodies an efficient data centre is needed.

b) *Pollution Load Control and Total Maximum Daily Load (TMDL)*

It is also recommended that the TMDL approach be studied and implemented. The TMDL approach is very challenging and it is recommended to be implemented in stages. It is therefore recommended that it be preceded with an immediate and short-term pollution load control. It needs the involvement and the commitment of not only federal agencies but also the state governments and local authorities. It will involve amongst others determining the beneficial uses of the water body to be protected (e.g. recreational, drinking water, conservation of aquatic life) and defining its assimilative capacity. It may need provision for special discharge standards for designated areas and a revision of current discharge limits which is considered as no longer relevant compared to available and affordable cleaner and greener manufacturing and process technologies and the advancement in pollution control technologies. Industries will need to be prepared to shift to cleaner and green technology including having tertiary treatment.

A Water Quality Control Plan (Basin Plan) and water quality objectives need to be established as the state's programme of actions to preserve, enhance and restore water quality in a specific region or water bodies. In controlling pollution load discharged into specific water bodies, The Environmental Impact Assessment procedure already in place can be further enhanced using water quality modelling to establish whether a new pollution source introduced will still be capable of maintaining the desired beneficial use. As a start, state governments need to identify environmentally sensitive areas that need protection or preservation in order to protect water resources. It will involve addressing not just industrial sources subject to EQA but all pollution sources will have their own allocation on pollution load.

c) *Review the methodology for WQI calculation*

It is recommended that the limitations of the existing WQI derivation be reviewed. The parameters, especially of emerging concerns that have an impact on public health and the ecosystem, need to be addressed. The upper and lower limits of the WQI determining parameters need to be reviewed and set appropriately considering the requirement of the effluent standards, raw water quality criteria and other specific requirements and the beneficial uses of water bodies. A review of the WQI method is needed to identify the main and most frequent

detected pollutants to be included in its formulation and to better assess the state of the water quality for policy intervention and informed decision making.

d) *Continuous effluent monitoring for selected industries with online and real time monitoring to DOE*

It is recommended that a programme for continuous effluent monitoring from major point sources for selected parameters be initiated online and real time to DOE. Technology for both monitoring the parameters and its communication is now widely available for this purpose. This will complement the self-monitoring and self-regulation approach and address the burden of the limited resources of enforcement agencies. It is pointless to enact more regulations to regulate activities if the enforcement capability is limited. It is of public concern that many enforcement agencies have limited resources and at the same time saddled with issues of integrity.

Conclusion

Effective water quality management is important for the protection and preservation of water resources. A coordinated effort at all levels; federal, state and local level in regulating major pollution source is an important element within the framework of IWRM. Pollution control should be addressed at source regardless it being a point or a non-point source. It is imperative that pollution load control and the TMDL approach be addressed vis-a-vis a uniform effluent discharge standard in order to protect beneficial uses of designated water bodies.

REFERENCES

Abdullah, AM & Zaki, Z 2013, 'Sustainable river water management in Malaysia'.

Academy of Sciences Malaysia 2014, 'Study on the status and issues on integrated river basin management (IRBM) in Malaysia'.

Department of Environment Malaysia 2014, *Environmental quality report 2014*, DOE, Malaysia.

Department of Environment Malaysia 1974, '*Environmental Quality Act 1974 (Act 127)*', DOE, Malaysia.

Rosnani, I & Lee, CM 2004, 'River pollution prevention and water quality improvement programmes', in *Proceedings of the 1st Malaysian Water Forum*, Kuala Lumpur, *Integrated Water Resources Management in Malaysia: Experience and Practices*, June 2004.

UNEP 2016, 'The global water quality challenge', <<http://www.unep.org/science/chief-scientist/Activities/EcosystemsManagementandAgricultureEfficiency/GlobalWaterQualityChallenge.aspx>>.

UN-Water 2012, 'UN-Water Annual Report'.

Zati S, Ahmad, TAZ, Mohd AHM Shapai, Saim, S & Ahmad, JS 2013, 'Lakes of Malaysia: water quality, eutrophication and management', *IIUM Engineering Journal*, vol. 14, no. 1.

Zulkifli, AR, Roshadah, H & Tunku, KTF 2012, 'Control of water pollution from non-industrial premises', *2nd International Conference on Water Resources*, Langkawi.

Water and Land Use

Summary Brief

Datin Paduka Dr Dahlia Rosly



Land use activities, whether converting natural landscapes for human use or involving other processes of land-take have transformed a large proportion of the planet’s land surface, bringing about environmental and climate consequences. Urban areas worldwide have expanded in recent decades, accompanied by large increases in energy and water needs. The definition of land, land cover and land use has often been interchangeably used and should be understood in their various contexts. The land cover refers to the surface cover on the ground, whether vegetation, forests, impervious surfaces, and other land and water types (including wetlands or open water) urban

infrastructure, or bare soil. The land cover does not describe the use of land. Land use shows how people use these resources — whether for development, conservation, mixed uses, agriculture or industries which have various implications to water resources. This includes components relating to changes in urbanisation which are the main users of water.

The following table (Table 4.2.4.1) describes the types of major land uses and land use activities that would have consequential impacts on the quantity and quality of water and their sources.

Table 4.2.4.1. Type of Land Uses

Land Use Types	Current Land Use	Land Use Activities and Forms
(i) Built-up areas	Housing Industry Commercial and services Institutions and community facilities Mixed development recreational and open space	Planned housing, unplanned housing, (with various sizes and densities, footprints, and water needs) Planned industry, unplanned industry, mines/quarry Planned commercial, unplanned commercial Education, health, religious, security, welfare, government use, private sector use, other community facilities Housing, commercial, recreation Open space, sports, and recreational facilities; local, state and national parks Natural, artificial
(ii) Transport, infrastructure, and utility	Transport infrastructure, and utility, and ancillary uses	Road, rail, transport facilities and depots Stations and sub-stations for electricity, water, gas supply irrigation and drainage, solid and waste toxic disposal, sewerage, and telecommunication
(iii) Agriculture	Agriculture	Rubber, oil palm, rice, other crops, idle agriculture land
(iv) Livestock and aquaculture	Livestock and aquaculture	Livestock and aquaculture
(v) Forest	Forest	Forest land, wetland forest, peat forest, low impact tourism, recreation, research
(vi) Water bodies	Water bodies	Recreation, water supply (Natural, artificial)
(vii) Coastal	Coastal	Aquaculture, tourism (Natural, artificial)

Global Trends

Land as a resource plays an important role in various aspects of growth and development. While land use has generally been considered a local environmental issue, it is becoming a force of global importance. Worldwide changes to forests, farmlands, waterways are being driven by the need to provide food, fibre, water, and shelter to more than six billion people. Global croplands, pastures, plantations, and urban areas have expanded in recent decades, accompanied by large increases in energy, water, and fertiliser consumption, along with considerable losses of biodiversity (Foley *et al.* 2005). Land-cover changes such as clearing forests and other environmentally sensitive areas affect regional climates through changes in surface energy and water balance, causing declines in biodiversity through the loss, modification, and fragmentation of habitats and the degradation of soil and water. Thus, how land use is designed, interact and functions have a direct relationship to the wellbeing of water, their quality and quantity and the efficiency of their use and conservation. Large scale development of land for housing, agricultural and industrial uses also poses significant water implications.

Water demands associated with land use practices, especially irrigation, directly affect freshwater supplies through water withdrawals and diversions. Agriculture has significantly high consumptive use resulting many large rivers to have greatly reduced flows. In addition, the extraction of groundwater reserves is almost universally unsustainable and has resulted in declining water tables in many regions (Tyler & Fajber 2009). Intensive agriculture (including aquaculture) increases erosion and sediment load and leaches nutrients and agricultural chemicals to groundwater, streams, and rivers. The resulting degradation of inland and

coastal waters impairs water supplies, causes oxygen depletion and contributes to waterborne diseases (Butterworth *et al.* 2010). Large-scale developments too have consequences on wetlands. Uncontrolled land development has resulted in a decline wetlands country and wetlands habitat has also been impacted by the development of the surrounding land resulting in the loss and degradation of habitat.

Global trends also show there is a “disconnect” between land use planning and water resources planning (Van de Wetering 2007) due to a variety of factors mainly the differing levels of governments and decision making for land use planning and for water planning. Land use decisions in most states or of the similar hierarchy have been delegated to counties, municipalities or local authorities developing zoning and building permits. Meanwhile, water allocation stems from the cumulative decisions of individuals awarded rights based land ownership. Different levels of government that are involved with these decisions have different goals: state governments that regulate water are primarily motivated to protect their rights and economic investments, while cities and smaller local planning authorities plan and regulate land in view of balancing public and private needs.

To reiterate, the relationship between the type of land and the intensity of its uses strongly influences the quantity and quality of water sources. The relationship between land use with water quality and water quantity can be said to bidirectional whereby land use activities have direct impacts on water resources, while water quality and quantity is greatly influenced by the sitting of land use activities. It is indeed important to ensure there is the best solution in resolving the water issues as well as helping in achieving sustainability of water resources and at the same time securing the development of

the nation. Sustainable land use policies must also assess and enhance the resilience of different land use practises.

Current Status in Malaysia

Water-quality issues that relate to urban development stems from population growth. To sustain economic growth, Malaysia requires a population base, consequently increasing the demand for land and water resources. Thus, an increase in population and rapid urbanisation in Malaysia coupled with global climate change poses significant challenges for water management in Malaysia. Urban population share is expected to increase by 80% in 2025. The National Physical Plan 3 has projected that the population of Malaysia would be 45.5 million in 2040 (National Physical Plan 3, 2016). The increase in urban population requires support facilities like housing, roads, shopping, recreation, and other commercial and industrial facilities all competing for land and water and increasing the stress on the water resources in and around rapidly expanding urban areas.

In addition, when development takes place the effects it can have on precipitation run-off and water quality can be greatly compromised and open to the risks such as flash floods and landslides. Unchecked urbanisation also substantially degrades water quality, especially where wastewater treatment is absent. Other related issues of concern are sewage overflows, groundwater contamination from waste disposal sites, water-borne pathogens, pesticides, and nitrogen used in agriculture to grow crops and phosphorus concentrations in groundwater affecting the water quality of surface water. Manufacturing industries, sewage treatment plants, individual septic tanks, communal septic tank, wet markets and food services establishments are largely urban land use

components threatening both water quantity and quality.

The use of land in rural areas for purposes such as poultry and animal farms and agro-based industries also becomes point sources for water pollution. Water quality is often compromised from the incompatible location of land uses such as landfills at proximity to groundwater sources. Upstream pollution from the 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.

To rationalise competing needs, present and future, integrated land use and water planning is most important as a balanced approach to the sustainable use of natural resources, in the context of reducing climate change impacts, to maintain resilience and abate the risk of natural disasters such as floods and other long-term impacts of climate change.

Water management including its conservation is an important climate change adaptation response. Referring to the National Water Resources Study (2000–2050), the demand for water supply in Malaysia is expected to rise 1.2% annually. Although there are many initiatives at the policy level for Integrated Water Resources Management in Malaysia, implementation remains a challenge as water and land is a state matter while the interests in developing land and water cuts across a multiplicity of agencies and requires efficient coordination and agreements between the Federal and State Governments. In the past, there seems a “disconnect” between land use planning and water resources planning but present initiatives are evident in trying to bridge various policies and agencies. Policy-wise and

in the context of sustainable development, water, and land have been addressed in various national policies such the National Water Resources Policy, the National Physical Plan, National Urbanisation Policy, and the National Policy on the Environment). In the latest review Malaysia's National Physical Plan, one of the three thrusts of the NPP is 'spatial sustainability

towards resilience to climate change' through sustainable spatial management including those pertaining land and water with three strategic thrusts, 15 strategies, and 42 actions. Table 4.2.4.2 summarises the implication to water resources stemming from land use issues.

Table 4.2.4.2. Relationship between Land Use and Implication to Water Resources

Land Use Types	Land Use Issues	Implication to Water Resources
Forest	Increasing intensity of deforestation, Encroachment of development, development on forested hills. Also encroachment of development into peat forests and wetlands.	Increasing magnitude and frequency of runoff events and reduced base flows, increased pesticide contamination, erosion, and sedimentation of stream and rivers. Lowering of water table
Industrial	Coal mines, power plant and other industries would become a catalyst to urbanising of rural lands and the consequent degradation of land.	Settlements located at the downstream to the power plants would be severely affected due to the pollution of their water bodies and streams by the effluents. The urbanisation of rural areas would increase water demand
Urbanisation	(Commercial, industrial, residential) High urbanisation rate. Incompatible siting of landfills at proximity to groundwater sources.	Deterioration of the water resources system, drying and shrinking surface water bodies, Over-exploited and exhausted groundwater, water pollution and the requirement for extensive water management and low water use efficiency. Approval for large tracts of residential development would depend on water availability.
Infrastructure and utility (water supply)	The construction of large hydro dams to meet increasing demand for electricity	Affecting seasonal inundation patterns both upstream and downstream, as well as water flow, fisheries habitat, and agricultural production.

Note: Adapted from Anis *et al.* 2015, *Jurnal Teknologi Sciences & Engineering*, vol. 35, no. 5, pp. 143–149

Recommended Strategies

(i) Enabling Policies in Land Use Plans

The National Physical Plan (NPP) gives priority to improving security and sustainability of water resources and

outlines strategies to guarantee the sustainability of water resources in line with the National Water Resources Policy (DSAN). The NPP describes the uses of water bodies and implications of development on water quality, quantity

and conservation as a strategic guide to State Structure Plans, Local Plans, and Special Area Plans. The NPP had proposed measures to ensure the long lasting water resources to meet the needs of the population in particular for productive capacity national resources in agriculture, industry, fisheries and water supply.

One of the three strategic thrusts of the latest review of the National Physical Plan (known as the National Physical Plan 3) is to ensure 'spatial sustainability towards resilience to climate change' through sustainable spatial management including those pertaining land and water. This strategic thrust is affected into two strategies related to water resources and climate change i.e. to improve the sustainability and security of water resources; and management of environmentally sensitive areas.

(ii) **Management Instruments**

All strategies in NPP3 are supported by respective actions. For the chosen strategies highlighted above, key areas for sustainable water resources management are as follows:

- a) Improving security and the preservation of water resources for long-term social and economic benefits;
- b) Monitoring of groundwater extraction in critical areas;
- c) Gazette and protect forests in the upper reaches of the river basin to maintain the source of water supply;
- d) Enhancing the quality of water resources in providing sustainable water supplies;

- e) Implement water reuse; and
- f) Managing underground water resources to ensure the availability of water.

- *Gazetting water catchment areas*

Most watershed areas have been gazetted as permanent forest reserves which in particular as part of the forest watershed. This accounts for around 14.9% of the total area of permanent forest reserves in Peninsular Malaysia. Efforts to gazette water catchment forest must be upgraded to include all the upper reaches of river basins as well as a source of raw water catchment area for existing and proposed dams. This is a major step in controlling development and inappropriate or incompatible land uses in these areas. It is pertinent that the gazetting of water catchment areas be supported by efforts in surveillance, enforcement, and conservation. Similarly, wetland areas of significance should be gazetted as protected areas as the first step in efforts conservation.

- *Management of river reserves and development along the river corridor*

River reserves play an important role as a buffer between the river and adjacent land and work in controlling the flow of surface water and river pollution mitigation. At

downstream areas of the river, the reserves of major rivers should be protected and managed sustainably. Provision of minimum reserves river as in Drainage and Irrigation Department Guidelines should comply with, and any construction on or of river reserves for development should be rationalised. Structure Plans, Local Plans and Special Area Plans at the state, district and town level shall be used as control document with these guidelines incorporated in Development Plans. Rivers also functions as amenities to the residents along the river, mainly as a corridor connecting networks and green spaces. Where feasible reserve requirements and riparian corridor along the river can potentially be used as a low impact recreation area in line with existing guidelines. These shall be identified in the Development Plans henceforth and gazetted.

The National Physical Plan concurs that IRBM should be established for all major river basins in Malaysia to strengthen river basin management with coordination between government agencies. Strengthening of integrated river basin management and the preparation of strategic land use plans have been initiated in view of conservation, management and development of water, land and

other sources adjusted to ensure economic and social benefits were obtained without affecting the river basin system. Spatial and physical planning at the local level including design structure shall emphasise integrated river basin planning. The cross-border or trans-boundary sharing of responsibilities should be applied.

(iii) Institutional Challenges

In line with NPP, Local Plans in Local Authorities addresses water component as a strategy to link water and land use planning. At neighbourhood and local levels, no approval would be given to new housing developments without the assurance of sufficient water supply. In Selangor, Syarikat Bekalan Air Selangor (SYABAS) as a principle, do not support planning applications without a clear indication of water supply. This requirement also applies to industrial and commercial development and subdivisions for project development. In other States, these types of development would require being submitted to the water provider. At present housing developments over 100 hectares are required to be tabled to the National Physical Planning Council and most conditions attached by SYABAS clearly States that these developments should show proof of adequate water supply. But the political reality is often that while land use plans prepared by professional planners may recognise the limitations of water resources, the actual decisions are taken pursuant to those plans are often heavily influenced by growth advocates, with little consideration for the burdens this places on the water sector.

Way Forward at Local Level — Minimising impacts of urbanisation and strengthening requirements for change of use.

Similarly, many local governments in developing and developed nations require that developers show adequate water rights or an adequate water supply to meet the demands of new projects. However, implementation and deliberating detail requirements is a challenge, often resulting in development without adequate water after construction. These are some snapshots of institutional and requirements which presently regulate land use change for some Local Planning Authorities.

- (i) Implement subdivision regulations requiring developers to provide “adequate evidence that water supply is sufficient in terms of quality, quantity, and dependability and readily available to ensure an adequate supply of water for the type of subdivision proposed.” This would include housing (with a different need at different housing density), agriculture projects, industries and other land uses that are water intensive.
- (ii) Local authorities to adopt comprehensive general plans governing local land use decisions and require that the water-land use connection is addressed including specifically taking into account the availability of water systems.
- (iii) Create incentives for developers to voluntarily adopt water conservation rather than relying solely on the acquisition of new supplies to provide water for new development. For example, the builder can take the initiative to install extra-efficient water fixtures to lower water demand.
- (iv) Precautionary approach for water acquisition. Water acquisition for

development should not be done at the expense of rural areas and the environment.

Smart Growth and Water Use

This is a way forward for both the regional level and local levels. Smart growth is a more sustainable way to build and maintain our urban areas, attempts to curb urban sprawl and improve the environmental wellbeing of communities. Smart Communities and developers can reduce run-off quantity, protect water quality, and conserve water by developing in a compact fashion preserving ecologically critical open space, and using green infrastructure strategies. Associated features are as follows:

- (i) Compact development generates less storm water run-off per unit of development because it creates a less impervious surface. It can also conserve drinking water because it requires shorter pipes to serve a community, which reduces the amount of water lost to leaks.
- (ii) Directing development to existing communities can help reduce the pressure to develop on open space that might have valuable ecological functions such as buffering a water body.
- (iii) Green infrastructure techniques, such as rain gardens, permeable soils or pavements, and green roofs, functions to support the natural processes to capture storm water, slow it down, absorb some of it into the ground, and filter out pollutants before releasing the remaining run-off to storm sewers or waterways. Other elements such as rain barrels and cisterns can store run-off for non-potable uses such as irrigation, which helps conserve drinking water. In addition to protecting

water quality, these green infrastructure practices can make streets and buildings more attractive and reduce ambient air temperatures.

Smart growth is also closely associated with sustainable land use practices such as brownfield and infill development and mixed-used land development. These can be effected by controlling the scale when opening new areas for development. Sustainable planning principles do not encourage the opening of new areas for development when there is no apparent population demand in the immediate location. Expanding the urban area in situ thus sharing existing infrastructure affords less stress and energy to the region. This is one of the features of smart growth affording the redevelopment of uneconomic urban areas or brownfield areas and supporting infill development. Current government policy favours the use of brownfield sites in order to prevent further loss of rural land and associated natural resources. Reactivating or refurbishing obsolete or inactive area in the city with gentrification features would value-add to the liveability and resource efficiency existing communities. Another approach that embodies smart growth is mixed land use development affording smaller footprints and known to offer more liveable lifestyle while preserving environmentally sensitive areas and other natural resources elsewhere.

Conclusion

The present situation shows that while many good policies and strategies for action have been identified and are in place, the elements of water management are still rather fragmented. There is a need to continuously commit to a less fragmented approach to integrated water management where land and water have to be managed together. Good governance

is key to implement guidelines and codes despite challenges and pressure from various stakeholders in planning for land and water. Though there is a multiplicity of players, there should be an optimistic perspective for planning land and water in an integrated and sustainable way, provided inter-agency roles can be brought together to share information with a focal point or an effective central entity that would ultimately be responsible for the water resource and land use activities as a whole. The way institutions function, how they coordinate with each other and construct policies needs a good legal foundation. Policies and strategies for action have been well documented; however, implementation remains a challenge. Land governance is about the policies, processes and institutions by which land, property and natural resources are managed. It covers all activities associated with the management of land and natural resources that are required to fulfil environmental, social and political objectives in order to achieve sustainable development in a changing climate.

REFERENCES

- Anis, SS, Robiah, S & Chang, WS 2015, 'The need for land use assessment', in *Jurnal Teknologi*, vol. 75, no. 5.
- Butterworth, J, Warner, J, Moriarty, P, Smits, S & Batchelor, C 2010, 'Finding practical approaches to integrated water resources management', *Water Alternatives*, vol. 3, no. 1, pp. 68–81.
- DeFries, R, Asner, G, Houghton, R (eds) 2004, 'Ecosystems and land use change', *American Geophysical Union, Geophysical Monograph Series*, vol. 153, Washington, DC.
- Enemark, S 2013, 'Building spatial frameworks for sustainable and transparent land governance', in the *Annual World Bank Conference on Land and Poverty*, 8-11 April, The World Bank Washington, DC.
- Environmental Law Institute, Washington, D.C. Colorado Water Conservation Board 2008, *Wet growth: should water law control land use?*
- Foley, A *et al.* 2005, 'Global consequences of land use', *Science*, vol. 309, no. 5734. Center for Sustainability and Global Environment (SAGE), University of Wisconsin, Madison, USA.
- Forsyth, T (eds) 2005, Land use impacts on water resources—Science, social and political factors, *Encyclopedia of Hydrological Sciences*, John Wiley & Sons, Ltd.
- Institute of Water Research 2014, *Watershed approach: land use effects on water quality and quantity*, <<http://35.8.121.139/edmodule/water/wtrfrm1.htm>>.
- Klein, B & Kenney, DS 2009, *The land use planning, water resources and climate change adaptation connection: challenges and opportunities: a review*, University of Colorado Law School, Boulder, USA.
- Khalid, MR, Rahman, AS & Mazlin, M 2013, 'Legal perspective on development policies for sustainability of water in Malaysia,' *Sustainable Development*, vol. 21, no. 3, pp. 144–151.
- Laws of Malaysia 2006, *Town and Country Planning Act, Act 172*.
- Metropolitan Area Planning Council 2016, *Promoting Smart growth and regional collaboration*, <www.mapc.org>.
- National Physical Plan 3 (n.d.), *Federal department of Town and Country Planning Malaysia*, Ministry of Natural Resources and Environment Malaysia 2011, National water resources study (2000–2050), National Water Resources Study (2000 - 2050), 2011.
- Newson, M 1997, *Land, water and development. Sustainable management of river basin systems*, London, Routledge, New York.
- Suhaily, Y & Zainudin, O 2010, 'Water catchment management: a Malaysian perspective', *Global Journal of Environmental Research*, vol. 4, no. 1, pp. 34–39.

The USGS Water Science School 2016, 'The effects of urbanization on water quality', <<http://water.usgs.gov/edu/urbanquality.html>>.

Tyler, S & Fajber, L 2009, *Land and water resource management in Asia: challenges for climate adaptation, international institute for sustainable development*, Winnipeg, <www.iisd.org>.

Van de Wetering 2008, 'Bridging the governance gap: strategies to integrate water and land use planning', in *Summer Conference*, Public Policy Research Institute, University of Montana, Boulder, Colorado.

<http://msue.anr.msu.edu/news/the_difference_between_land_use_and_land_cover>.

<<http://www.jurnalteknologi.utm.my/index.php/jurnalteknologi/article/view/4332/3036>>

Water and Health

Expert Review

Professor Dr Yang Farina Abdul Aziz FASc

Defining Water and Health

Water is essential for life, but with the absence of adequate water and sanitation management services, people become vulnerable to the exposure of preventable health risks. The relationship between Water and Health is directly linked to water, sanitation and hygiene (WASH), a focus area of the World Health Organization (WHO). The inadequacy of WASH will lead to a significant impact on health and well-being and results in a large financial cost, including a sizeable loss of economic activity (WWAP 2015).

WHO has defined water-related diseases as:

- Those due to micro-organisms and chemicals in water people drink;
- Diseases like schistosomiasis which have part of their lifecycle in water;
- Diseases like malaria with water-related vectors;
- Drowning and some injuries; and
- Others such as legionellosis carried by aerosols containing certain microorganisms.

The source of contamination and chemical pollution of the water bodies are from the poor management of agricultural, industrial and urban wastewater. This often leads to waterborne diseases caused by the presence of microorganisms, heavy metal and chemicals. Diarrhoea is the most widely known disease linked to contaminated food and water but there are other hazards (WHO 2015).

Water and Health also includes vector-borne diseases. An example is the *Aedes aegypti* mosquito, known as vectors that breed in water that transmit the dengue fever. Water and Health examine both acute and chronic water-related diseases.

Brief Review of Global Trends

According to UNESCO's World Water Development Report (WWAP 2012), the water demand in all sectors of productions is expected to increase in the future. This is largely influenced by the population growth, food and energy demand, and rapid urbanisation. The world is currently looking at both quantity and quality of water to support the rising water demand.

However, globally threats from unsafe water pose great challenges to health which according to WHO may be summarised as follows:

- No safe drinking-water: almost 1 billion people lack access to an improved supply;
- Diarrhoeal disease: 2 million annual deaths attributable to unsafe water, sanitation, and hygiene;
- Cholera: more than 50 countries still report cholera to WHO;
- Cancer and tooth/skeletal damage: millions exposed to unsafe levels of naturally-occurring arsenic and fluoride;
- Schistosomiasis: an estimated 260 million infected; and
- Emerging challenges: increasing use of wastewater in agriculture is important for livelihood opportunities, but also associated with serious public health risks.

Generally, in developing countries, the main health concerns related to water is due to the presence of microorganisms and the lack of proper sanitation. Inadequate drinking-water, sanitation, and hygiene are estimated to cause 842 000 diarrhoeal disease deaths per year (WHO 2014), and contribute substantially to the other diseases listed above. The other major health concerns are due to vector-borne diseases such as malaria, dengue and the latest to affect South America the Zika virus. However, the presence of emerging pollutants in water is another important area of concern. Lifestyle and extensive farming utilising pesticides have resulted in the presence of minute quantities of endocrine disrupting chemicals (EDC), pharmaceuticals and personal care products (PPCP). The data collected to date does not indicate that the trace levels of EDC and PPCP in potable water pose

an unacceptable risk in terms of health effects. However, there remain extensive data gaps in terms of occurrence levels, pervasiveness, and synergism/interaction between chemicals that require additional investigations. The chronic effects of low-level exposures of EDCs and PPCPs are still not clearly understood and currently studied by various research groups. Besides the real health concerns, there lies within many consumers the fear of these unknown emerging pollutants. The plethora of information easily available on social media and the internet has heightened the awareness of consumers as to the presence of these chemicals in drinking water and people remain concerned. Residential treatment technologies or devices that can demonstrate effectiveness on one or more of these compounds can help to lessen the anxiety associated with this issue.

Globally, due to the limited quantity of freshwater, there is a strong emphasis on alternative water resources. Many countries are looking into groundwater extraction and rainwater harvesting to increase the availability of freshwater. Health-consciousness of the public has also led to the increase of awareness in water quality prompting water operators and Government to look into Water Safety Plans to safeguard the quality of drinking water from source to tap. The Water Safety Plan acts as a preventive measure through the utilisation of comprehensive risk assessment and risk management tools to identify and mitigate risks at an early stage before they escalate into serious issues.

Furthermore, the highly anticipated 5th edition of the *Guidelines for Drinking-water Quality* by WHO is also about to be completed. With its completion, the guidelines will serve as an authoritative basis for the setting of national regulations and standards for water safety in support of public health.

Snapshot of Current Status in Malaysia

The current water treatment plants operate based on the conventional method which is guided by the Ministry of Health's Guidance Value. However, the conventional method is no longer sustainable due to the high level of water pollution. When water quality falls below the acceptable standard by the water treatment plant, it will result in the closure of it.

In general, the Malaysian populace has adopted a more health-conscious lifestyle and become more demanding on matters related to health, in this case — the water from the tap. This can be seen from the thriving business in home water purification systems.

Awareness, advocacy and capacity building programmes have also come to fruition when the outbreak of waterborne diseases during the 2014 – 2015 floods was prevented. With proper training given to the emergency response team and the awareness of the community, an epidemic such as cholera and typhoid has successfully been prevented.

The Ministry of Health (MOH) initiated the Water Safety Plan for Malaysia since 2012. The main focus of MOH is in non-communicable diseases. MOH plans to table the Safe Drinking Water Act to the Cabinet in 2016.

The statistics on waterborne diseases and vector-borne diseases in Malaysia are listed in Table 4.2.5.1.

Table 4.2.5.1. Statistics of Water-related Diseases in Malaysia (2013)

Incidence Rate and Mortality Rate of Communicable Diseases, 2013 (per 100,000 population)				
Communicable Diseases	Incidence Rate	Mortality Rate	Acute	Chronic
Food and Water Borne Diseases				
Cholera	0.58	0.00	✓	
Dysentery	0.28	0.00	✓	✓
Food Poisoning	47.79	0.04	✓	
Hepatitis A	0.41	0	✓	✓
Typhoid	0.73	0.01	✓	✓
Vector Borne Diseases				
Dengue	143.27	0.00	✓	✓
Dengue Hemorrhagic fever	2.60	0.31	✓	
Malaria	12.96	0.05	✓	✓
Plague	0.00	0.00	✓	
Typhus	0.03	0.00	✓	✓
Yellow fever	0.00	0.00	✓	

Communicable Diseases	Incidence Rate	Mortality Rate	Acute	Chronic
Vaccine Preventable Diseases				
Acute Poliomyelitis	0.00	0.00	✓	✓
Other Infectious Diseases				
Leptospirosis	15.00	0.24	✓	✓

Source: Ministry of Health Malaysia (2014)

Issues on Water and Health in Malaysia

Generally, as Malaysia is progressing towards being a fully developed nation by 2010, the number of reported water-related diseases due to micro-organisms is very small. However, there are still a number of food poisoning cases in part due to the poor handling and lack of hygiene in food preparation. The main threat in Malaysia is the widespread occurrence of water-borne diseases such as dengue.

Other health issues related to water are as follows:

- Lack of research in acute and chronic diseases associated with drinking water;
- Lack of data on chronic diseases associated with drinking water;
- Lack of studies to prove the association of waterborne diseases to bacteria, heavy metals, chlorination byproducts and EDC;
- Lack of monitoring;
- Lack of data to show coverage of potable water in the country; and
- Lack of analysis to understand the correlation of diseases occurrence.

Recommended Strategies for Nationwide Implementation

Following are the strategies to be undertaken to minimise water-related diseases in Malaysia.

(i) Enabling Environment

- Draft Safe Drinking water Act (Akta Air Minum Selamat)*
The Ministry of Health plans to table the Act to the Cabinet. With its approval, the drinking-water standards will be revised.
- Policy to support Integrated Catchment Management as part of Integrated River Basin Management*
Support proper planning and development of catchments to reduce contamination and chemical pollution from agricultural, industrial and urban wastewater.
- Strengthen the policy for rainwater harvesting*
Have the existing policy strengthened to promote rainwater harvesting as an alternative source of water?

(ii) Institutional Framework

- a) *Establish a National Technical Committee*
To form a National Committee between all water-related Government Agencies to promote collaboration and reduce the overlapping responsibilities.

b) *Construction of Dams*

Storage of high-quality water to reduce treatment costs.

c) *Alternative Water Resources*

Groundwater extraction and rainwater harvesting.

(iii) Management Instruments

- a) *R&D*
Conduct more correlation studies on chronic diseases and pollutants in water
- b) *Monitoring (Operations and Maintenance)*
Improve monitoring frequency on the persistence of pollutants especially in hot-spot areas (extensive industrial and farming areas)
- c) *Information Management*
Promote sharing of data and establish a database accessible to the public
- d) *Economic and Financial Instruments*
Tariff adjustment to enable water operators to upgrade their services
- e) *Legal*
Strengthen enforcements on regulations.

Conclusion

As Malaysia becomes a high-income nation by 2020 it is only timely that its drinking water standards should reflect the ideals of a developed nation. More research is thus required to look at the prevalence of emerging pollutants. In areas where the threat of pollutants is high, it is about time that alternative water treatment system is utilised adopting advanced oxidation methods.

(iv) Investments in Water Infrastructure

- a) *Upgrade Water Treatment Plants and Sewerage Treatment Plants*
Enable better treatment of raw water to remove new emerging pollutants in hot-spot areas

REFERENCES

World Health Organization 2015, *Drinking-water fact sheet*,
<<http://www.who.int/mediacentre/factsheets/fs391/en/>>.

World Water Assessment Programme, 2012, *The United Nations world water development report 4: managing water under uncertainty and risk*, Paris, UNESCO.

The United Nations World Water Development 2015, *Water for a sustainable world*, UNESCO.

Water and Green Growth

Expert Review

Professor Dr Chan Ngai Weng

Humanity is currently at its highest level of development, both technologically and economically. Unfortunately, however, it is also at the edge of global environmental destruction exacerbated by global warming with water problems right at the centre. This dangerous situation is brought about by the traditional model of rapid development at all costs without due consideration to the environment, including water. Classic environmental disasters brought about by human mismanagement such as Silent Spring (Carson 1962), Easter Island (Ponting 2007) and the Aral Sea (Breckle *et al.* 2012) are warnings that nature has limits and deserve due respect. Yet, there are also many cases whereby humans are living in harmony with the environment precipitating equal development for both <<http://epi.yale.edu/reports/2016>>. The moral of the story is that development does not always have to be in conflict with the environment but be in harmony.

Crucially, a balance needs to be struck between development and environmental conservation (Chan 2006). In terms of water, global warming is expected to exacerbate water problems, along with the “business as usual” attitude whereby rapid development is prioritised at the expense of the environment.

At the *World Economic Forum in 2008*, the United Nations Secretary General Ban Ki-moon warned the world about an impending global water crisis by saying “*Time is Running Out for Water*.” He painted a very threatening picture of the potential effects of a global water shortage that may lead to war by saying “*The consequences for humanity are grave. Water scarcity threatens economic and social gains and is a potent fuel for wars and conflict.*” <<http://www.un.org/apps/news/story.asp?NewsID=25527&Cr=water&Cr1>>. At the World Water Forum in Istanbul in 2009, the United Nations warned that the worldwide demand for water will outstrip supply, especially in the developing world. Without better management to alleviate water shortages, the world is headed towards serious water problems (*Associated Press* (16 March 2009)). At the same forum, UNESCO also warned that population growth and mobility, as well as increased energy, production are contributing to the high demand for water.

Water shortages need good governance for effective water management. Economic growth cannot be achieved, let alone green growth, if water is not managed sustainably as it is closely related to poverty (the poor being marginalised

and have limited access to clean water). Hence, sustainable development cannot be achieved as there is no development (whether green or not) without water. Water resource is a pre-requisite for green growth and poverty eradication, as well as protecting environment and ecosystems.

In 2012, the theme of the Rio+20 international conference on sustainable development was “green economy” whereby all countries are expected to make their economies green. The concept of green economy is not new. It probably has its roots way back in 1992 during the *1992 Rio Conference or the United Nations’ Conference on Environment and Development*. The concept of a green economy and how to move towards one is currently stirring global debate (Khor 2011). The idea of a green economy, though not necessarily a new one, is emerging as a significant concept, though also a controversial one, that will be part of the international environmental debate this year. Significantly, the green economy has become a major theme of the Rio+20 conference to be held in 2012 in Brazil to commemorate the 20th anniversary of the historic *UN Conference on the Environment and Development* held in Rio de Janeiro in 1992, or better known as the Rio Summit <<http://www.un.org/geninfo/bp/enviro.html>>.

According to Khor (2010), the green economy appears to be a simple idea that is a timely boost for environmental protection. It is about an economy that is structured in such a way that it conserves natural resources and minimises pollution and greenhouse gas emissions. No one will argue over the concept. However, it is the way in which a green economy can be achieved that is still not very clear. There is yet no scientific agreement as to how the green economy can be achieved, nor is there an international consensus on what it means and how to move towards one. The fact is that

it costs more to be green. A green economy will cost both the supplier and buyer more. A green economy is basically environmentally-friendly, based on production and consumption patterns that are sensitive to the need to conserve natural resources, produces minimal pollution and emissions during the entire process of sourcing for raw materials, production processes, packaging, and disposal of product wastes. The economy also promotes environmentally-friendly lifestyles and consumption patterns. Hence, a green economy appears to be what the developed countries such as Denmark, Sweden, and Japan have achieved so far. However, developing countries are sceptical about whether the green economy will hinder their economic growth as well as their pursuits of social goals such as poverty eradication and job creation. Notwithstanding these arguments, the Rio+20 countries appear to believe that the green economy should be the way forward.

The United Nations defines sustainable development as embracing a holistic, equitable and far-sighted approach to decision-making at all levels whereby the emphasis is not only on strong economic performance but intragenerational as well as intergenerational equity. Sustainable development is best achieved via a balanced strategy of social, economic and environmental goals <<http://www.uncsd2012.org/index.php?menu=62>>. Although the theme in Rio +20 is green economy, it does not deviate from the emphasis in 1992 which was sustainable development. Without green economies, it would be difficult, if not impossible for the world to achieve sustainable development. A green economy is one that depends on green businesses built on the entire process of production from the production of the raw materials to processing, manufacturing, packing, distribution, consumption and handling of the waste products in an environmentally

friendly way. UNEP (2009) defines green economy as: “one that results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities”. A green economy requires green growth policies as a response to the traditional unsustainable energy and carbon intensive economic models based on constant growth that have caused climate change and impacted human health and national security, implying that if humans make an effort to change how they pursue economic growth, they can solve the environmental problems they have caused. Government of the Republic of Korea (The Ministry of Land, Transport and Maritime Affairs), the Presidential Committee on Green Growth and the Korea Water Resources Corporation (K-water) and the World Water Council, 2012).

UNESCAP (2010) defines green growth as: “a policy focus that emphasises environmentally sustainable economic progress to foster low-carbon, socially inclusive development”. Similarly, OECD (2011) defines green growth as: “fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services for human well-being”. Hence, green growth essentially embraces the three pillars of sustainable development, viz. economy (economic growth and development), environment (natural ecosystems and the resources and environmental services they provide), and society (socially-inclusive development). Hence, when water and green growth is married, it is combined with a strategy to invest in water infrastructure and water security that fosters economic growth and development, while at the same time protecting the environment (and its ecosystem services) and enhancing socially-inclusive development (benefiting people).

Figure 4.2.6.1 represents the strategic approach between green growth and water. As such, a green economy would include inputs into the production process such as energy, raw materials and water. There is no development without water. Water is needed if an economy is to develop. Water is needed to produce all products from computers to cars, clothes, electronic equipment, houses, house contents, books, etc. Hence, if an economy is to be green, it has to be blue first. That is to mean the use of water has to be water-friendly. This may require recycling of water and waste water, use of water-saving fittings, use of advanced waste-water treatment, reduction of non-revenue water, and changing human behaviour with regard to water use (Chan 2012a). In many developed countries, lack of water has necessitated the use of technology such as dual-flush cisterns, water regulators and rainfall harvesting systems which have substantially increased water efficiency and reduced water consumption/demand (Gleick *et al.* 2003; Tortalajada 2006; Willis 2009). Elsewhere in developing countries, inadequate water has also seen increasing use of water conservation methods such as water demand management techniques (IUCN 2000; Chan 2007a; Araral & Wang 2013).

Hon. Prime Minister Najib Abdul Razak had pledged Malaysia’s commitment at the Copenhagen Conference of Parties 15 in 2009 “To reduce carbon emission up to 40% in terms of emission intensity of GDP (Gross Domestic Product) by 2020 compared with its 2005 levels” (Ministry of Energy, Green Technology and Water 2012). In Malaysia, the National Green Technology Policy which calls for the national economy to be accelerated through the use of green technology, while at the same time, promoting sustainable development was launched in 2009. Under this plan, green technology involving the development

and application of products, equipment, and systems in a way that minimises degradation of the environment, conserves the use of energy and natural resources, and emits low or zero greenhouse gas emissions will be prioritised (Lim 2014). The Ministry of Energy, Green Technology and Water Ministry via the Malaysian Green Technology Corporation (GreenTech Malaysia) are responsible for green growth. The ministry has identified four flagships to catalyse green growth in Malaysia, viz. the

Green Malaysia Plan, Green Procurement, Electric Mobility and Sustainable Living. Under the Green Malaysia Plan, strategies and action plans that promote green technology in the areas of energy, buildings, transport, water and waste management will be formulated as these sectors are major contributors towards carbon emissions. So, the government's commitment towards green growth in the water sector is in place.

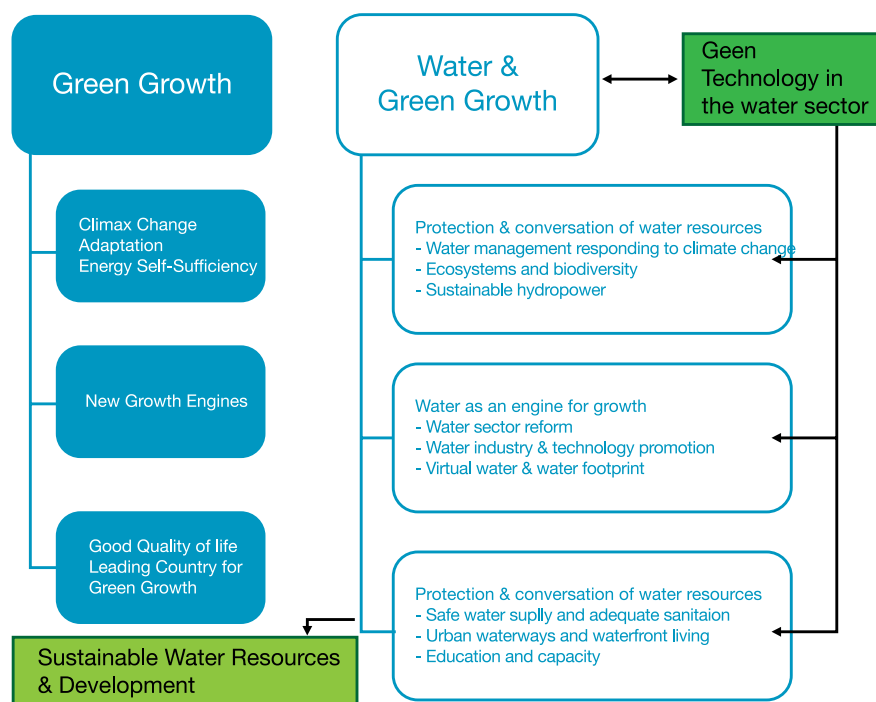


Figure 4.2.6.1. The Strategic Approach Between Green Growth and Water
(Adapted from Government of the Republic of Korea)

Source: The Ministry of Land, Transport and Maritime Affairs, The Presidential Committee on Green Growth and the Korea Water Resources Corporation (K-water) and the World Water Council, 2012.

Enabling Environment

A green economy and green growth needs an enabling environment to flourish. An enabling environment does not happen by itself, but needs to be created, often painstakingly and slowly. An enabling environment refers to the conditions that make green growth feasible and attractive. Enabling green growth means creating an environment conducive for economic activity to flourish and at the same time improve human well-being and social equity, and to minimise environmental risks and ecological degradation. It requires a holistic set of policies to generate significant public and private investments in the water sector. Such investments must overcome barriers created by traditional non-green businesses and have the edge to compete successfully in the market to ensure sustainability. An enabling environment requires a mix of policy tools, with timeframes for their implementation. To create an enabling environment, certain enabling conditions need to be put in place first.

Enabling conditions include many steps that progressively move towards producing an effective enabling environment. The first enabling condition is policy and regulatory frameworks. These include development strategies, laws and standards, and international policy architecture. The second enabling condition is the prioritising of green investments which include government policies and infrastructure, and incentives to encourage a private sector to invest in environmentally sustainable initiatives. The third condition is sustainable public procurement pricing to create and stimulate markets for green goods and services related to the water sector (e.g. water saving devices). The fourth condition is to enable pricing instruments to incentivise green investments in the water sector and to correct negative externalities. The final condition is

building the capacity of local and international businesses which enhance skills for green jobs, capacity for policy green reforms, green entrepreneurship and green business development.

In a country like Malaysia where economics is prioritised, and where profits for the water sector are essential in creating jobs, providing goods and services, and ensuring water security, the government must ensure that it creates, supports and promotes such an enabling environment. Hence, one of these enabling environment is the passing of water laws and policies that allow, favour and promote both a government managed water sector (e.g. Water Works Department) or a socially responsible private water sector (e.g. Perbadanan Bekalan Air Pulau Pinang Sdn Bhd) (Chan 2007b). An enabling environment also stimulates both international and local interests in the water sector, promotes innovations and initiatives and draws in investments, all of which can have positive effects on creating employment and generating human resource development. In Malaysia, since independence in 1954, rapid development, the creation of jobs and poverty eradication are some of the greatest achievements of the country's success.

These successes could not have been achieved without the effective development of water resources. Unfortunately, however, such remarkable economic achievements have come at a high price as environment had been severely degraded, including water resources. An enabling environment for water and green growth, therefore, must not follow the traditional model of development but radically change to adopt the new paradigm shift towards green growth and green economy (Government of Malaysia 2011).

The government must also ensure that it supports the creation of an enabling environment whereby civil society organisations (CSOs, e.g. non-governmental organisations or NGOs, community-based organisations, and non-profit organisations or NPOs) are given the space, freedom, and support to play their roles. These organisations are made up of committed individuals and powered by private energies to deliver and advance the public good (Rohani Hashim *et al.* 2010). These civil society organisations in Malaysia work in a wide spectrum of fields such as water, environment, education, health, science, human rights and others they embrace scientific, professional, commercial, religious, labour, ethnicity, equity, fine arts, communications, vulture and others. Others work to eradicate poverty and social inequity. They offer their energies to the country with great passion and commitment. Hence, the government should work with these organisations towards nation building and the protection of our environment and water resources. With a non-enabling environment that discourages working with civil society organisations, green growth and sustainable water resources would be difficult to achieve. Chan (2004) warns that “greenwash” by the authorities or the private sector whereby CSOs are relegated to a minor and unimportant role will stifle growth and development of the water sector. In contrast, it is necessary to engage and include such organisations towards a more inclusive development paradigm. The government must provide an enabling environment that encourages such organisations to share and shoulder a part of the burden of national development. CSOs are now very well equipped with resources, human and financial, as they have members who are professionals such as engineers, managers, doctors, professors and teachers. These professionals can offer expertise needed for green growth and water resources management (Chang *et al.* 2004).

In Malaysia, though development has always taken precedence over the environment, the national five year plans as well as other development plans have shown a greater tendency to encompass the environment into the development mainstream. According to Keizrul (2002), the enabling environment encompasses basically the policies and legislation which determine the “rules of the game” and enable stakeholders at all levels, and in all sectors of society, to play their respective roles in the development and management of the river basin and its resources. An enabling environment requires a clear policy on green growth and green technology related to the water sector, which clarifies the role of government as to who would be the planner, regulator, service provider, etc. The policy should be backed by appropriate law(s), which could be a comprehensive green growth law or a law to co-ordinate the various existing sectoral laws or a combination. Money matters, whether growth is green or not. Hence, a financing structure is a necessary enabling environment to support the policy and legislation. With adequate finance in the right places, an enabling financial environment that prioritises water investments linked to social and economic value needs to be put in place.

In terms of the financial environment, one cannot run away from tariff restructuring, with provision for cost recovery, if not profits. An enabling financial environment without cost recovery and cost efficiency and the necessary price support mechanism to cover the social value of water would not be effective. The use of “carrot” (incentives) and “stick” (fines) principles should also be incorporated into the enabling financial environment to encourage sustainable use of the resources through demand management. An enabling financial environment should also make it simple and profitable for privatisation of the water sector.

The success of Penang in water privatisation should be followed by all States (Chan 2007b). Equally, the failures of certain States in the privatisation of the water sector should be avoided (Santiago 2005).

According to Malaysia's 10th Malaysia Plan 2011–2015, the country has set a target to become an advanced economy by 2020, achieving this via a resilient, low-carbon, resource efficient, and socially-inclusive economy (Government of Malaysia 2011). The country plans to shift from the conventional and costly 'grow first, clean up later' path to a greener trajectory via Green Growth. The government wants to ensure that socioeconomic development is pursued more sustainably, beginning at the planning stage, and continuing throughout the implementation and evaluation stages. Though socio-economic development is vital in raising the quality of lives of Malaysians, natural resources must be exploited efficiently. The Malaysian government sees green growth as a game changer because it is viewed as a development trajectory that embraces the three pillars of sustainable development — economic, social, and environment. The government's green growth strategy, at least on paper, is supposed to profoundly touch every aspect to life from increasing economic growth, to changing mindsets and behaviour at all levels of the society, as well as influencing policy decisions in government, production decisions in industries, and consumption decisions by individuals.

Arguably, some of these claims in terms of government green policy, government green decisions and green incentives provided to industries may be true, but green production in industries is just beginning and is far from significant when taken as a whole (all industries considered). To be honest, green incentives are just not good enough yet

to entice industries into adopting green technology which is still more expensive and technically prohibitive. Some examples are the promotion of solar energy, hybrid cars, fit in tariffs, rainfall harvesting, water recycling plants, and water saving equipment and fittings. All of them are more expensive compared to traditional technology which is not water-friendly. Although given the right enabling environment, the perception of green growth is expected to change from a high cost to a long-term investment for some industries. The most difficult to achieve is to change people's mind sets and behaviours (Chan 2010a). To change an entire populace at all levels of the society is a most daunting task. It may take a generation or more to do so. Malaysia's New Economic Model (NEM), launched in March 2010, aims to transform the Malaysian economy from a mid-income to high-income economy with quality growth by 2020 (*The Star*, 30 March 2010). The keys to the NEM are "high income, sustainability, and inclusiveness" through an improved system of affirmative action with an eye towards sustainable development.

The NEM in itself can be considered an enabling environment for the economy to flourish. The last part here epitomises the so-called "Green Economy". Water would naturally be a key ingredient to sustain the NEM. Without adequate water resources, and without effective control of water disasters (including waterborne diseases), there would be no water security. Without water security, the NEM would collapse. Hence, before the economy can be green, it has to be blue first. In fact, without water security, the entire country would degenerate backwards into a struggling under-developed country. The importance of sustaining water resources and its security cannot be over-stressed and this is emphasised in the 10th Malaysia Plan <http://www.epu.gov.my/html/themes/epu/html/RMKE10/rmke10_english.html>.

Institutional Framework

While an enabling environment is a pre-requisite for success linking water and green growth, an institutional framework is necessary to put into practice green growth in the water sector. The term “institutional” in the context of water and green growth is seen in a wider context to include not just government, but all stakeholders, including the private sector, NGOs and the public. An institutional framework lays out the roles and functions of the various institutions at various levels of integration. At the federal level, green growth is the jurisdiction of the Ministry of Energy, Green Technology and Water. Under this ministry, GreenTech Malaysia has been formed to promote four flagships to catalyse green growth in the country, viz. the Green Malaysia Plan, Green Procurement, Electric Mobility and Sustainable Living. At the state level, state governments are encouraged to jointly promote these areas that lead to green growth. It is of paramount importance that state governments come on board the green growth bandwagon as land and water are under State jurisdiction. As such, state level institutions will have to play a pivotal role in implementing green growth in the water sector, with support from institutions at federal and local government levels. A comprehensive institutional framework in the context of inclusiveness should also be in line with the principle of participatory approach which engages the roles of civil society and communities in integrating them to the overall institutional framework. Currently, not all federal and state governments cooperate well in green growth and the water arena, much less between different state governments or between state and local governments.

Currently, institutional arrangements for the water sector in Malaysia is shared by a wide array of different ministries and government

departments, some complementing each other while others are competing against one another (Keizrul 2002). Institutional arrangements for green growth and water resources at government level are shared by many ministries and government agencies. At the Federal level, while the Ministry of Energy, Green Technology and Water (MEGTW) is the single agency in charge of green growth, the same cannot be said for water. While the MEGTW looks after water as a commodity (e.g. as in water supply), the Ministry of Natural Resources and Environment (NRE) looks after water as a resource. Under these two ministries are departments that are responsible for managing water such as in the Department of Environment, SPAN, Department of Drainage and Irrigation (DID) and others. Even the DID is split as it has two different divisions, one under the Ministry of Agriculture looking after irrigation and drainage while the other is under NRE looking after rivers and water resources. In terms of water resources, investments in water supply had always been under the purview and responsibility of the 13 States of the country, with the federal government relegated to a secondary role. Although the federal government drafts the water policies, water-related laws and regulations, and develops and implements the five-year development Malaysia plans, it is the state governments that carry out all the implementation of water projects within the state boundaries.

All Federal water projects are also carried out on state land unless the land is on the few federal territories. However, since the federal government collects all the taxes, it is the federal government that has the funds to finance all the water projects. The irony is that States have limited funds to implement water projects and have to depend heavily on the federal government for funding. Given such a scenario, most States depend on

fiscal transfers from the federal government to fund projects. Therefore, Malaysia is often considered a de facto unitary state based on federalism whereby the federal government had always and still continues to play a significant role in the development of the water sector, despite the water services being located within state boundaries and are legally an exclusive responsibility of the States. As a result of this scenario, the country was faced with huge debts by water utilities under state jurisdictions, due to poor efficiency and poor cost recovery and low tariffs. Water must have a valuation to its true value (Chan 2012b).

Consequently, in 2003 the federal government decided to embark on a water sector reform to make the sector more efficient via creating a sustainable funding mechanism and to improve the customer orientation of service provision (Kim 2012). However, this move was seen by the States as the federal's government's aim of taking over the water sector from the States. Via this reform, the role of the federal government in the water sector was considerably strengthened (Teo 2009). This led to the constitutional amendment approved in January 2005 whereby water services became a shared responsibility between the States and the Federal Government under the concurrent list. Two water laws on the reforms were passed in July 2006, viz. the *Suruhanjaya Perkhidmatan Air Negara Act 2006* and *Water Services Industry Act 2006* (WSIA). The former provides for the establishment of Suruhanjaya Perkhidmatan Air Negara (SPAN) or National Water Services Commission as the technical and economic regulator and set out the function and powers of SPAN.

WSIA provides the legal framework required for the regulation of the water and sewerage service industry. The Acts were enforced on 1 February 2007 and 1 January 2008 respectively.

However, until today only six States have taken up the facility by Pengurusan Aset Air Berhad, viz. Melaka, Negeri Sembilan, Johor, Perlis, Penang, and Perak. The remaining States have yet to sign. To add to the confusion, these two new laws and reforms only applies to Peninsular Malaysia while Sabah and Sarawak in East Malaysia have their own institutional arrangements in the water sector. Subsequent to these new reforms, the government has also declared that no more water services concessions will be awarded. Existing concessionaires that choose to remain with their concession agreements are allowed to operate until the end of their concessions. State water companies now require an operating licence and are gradually being corporatised.

Since investments in sewerage did not keep pace with investments in water supply, the responsibility for sewerage in much of peninsular Malaysia was transferred from local governments to Indah Water Konsortium (IWK) in 1994, a private company. Unfortunately, however, IWK did not have the acceptance of the masses and suffered huge losses when consumers refused to pay their fees. After about six years of suffering losses, the concession was cancelled and the federal government took over the ownership of IWK in 2000 (Chong 2001). All said, institutional arrangements for the water sector in Malaysia is far from satisfactory although several States have signed the agreement with the federal government to migrate to the new scheme.

For the green growth sector, the institutional framework is clear and effective as the MEGTW is the single agency in charge of green growth. Under the MEGTW GreenTech Malaysia is charged with the promotion and catalysing of green growth in the country. Similarly, for the water sector, the ideal institutional framework would be a single authority vested with all the

right and might to deal with the water sector, including both water as a commodity (service) as well as a resource. Currently, SPAN is doing this job on the water as a commodity aspect but does not have jurisdiction over water as a resource. Such a sectoral approach is not effective as management of the water sector is divided and not in a comprehensive and integrated manner. A single agency (e.g. a Ministry of Water by itself) would serve as a one-stop agency responsible for overall planning, co-ordinate, monitor, regulating, licensing, enforcing and managing the sector and its resources, looking at both the natural as well as human aspects of water.

To avoid biases and potential conflicts of interest, this agency should focus on a regulatory role and not be at the same time a service provider or implementer (developer) (Keizul 2002). Furthermore, the institutional capacity building will be needed to build up the knowledge, skills and expertise required to carry out the tasks required in the sector. Such capacity building efforts should not be confined to government institutions but should include the private sector institutions, their professional associations (e.g. Institution of Engineers, Malaysian Water Association etc.) as well as NGOs (e.g. Water Watch Penang, Malaysian Environmental NGOs, WWF Malaysia, etc.) and other community institutions.

Management Instruments

Once an enabling environment and the institutional arrangements are in place, management instruments are needed to carry out the projects/programmes and plans. Management instruments are described as the elements and methods that enable and help decision-makers to make rational and informed choices between alternative actions. In the water sector, it includes a

wide range of methods, both quantitative and qualitative, based on a combination of multi-disciplines including green technology, hydrology, hydraulics, environmental sciences, engineering, law, sociology and economics (Global Water Partnership <http://www.gwp.org/en/ToolBox/TOOLS/Management-Instruments/>). Every country is different climatically, geographically, politically, economically, socially and otherwise. Hence, no one size fits all. Management instruments are therefore expected to be markedly different from one country to another.

To achieve green growth in the water sector, it is necessary to select the management instruments that not only better suit the country but also suit certain conditions and specificity. As the existing social, economic and political contexts may differ over time and space, and available resources also vary, a management instrument may be suitable for a specific temporal (time) and location (space) may not be applicable for another location or time. Hence, it is imperative that policymakers and decision makers understand how a selected management instrument work, and the experiences and lessons that have been acquired after applying these instruments on different realities, so that it is possible to select best options while adapting to local conditions. One bad example that we have inherited from other countries is the use of timer-based urinals in male toilets. These urinals continue to flush and waste water during low seasons where there are few visitors. In universities and schools, the urinals continue to run during the three-month holiday period although there is not a single person using them. Consequently, if the management instrument here is timer-based urinals, then it has failed miserably (Chan 2013).

Chan (2011) claimed that historically and traditionally, the main management instrument use for water supply was the top-down government-centric Water Supply Management (WSM) instrument. As a management instrument, WSM is anything but green. This is because WSM requires huge investments in infrastructures such as dams, treatment plants, interstate water transfers canal and tunnels, and other constructions. Building all these structures would have disastrous consequences on the environment and can hardly be considered green growth. Arguably one can say that these structures can be built by green architecture. This then can be considered green growth in the water sector. However, looking at all the current structures that have been built in Malaysia past and present, it would not be wrong to say that the majority are not green structures.

Their construction had involved deforestation, use of fossil fuels, dislocation of local communities, destruction of water catchments, sedimentation and water pollution, and downstream flooding, to name a few of the problems (Chan & Wan Ruslan 1997). In contrast, water demand management (WDM) is a much greener instrument for solving the country's water problems. WDM is relatively free of capital investment (Capex) and the water-saving devices are considered green technology (SPAN 2013; Chan 2016). Malaysia can still use the WSM instrument selectively, but must ensure the construction of structures follow the green architecture or green building regulations. Another component of green growth is capacity building of contractors, businesses and communities. Contractors and businesses must have green labelling of their water products which follows SPAN guidelines. When all these stakeholders in the WDM sector work in tandem, then the growth of this sector will be green as the actors, products and processes are all green. Green products will

also eventually lead to a change in both water behaviour (e.g. control of water flow, pressure, quantity and quality, etc.) via green technology products such as dual-flush cisterns, water regulators, automatic faucets, and push-flush urinals (Chuah 2010).

Technology, however, cannot change human behaviour in relation to water use. In this respect, changing human behaviour in the way people look at water and use water is also a management instrument, albeit a sociological one. Research has shown that human behaviour is extremely complex. More so, when the behaviour has been conditioned and practised over decades, it is extremely difficult to change. Hence, in the area of water resources management, water managers, especially engineers and technical experts are very sceptical about the success rate of achieving sustainable water resources supply by changing human behaviour via water demand management (Chan & Nitivattananon, 2006). Hence, technical and scientific experts are more inclined to change the behaviour of water (via the entire spectrum of water supply from abstraction to treatment and distribution). Results from many studies have shown that water behaviour can be manipulated and changed to achieve specified targets. For example, water pressures and water flow can be easily manipulated via technical solutions. When water has reached the consumers, water consumption can also be reduced via controlling pressure, use of water friendly equipment, restriction valves, water regulators, dual-flush toilet systems and pressurised flush systems which require less water.

Results of such technical applications to change the behaviour of water have yielded reductions in water consumption between 20 to 40% of normal water use (Chan 2012a). On account of this, large water users such as big

hotels, universities, factories and industries have adopted technical water demand management measures to change water behaviour. However, social scientists, especially researchers in the field of environmental humanities believe that merely adopting a technical solution that only addresses a technical problem does not solve the entire problem of inadequate water supplies (Chan 2010b). This is because, water management and use are human-managed activities that take place within a social-cultural context, and serve societal needs. Hence, social science as a management instrument, has much to contribute to better water management, particularly on understanding who manages water, who uses water and for what purposes, who has access to water and what are the priorities, how water use patterns can be modified, and how new innovations in water efficiencies can be adopted in society (Phang *et al.* 2014). Social science also contributes to Government-Private Sector-NGO partnerships, and community water management, policy initiatives, tariffs determination, and other social aspects of water management. In fact, in IWRM, one of its principles is that of inclusiveness of the social dimensions that involves the use of social impact assessments, social indicators, and other social management instruments to ensure that the social dimension of a sustainable water policy is included. This includes equitable access, the role of women, and proportion of water bill in family income.

Another management instrument to kick start green growth in the water sector is that of green procurement. In fact, this is the second flagship of the MEGTW which advocates the purchase of environmentally-friendly products in the water sector. As the enabling environment has been put in place by MEGTW, the next step is to get multinationals and local companies to change their procurement habits, as well

as to manufacture and market green products and services. MEGTW has recently launched MyHijau, a directory of green products and services. To this end, awareness campaigns and exhibitions need to be held year-round to create the awareness and encourage both public and private sectors to adopt the habit of green procurement.

The National Water Services Industry Commission's Guidelines for voluntary water efficient products labelling scheme launched in 2013 is a good example of water efficiency guidelines for the water sector that encourages the use of green products towards green growth in the water sector (National Water Services Industry Commission 2013). These guidelines, though not mandatory yet, is a good management instrument to ensure only water-saving fittings remain in the market at the eventual banning of water-wasting traditional water fittings and equipment. In many developed countries, people willingly adopt a water-friendly lifestyle and move towards wise water consumption and use of water-friendly fittings, all of which lead to significant water savings, as is the case of Australia, Japan, Denmark, Singapore and some parts of the United States. As a management instrument, the government needs to highlight the best management practices of WDM in Malaysia, both in terms of green technology and human behavioural change in water efficiency management towards achieving green growth. Water efficiency and water conservation are seen as a pre-requisite towards achieving green growth which ultimately leads to a green economy. In this respect, government should seek to highlight alternative, affordable and highly effective water saving devices and water conservation methods of changing water behaviour towards reduction in water use, as well as effective measures of changing human behaviour in relation to the ways people look at

water and how they use water towards long-term sustainability of water resources in the country. All these are definitely green methods that will eventually lead towards green growth.

In Malaysia, an example of a successful WEM practice is that of N-Park Condominium, a 965 unit apartment in Penang. This is a smart partnership project between the Federal Government (via the Drainage and Irrigation Department), N-Park management Corporation, *Perbadanan Bekalan Air Pulau Pinang Sdn Bhd* and Water Watch Penang. This is the best management practices (BMP) project on water demand reduction based on the demonstration project model. The main objective is to create greater awareness about the importance of water conservation and the creation of a “water valuing” community network in Malaysia. The N-Park Water Saving Project includes installation of a rainfall harvesting system made up of six tanks of 10,000 litres each, installation of water-saving equipment and fittings in the common toilets, and installation of water saving devices and fittings in individual apartments. The project over 15 months has shown significant water savings in terms of water consumption which was reduced by between 20 to 30 % in the condominium. This level of reduction in water use was achieved by merely changing the behaviour of water via pressure restrictors, water regulators, water saving equipment and water saving gadgets.

In addition, participants and the community of the N-Park Resort Condominium have also gained an insight and awareness on the importance and significance of water, Water Demand Management, rainwater harvesting, water-saving devices and greater neighbourliness amongst the residents. Here, human behaviour change was also put into effect as participants were taught many ways to reduce water consumption, such as

brushing teeth with a cup instead of a running tap, washing cars with two pails of water instead of a running hose, switching off the shower when shampooing, etc <<http://www.waterwatchpenang.org>>. In terms of monetary savings, the condominium saved RM3609 for the two months of April and May 2010, RM3524 for the two months of June and July 2010 and RM1249 for the two months of August and September 2010. This translates to an average monthly saving of RM1397. This project not only demonstrates that our high monthly rainfall gives great potentials for rainfall harvesting, but also proves that such a project can be easily replicated throughout the country, not just for apartments and condominiums, but also for all other high-rise buildings, including hotels.

In terms of hotels, Taigate Industries Sdn Bhd, one of the few businesses focused on WEM, has demonstrated that all the hotels that have adopted the Taigate System has achieved significant savings (Chuah 2010). A hotel in Johor Bahru achieved an average monetary savings of RM9,026 over a 30-month period. This represents only the direct savings in terms of water costs (which excluded hotel savings in wastewater treatment, water pumps maintenance and heating costs which were also reduced as a result of less water being used). The payback period based on the hotel's RM250,000 investment in the project was calculated to be about 2.3 years. Thereafter, it is savings all the way to the bank to the tune of RM9,026 every month. On top of that, the hotel gets a green image that is a huge attraction to green travellers and green businesses. The most unbelievable part is that despite increases in occupancy rate, the water consumption was seen as decreasing. Before installation of the water saving system, the water consumption pattern follows closely the occupancy rate. Another hotel, also in Johor Bahru, achieved an average monetary savings of RM8,763 over a

19 month period. The payback period based on the hotel's RM270,000 investment in the project was calculated to be about 2.56 years.

Water tariff restructuring is another management instrument that needs to be put in place if green growth in the water sector is to be achieved. Historically until now, the reluctance of many state governments to price water like other goods (such as electricity and telephone charges) has brought about negative effects on the water sector. Water should be treated as a socio-economic good with a positive pricing where there is competing demand and finite supply because the wrong pricing of water will lead to misallocation of resources and wastage of water (due to no encouragement or incentives to save water) (Leow 2016). Chan (2016) has lamented that low tariffs that are heavily subsidised by state governments are making the water sector unsustainable due to high NRW losses and per capita water consumption. Both these are making the growth in the water sector and other sectors big contributors to carbon emissions. This is translated as non-green growth, even though the growth generates huge incomes and other aspects of economic developments. As a management instrument, it is crucial that water tariffs be restructured to ensure they encourage water conservation. The current domestic tariffs throughout the country are heavily subsidised by the government (federal and state) and do not even come close to cost-recovery. Such low tariffs do not encourage water conservation in all sectors, be it industrial, domestic or agriculture. Industries do not find it economically attractive to install recycling plants, water saving devices or look for alternative water sources such as groundwater or rainfall harvesting as water tariffs are much too low. Tariffs must be reasonably high to make green technology investments in the water sector economically feasible. For domestic water supply, a tariff

structure of at least cost recovery if not marginal profits should be implemented. With some profits, water service providers, be it government or privatised entities, will be able to keep their noses above the water, so to speak. To ensure the poor are not victimised, tariffs for the first 20 m³ per month per family should stay. From the 21 m³ onwards, the tariff should be first at cost recovery followed by a sharp increase for every subsequent 10 m³ of water used.

Investments in Water Infrastructure

Finally, investments in water infrastructures must be based on green infrastructures that contribute towards green growth. Investments are inevitable to ensure the economy flourish and there are jobs for fresh graduates. In essence, despite the non-green nature of huge infrastructures, the population is exploding and industries and agriculture expanding. This ever increasing need and demand for water vis-à-vis a finite amount of water will eventually see demand outstrip supply. Green investments will ensure that companies active in the water sector will benefit from what is required by the country, i.e. to push for green growth and a green economy. Malaysia is no longer a poor and backward developing country banking on dirty industries and non-green production systems. The country is nearly there as a developed nation and with an educated populace and far sighted government, has planned for green growth and a green economy.

Malaysia cannot compete in the international arena if its products are not labelled green. The importers and customers all demand it. If we do not have green products, they will not buy from us. By the same token, it pays for hotels to go green as their clientele are highly educated and many will book hotels not solely based on price

and reputation but increasingly on how green the hotel is. Therefore, investments in the green technology used to build water infrastructures are the necessary drivers to ensure Malaysia does not fall by the side but keep its competitive edge. At the same time, consumers are increasingly concerned about national water safety and water quality. Investments in water infrastructures are needed to tackle these issues. This is one potentially huge area for green businesses to invest in.

Investments in green technologies in the water sector is also necessary for the face of climate change as Malaysia will increasingly be experiencing

increased incidence of extreme weather events that can magnify into disasters such as the 1997/98 El Nino drought, the current El Nino and the massive floods in Johor in 2006/2007 and Kelantan/Pahang in 2014 (Nor 2016). Yet, interestingly, natural disasters such as floods and droughts can give rise to a number of innovative new investment opportunities. For example, it is worth noting that there are some new technologies that have been developed to counter the severe drought. Likewise, green technologies using water saving devices could be the new investments that everybody needs. Water recycling, rainfall harvesting, and desalination could be the new investments to drive the green growth in the country. During El Nino droughts, the lack of water will make the treatment of brackish water, reverse osmosis, and desalination technologies attractive and economically viable as they become more competitive.

Investments in grey water products as in the treatment of wastewater also have huge potentials as the treated wastewater can be used for irrigation and industrial applications. In many countries, reverse osmosis desalination of seawater for potable water is increasingly affordable and looks to be one of the water

solutions in the longer term. As energy costs drop vis-à-vis improvement in technology, the cost of desalination (which until recently was prohibitive for developing countries) has now become feasible. Considering that the cost of reverse osmosis is now about only twice the price of conventional extraction and treatment of river water, this technology if it embraces green technology, will become possible (*Gottelier 2015*).

Conclusion

In the aftermath of Rio+20, the goal to sustainable development is repackaged via the “green economy” concept. Malaysia subscribes to this concept and has realigned its development plans in tandem with targeting a green economy via green governance, green technology, and green production. In terms of water resources management, this chapter has argued that the water sector can be green and this can lead to green growth in the economy. To achieve green growth in the water sector, a positive enabling environment needs to be first created, followed by institutional arrangements and management instruments and investments, though not necessarily all in infrastructure development. This chapter has discussed all these in detail and concludes that all these can be achieved. However, there are many hindrances that obstruct the march towards a green economy. Amongst them are low water tariffs and reluctance of politicians to revise tariffs, a misconception amongst industry players that green technology is expensive, lack of attractive significant incentives to go green, low awareness of consumers on green technology who prefer to look at price above all, lack of laws and mandatory regulations for the implementation of green technology in the water sector, and a high dependence on the government top-down WSM instrument.

Despite all these hindrances, with political will, proper regulatory control, and better governance, the water can be green and can contribute significantly towards green growth in the country. This chapter also concludes that despite countries chasing a green economy towards sustainable development, an economy cannot be green unless it is blue first. That is to say “Water must first be addressed” well before economy. In the light of global climate change reducing water availability, coupled with population, industry and agricultural growth, WDM is a great green instrument of green growth that leads to sustainable water resources management. The amount of water is finite but water demand is infinite. WSM is not green and needs to embrace green building codes and use green processes and products.

More importantly, WSM can no longer remain as the sole water management approach. As long as water consumers do not heed the call to play their part in water conservation, WSM will not be able to supply all the water that is demanded. Hence, there is an urgent need for the water consumers (industry, businesses, universities and schools, and households) to play a more active role in helping to conserve water resources, viz. to reduce their water demand. This chapter has illustrated how all these water consumers can apply WDM measures to save water. Currently, domestic water users consume roughly more than half of Malaysia’s total water demand. Because of this huge volume, any reduction in consumption can save the country a lot of water, and ensure long-term sustainability. On the national front, WDM and other green strategies will ensure that our water resources are not depleted but remain sustainable. Money saved without having to embark on mega-water infrastructure non-green projects will certainly be very useful in addressing the other water problems in the country such as the high percentage of non-

revenue water, upgrading of water treatment plants, maintenance of existing dams, national campaign on educating the public on awareness and other important water-related projects.

Acknowledgements

The author wishes to thank the Sumitomo Foundation for supporting the project *Collaborative Learning of Integrated River Basin Management: A Comparative Study of the Tsurumi River Management Model and Pinang River Management Model* under the Sumitomo Foundation Fiscal 2014 Grant for Japan-related Research Projects, 31 April 2015 – 31 March 2016 from which this paper is written.

REFERENCES

- Araral, E & Wang, Y 2013, 'Water demand management: review of literature and comparison in South-East Asia', *International Journal of Water Resources Development*, vol. 29, no. 3, pp. 434–450.
- Associated Press*, 16 March 2009.
- Breckle, SW, Wucherer, W, Dimeyeva, LA & Ogar, NP (eds.) 2012, *Aralkum — a Man-made desert: the dessicated floor of the Aral Sea (Central Asia)*, Ecological Studies 218, Springer-Verlag Berlin Heidelberg.
- Carson, R 1962, *Silent spring*, First Mariner Books Edition 2002, New York.
- Chan, NW 2004, *Managing water resources in the 21st century: involving all stakeholders towards sustainable water resources management in Malaysia*, Bangi, Environmental Management Programme, Centre for Graduate Studies, Universiti Kebangsaan Malaysia.
- Chan, NW 2006, 'Striking a balance between development and environment in Cameron Highlands', in *Cameron Highlands: Issues and Challenges in Sustainable Development*, ed NW Chan, Penang: School of Humanities, Universiti Sains Malaysia.
- Chan, NW 2007a, 'A comparative study of water conservation in hotels in Georgetown (Malaysia) and Pattaya (Thailand)', in *Proceedings of the 3rd Southeast Asia Water Forum*, Kuala Lumpur.
- Chan, NW 2007b, 'The perbadanan Bekalan Air Pulau Pinang Sdn Bhd: a good example of corporate social responsibility of a private water company', In *Proceedings of International Forum on Water Environment Governance in Asia — Technologies and Institutional Systems for Water Environmental Governance*, Ministry of Environment, Japan, Tokyo, 19–25.
- Chan, NW 2010a, 'Changing water behaviour and human behaviour: keys to attaining sustainable water resources management', in *Proceedings of the First National Seminar on Environmental Humanities*, ed NW Chan, Penang: Social Transformation Platform, Universiti Sains Malaysia.
- Chan, NW 2010b, 'Water demand management (nega-litres) demonstration project at N-PARK Condominium BMP project: a smart-partnership Pilot project on IWRM involving government-private sector-NGO-local community', in Keynote paper presented at *National Seminar/ Workshop on Integrated Water Resources Management (IWRM)*, "Making IWRM Work at local level—Lessons learnt", 25 October 2010, Penang.
- Chan, NW 2011, 'Water Demand management: balancing a change in water and human behaviour as complementary measures in sustainable water resources management', in *Asia Pacific Regional Water Conference & Exhibition*, Subang, Malaysia, 15 – 17 March.
- Chan, NW 2012a, 'Transforming School of Humanities Universiti Sains Malaysia into an example of a best management practice in water demand management', in *International Proceedings of Chemical, Biological and Environmental Engineering*, 161–165.

- Chan, NW 2012b, 'Water Valuation', in *Malaysia Water Resources Management Forum 2012 "Time for Solutions"*, 26–27 November 2012, Putrajaya.
- Chan, NW 2013, 'Water—Issues and conservation in the Asian Region: benefits and challenges in the School of Humanities Universiti Sains Malaysia Water Saving Project', Invited Keynote Paper presented at the *International Sustainable Campus Network (ISCN) 2013*, Working Group 1 Program as of June 12, 2013, National University of Singapore, Buildings and their sustainability impacts.
- Chan, NW 2016, 'Raising awareness and its impact on water usage in Penang, Malaysia', in *Asiawater 2016*, Kuala Lumpur, Malaysia, 6 April 2016.
- Chan, NW & Nitivattananon, V 2006, 'Effective Management of Water Resources Via Demand management: Some Examples from Southeast Asia', in *IHP International Symposium on Managing Water Supply for Growing Demand*, Bangkok, Thailand, 16–17 October 2006.
- Chan, NW & Wan Rusli, I 1997, Impak manusia terhadap unsur-unsur kitaran hidrologi di Malaysia, Ilmu Alam 23.
- Chang, WF, Chan, NW, Hajar AB & Khor HT 2004, 'Approaching integrated Water Resources Management (IWRM) via smart-partnerships with government, industry and other NGOs – The role of water watch Penang', in *"Rivers '04 Proceedings of the 1st International Conference on Managing Rivers in the 21st Century: Issues & Challenges"*. River Engineering and Urban Drainage Research Centre, eds AG Aminuddin et al. Engineering Campus, Universiti Sains Malaysia, 302–313.
- Chong Yen, L 2001, 'IWK bailout a wastage of public funds. MalaysiaKini', 19 April, viewed <www.malaysiakini.com/news/2090>.
- Chuah, L 2010, 'Examples of water savings from implementation of water conservation measures in hotels and hostels', in *Aqua Save Workshop and Exhibition*, Penang Skills Development Centre (PSDC), Bayan Lepas, Penang, Perbadanan Bekalan Air Pulau Pinang Sdn Bhd.
- Gleick, P, Haasz, D, Henges-Jack, C, Srinivasan, V, Wolff, G, Cushing, KK & Mann, A 2003, 'Waste not, want not: the potential for urban water conservation in California', Report Prepared for the California Dept. of Water Resources, Pacific Institute, Oakland, CA.
- Global Water Partnership, <<http://www.gwp.org/en/ToolBox/TOOLS/Management-Instruments/>>, viewed 12 April 2016.
- Gottelier, S 2015, 'The future of water: why investing in water infrastructure and technologies is important to all of us', *March 2015 eJournal* <<http://www.greenmoneyjournal.com/>>, viewed 12 April 2016.
- Government of Malaysia 2011, *Chapter 6: Pursuing green growth for sustainability and resilience. In Tenth Malaysia Plan, 2011–2015*, Kuala Lumpur.
- Government of the Republic of Korea [The Ministry of Land, Transport and Maritime Affairs, the Presidential Committee on Green Growth

and the Korea Water Resources Corporation (K-water)] and the World Water Council 2012, *Water and green growth*, edn 1, 2012, Seoul, Government of the Republic of Korea and the World Water Council.

Keizrul, A 2002, 'Integrated river basin management', in *Rivers: Towards Sustainable Development*, ed NW Chan, Penerbit Universiti Sains Malaysia.

<http://www.epu.gov.my/html/themes/epu/html/RMKE10/rmke10_english.html 27/1/11>.

<<http://www.un.org/apps/news/story.asp?NewsID=25527&Cr=water&Cr1> 15/9/11>.

<<http://www.waterwatchpenang.org> 28/1/11>.

<<http://epi.yale.edu/reports/2016-report>>, viewed 8 April 2016.

<<http://www.uncsd2012.org/index.php?menu=62>>, viewed 8 April 2016.

IUCN 2000, 'Towards developing effective water demand management strategies for Southern Africa', in *Proceedings of the Regional Water Demand Management Conference*, Johannesburg, Republic of South Africa.

Khor, M 2010, 'Make global water crisis a top priority issue, global geopolitics and political economy', September 29, 2010, <http://globalgeopolitics.net/wordpress/2010/09/29/make-global-water-crisis-a-top-priority-issue/> 27/1/11>.

Kim, CT 2012, 'Malaysian water sector reform—Policy and performance', PhD thesis, Wageningen University, Wageningen, NL.

Leow, PF 2016, 'Challenges of water pricing: the Malaysian experience', in *Asiawater 2016*, Kuala Lumpur, Malaysia, 6 April 2016.

Lim, CY 2014, 'Catalysing green growth: 4 keys to a sustainable future', *The Star* (Online) 21 July 2014, <<http://www.thestar.com.my/news/environment/2014/07/21/catalysing-green-growth-4-keys-to-a-sustainable-future>>.

Ministry of Energy, Green Technology and Water 2012, 'Research and innovation—green technology policy', in *Malaysia Water Resources Management Forum 2012: "Time for Solutions"*, 26–27 November 2012, Putrajaya.

Nor, AZ 2016, 'Integrated assessment of extreme rainfall-runoff on flood hazard, water quality and microbial variability, and enhancement of standard operating procedures (SOP) for flood disaster awareness: case study of Sungai Pahang River Basin', in *Bengkel II Kajian Bencana Banjir 2016*, 4–6 April 2016, Putrajaya.

Phang, WL, Lai, CH & Chan, NW 2014, 'Domestic water saving practices as a water demand management strategy in Penang, Malaysia', in *Proceedings of 13th International Conference on Urban Drainage, Sarawak, Malaysia*, 7–12 September 2014, Kuching, Universiti Tenaga Nasional.

Ponting, C 2007, *A green history of the world: the environment and the collapse of great civilizations*, Penguin Books, New York.

Organisation for Economic Co-operation and Development (OECD) 2011, *Towards green growth*, viewed 12 Feb. 2012, <www.oecd.org/dataoecd/37/34/48224539.pdf>.

Rohani H, Mariani AA, Mohamad MY, Kamaliah, S, Ramli, M, Adnan, H & Wong, CJ 2010, 'The environmental non-governmental organizations (ENGOS) in Malaysia Northern Region: their roles in protecting water resources', *International NGO Journal*, vol. 5, no. 7, pp. 167–170.

Santiago, C 2005, 'Why water must not fall into private hands. Profitable and efficient Penang Water Authority is a model for the public management of water supply', *Aliran Monthly*, vol. 25, no. 1.

SPAN (2013) *Guidelines for voluntary water efficient products labelling scheme*, Kuala Lumpur, Suruhanjaya Perkhidmatan Air Negara, viewed 11 April 2016, <<http://www.span.gov.my/pdf/wepls/guidelines.pdf>>.

Teo, YH 2009, 'Water sector reforms in Malaysia', *Water Utility Management International*, vol. 4, no. 1, pp. 16–17.
The Star, 30 March 2010.

Tortalajada, C 2006, 'Singapore: an exemplary case for urban water management', <http://hdr.undp.org/en/reports/global/hdr2006/papers/Cecilia_Tortajada_Singapore_casestudy.pdf 19/2/11>.

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) 2010, *Guidelines for establishment of the national strategies for eco-efficient water infrastructure development*, Draft report, Bangkok, UNESCAP.

Water and Gender

Expert Review

Sunitha Bisan

This paper seeks to introduce why gender is important for a more inclusive and integrated water sector management in Malaysia. The paper is structured into three (3) sections. First section (*Why Gender Matters*) provides an introduction of gender and the common terminology for gender analysis. Second section (*Why Gender Mainstreaming*) explores why gender mainstreaming is important in water sector management. Third section (*Recommendations*) discusses some recommendations to strengthening gender mainstreaming processes in water sector management in Malaysia.

This paper starts by acknowledging that Malaysia is committed to gender mainstreaming and promotion of gender equality through its international commitment such as Convention on the Elimination of All Forms of Discrimination against Women as well as the current Sustainable Development Goals (SDGs). These commitments have been translated into national development priorities and policies. However, measures to implement gender mainstreaming are still weak. Further, the data available on gender and water sector management is extremely limited. Given these constraints, this paper aims to offer some strategic pointers

on why as well as how gender considerations and actions can be incorporated into water management.

It is increasingly being recognised that challenges in developing pathways for sustainable development including water management are the challenge of gender equality and climate change. The unsustainability of development and gender inequality are interconnected and need to be addressed together as climate change accentuates inequalities with gender being most pervasive. Yet, we find that the climate debate struggles to recognise gender mainstreaming as a means to support the effective actions for mitigation and adaptation (Dankelman 2010).

The recent Paris Agreement adopted on 12 December 2015 by 195 parties to the United Nations Convention on Climate Change (UNFCCC) had intense deliberations on various issues including gender. Finally, gender is seen referenced, albeit limitedly. The Paris Agreement set to be in operations by 2020 does have some important shortfalls, in particular for means of implementation. Sadly, the Paris Agreement does not explicitly mention water

despite the fact that water is a high priority for development (Goal 6, SDGs).

These challenges demonstrate an emerging demand and need to understand priorities, needs and linkages between gender and the scale of environmental impacts on natural resources, in particular water. Gender mainstreaming highlights the differential cause and effect on men, women, boys and girls as gender and climate change are key influencers in their lives that create different exposures and vulnerabilities.

This highlights the World Water Vision Report (2000):

“To ensure the sustainability of water, we must view it holistically, balancing competing demands on it—domestic, agricultural, industrial (including energy), and environmental. Sustainable management of water resources **requires systemic, integrated decision making**” (emphasis added)

Why Gender Matters

Gender, as it has historically been advocated as a means of women’s empowerment, has been stereotyped into welfare based programmes and actions that support the uplifting of women’s status. This is one of the reasons why gender is rarely addressed in environmental resources and climate change debates and programmes. Gender becomes relevant only with people’s participation bearing a general attitude of “adding” women. Additionally, this tendency is because gender dimensions are “not self-evident, and there is little data, research, or

case studies clarifying and exemplifying the linkages between gender justice and climate change” (Roehr2007).

Despite the strong commitments seen in government policies, systemic change needed to keep pace with contemporary challenges of economic, environment, social and cultural conditions are rather slow. Gender supports a transformative thinking that is crucial to ensure sustainable water resources development and efficient water supply services. The situation is not about not having enough water but an issue of management.

In order to support a more integrated approach to water resource management, new spaces for transformation is needed. These frameworks not only need to understand the differentiated factors that impact lives of women and men but also how they cope and respond to these disadvantages.

Women and men are not homogeneous groups but include other intersectional factors such as age, ethnicity, education, location, and economic backgrounds. This raises the important caveat of one-size fits all approach. Gender analysis highlights these gender differences in gender roles, time use, access and control over assets, access to credit including markets of individuals irrespective in a rural or urban community. This includes understanding how individuals care for their families and community including the sharing of traditional knowledge in protecting and managing their natural resources.

Gender Analysis is not about making separate plans including. It is about determining the needs of men and women, how and where they differ as well as the difference in respond to proposed changes and interventions. It is

important to appreciate that “gender” is not another word for women. Gender is a concept that includes men, women, boys and girls and not limited to a heterosexual masculine privilege.

Gender analysis makes visible:

- *WHO* by exposing the different interests and privileges of different members of community based on sex, age and relationships etc. have on resources including natural resources.
- *WHEN* by appreciating the types of access to these resources.
- Importantly, *HOW* can the water resource be better managed? Would an economic approach with market mechanism create better utility?

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 the issue of drought, heavy rainfalls, and frequency of floods increase women’s burdens. Therefore, in ensuring a cost effective and efficient approach to addressing water-issue including water governance, gender mainstreaming is important.

Why Gender Mainstreaming

The convergence of these various issues influences how the response to climate impact

or perception of future impacts is formed. These responses can be spontaneous, involuntary or deliberate. Gender analysis promotes greater inclusion, not only for environmental and biodiversity conservation but also as a prerequisite to poverty eradication and sustainable development where water sector management is essential (Adger & Kelly 1999).

It is important to acknowledge that gender mainstreaming create outcomes that are not only supportive of national development but also ones that improve the quality of life. Actions that are based on stereotyping fail to capture actual people’s attitudes and behaviours. Programmes and policies that are based on stereotypes may result in reinforcing or contributing to gender and other inequalities (Rommes 2006).

The Malaysia’s National Communication No 2 (NC2) to the UNFCCC reported that health issues concentrated on communicable diseases such as vector-borne diseases, such as malaria, dengue and water-borne diseases like diarrhoea (NRE 2011). The NC2 appraises that although there are “several modes of transmission for diarrhoeal diseases which include food, water, insect and contact with infected person”, these incidences are “greatly influenced by the level of sanitation and the availability of clean water supply” (NRE 2011, p. 60). It was further linked to climate change as an issue of water availability during times of drought and rainfall run-off that contaminates the clean water supply. This report neglects to incorporate gender analysis for various reasons including the lack of available research on the subject.

In our effort to operationalise our Intended Nationally Determined Contributions (INDCs), water management is important. Water is a key resource not only for households but it is

required to produce nearly all forms of energy from solar to hydropower. In order to capture the importance of water, gender analysis needs to be promoted to ensure issues of land use, infrastructure, and conservation of resources, challenges and opportunities needed to mitigate gender inequalities. This analysis should include also water as a natural resource. Existing patterns of governance determines how benefits are distributed and what issues are recognised. The lack of emphasis placed in water is strange in the context of promoting a low carbon development pathway and green economy.

Gender mainstreaming with enabling gender methodologies from data and analysis needs to be incorporated into the water value chain that includes the design of policies, private sector influence, and end-users. In a recent study on the nexus of Climate Change and Sexual and Reproductive Health, it was highlighted that management and implementation are still a challenge. A Sarawak participant shared:

“Before 2014 we do not have piped water. Water is polluted by the paper mill at the area. In August 2014, the government built water pipes but there is no water in the taps. When we inquire, we were informed that the filter was faulty and there are no more funds to replace this filter. The Department of Health and also the Department of Environment has tested the water in the area and it is not fit for drinking.”

This struggle is reflected in the differing levels of gender mainstreaming initiatives at national level and management. The transformation towards sustainable development calls for inclusion that “no one is left behind” and ensuring the regenerative capacity of our

natural resources. This highlights two hidden and neglected spheres: (i) natural resources; and (ii) unpaid care work. In order to address gender inequality, it implies changing and redistributing unpaid care work as well as attention to natural resources. Gender mainstreaming with intersectional analysis and budgeting are key mechanisms that support an inclusive framework.

Recommendations

Several lessons can be learnt from gender mainstreaming activities that can reduce these disadvantages. The Government of Malaysia in its pursuit for an inclusive development had stressed the importance of gender equality as a key enabler.

(i) Sex-disaggregated Data

It is acknowledged that proper statistical data aids policy formulation, budget costing and evaluation processes. In 2008, the Chief Secretary had furthered issued a letter to call for the compilation of such data not only from a biological segregation but also looking at economy, education, health and social including data on women in decision-making levels to be undertaken for all programmes, budget preparations and plans of action by all ministries, government offices including Federal, State, District and local government. Efforts have been undertaken to ensure this happens including the national budgetary process that conscientiously builds upon gender budgeting processes.

(ii) Gender Indicators and Analysis

The pathway of incorporating gender is to ensure gender awareness is

increased and understandings of gender methodologies are enhanced. This should also be supported with strong monitoring and evaluation mechanisms. Indicators to measure how gender is integrated into activities are important. If matters were not made visible, it would not be tracked.

The general approach is to use social indicators to ensure gendered realities is not sufficient. Sustainable development and environmental issues are generally measured through economic costs that rarely identify the internalised costs of pollution, loss of income or even health impacts through a gender lens. Therefore gender not only needs to be integrated but more so it needs to be transformative (Aguilar *et al.* 2015).

More efforts to ensure gender gaps and women's situations are needed. Many times there is neglect as these are sites of contestation of power, opportunities and privileges as determined by patriarchal settings. As a result, gender gaps in areas of access to resources are rarely fully analysed (Johnsson-Latham 2007).

(iii) Gender Balance for Enhanced Competitiveness and Sustainability

Gender balance advocacy is a continued progress especially in sectors that are not traditionally seen as a woman's domain. The water sector is one of the many sectors that women participation in decision-making is lacking. The government of Malaysia has adopted an affirmative action to ensure women are equitably represented in decision-making. This policy has increased the percentage of women holding decision-making positions in the public sector from 18.8% in 2004 to 33.7% in December 2013.

The number of women overall in the water management industry both public and private is still limited. The lack of diversity is related to many factors including education. Efforts to increase diversity and participation of women in renewable energy sector have shown potential benefits from increased financial performance, increasing inclusiveness and proactive investments linking to reduced carbon footprints.

It is important to understand that gender equality in decision making with affirmative actions is limited as the culture of preserving status quo, the perception of knowledge and stereotyping women can be a barrier for continued tenure and inclusion. Governance needs to be transparent to avoid a decision being made behind the scene (Aguilar *et al.* 2015).

(iv) Identify strategies for closing gaps

The struggle to ensure gender responsiveness in water sector management needs to be addressed with renewed momentum and agenda. The roadmap for SDGs has clear linkages on the water that needs to be translated into the broader national implementation of the current 11th Malaysia Plan and the INDCs.

The steps from short-term project level actions ranging from developing the clearer design, checklists, key indicators, monitoring and evaluation tool with proper statistical data to establish baselines and progress are needed. These methods are in place but require a greater political commitment to evidence gender mainstreaming.

This can be done through:

- a) Enhancing capacity of ministries, departments, the private sector and other implementing partners including the community in gender responsiveness. This can be done through strategic awareness building, project cycle enhancements to evidence gender responsiveness and documentation of successes as well as challenges.
- b) Piloting a gender-mainstreaming project to validate and highlight the various methodologies available.
- c) Enhance awareness of political and local community leaders to link gender equality to an efficient water resource management. This is needed to support an integrated approach including the buy-in to continue to view water as a critical resource for development and sustainability.

(v) Increase Research on Gender Issues in Water Sector

The challenges of proper sex-disaggregated data and gender analysis need to be addressed through research. The research and academia can help map and highlight the gendered realities through qualitative and quantitative data analysis and surveys. These researchers can inform how gender-responsive actions can improve overall developmental planning as water management is an integrated approach.

Conclusion

Water is a critical resource for human survival and sustainability of our development. The demands and utility of water resources are significant in this renewed commitment to sustainability. While it is important to address larger issues like climate change, the water sector should not be neglected, as it is pivotal. The current neglect challenges not only the realm of management but also the opportunities at each and every level to mitigate impacts of climate as well as gender inequalities.

While these transformations may seem daunting, there is room for optimism. Many efforts are already being undertaken nationally to ensure proper planning through integrated water resource management and river basin management. In fact the integrated approach of water resource management helps promote sustainability of vital ecosystem that reflects the fundamental interconnections for sustainable development.

REFERENCES

- Aguilar, L, Granat, M & Owren, C 2015, *Roots for the future: the landscape and way forward on gender and climate change*, Washington, DC, IUCN & GGCA.
- Dankelman, I & Jansen, W 2010, 'Gender, environment and climate change: understanding the linkages', in *Gender and Climate Change: An Introduction*, ed I Dankelman, Earthscan Ltd. London.
- Global Water Partnership, <<http://www.gwp.org/The-Challenge/What-is-IWRM/>>.
- Johnsson-Latham, G 2007, *A study on gender equality as a prerequisite for sustainable development*, Ministry of Environment Sweden, The Environment Advisory Council.
- Ministry of Women, Family and Community Development 2015, *Ministerial roundtable: public/ private sector partnership advancing economic opportunities for women and girls*, Ministerial Best Practices III: Preventing Stereotypes.
- Moser, A 2007, *Gender and indicators*, Overview Report, United Nations Development Programme, Bureau for Development Policy, Bridge, Institute of Development Studies, UK.
- Rake, K 2002, *Gender budgets: the experience of UK's women's budget group*, Basel, Switzerland.
- Roehr, U 2007, *Gender, climate change and adaptation. Introduction to the gender dimensions*, BothENDS. Skutsch, M 1998, 'The gender issue in energy project planning: welfare, empowerment or efficiency?', *Energy Policy*, vol. 12, no. 26, pp. 945–55.
- Sørensen, K, Rommes, E & Faulkner, W (eds) 2011, *Technologies of inclusion: gender in the information society*, Tapir Academic Press, Trondheim.
- Veena, N & Kusakabe, K 2015, 'Gender and land tenure in the context of disaster in Asia', in *Gender and Land Tenure in the Context of Disaster in Asia*, eds K. Kusakabe *et al.*, vol. 21, Springer International Publishing.
- Walker, *et al.* 2009, 'Stockholm Resilience Centre', viewed 8 Jan, 2015, <<http://stockholmresilience.org/21/research/research-news/9-11-2009-a-dwindling-capacity-to-cope-with-crises.html>>
- Zaharaton, RZA 2004, 'IWRM Implementation Realities in Malaysia', <http://www.epu.gov.my/c/document_library/get_file?uuid=9d4b6282-1234-4d84-ab98-1dab05757b05&groupId=283545>.

Virtual Water and Water Footprint

Expert Review

Dr Zainura Zainon Noor and
Noor Salehan Mohammad Sabli

Defining Virtual Water and Water Footprint

It has been widely recognised that water usage can have different impacts on the environment, depending on where water is used, what type of water is used, and how much water is polluted. The concept of water footprint (WF) emerged in the early 2000s due to worrying trends of water scarcity and interconnections of water usage worldwide. By definition, the WF indicates that water use looks at both direct and indirect water use of a consumer or producer (Hoekstra 2003). This particular water indicator concept kick-started from the realisation that human impacts on freshwater systems can ultimately be linked to human consumption and issues like water shortages and pollution can be better understood and addressed by considering production and supply chains as a whole. Water use is measured in terms of water volumes consumed (evaporated) and/or lost polluted per unit of time. A WF can be calculated for any well-defined group of consumers (e.g. an individual, family, village, city, province, state or nation) or producers (e.g. a public organisation, private enterprise or economic sector). The WF is a geographically explicit indicator which

shows volumes of water use and pollution, as well as the locations.

The total WF breaks down into three components: the blue, green and grey WF (Hoekstra *et al.* 2009). The blue WF is the volume of freshwater that evaporates from the global blue water resources (surface water and groundwater) or is lost as a result of the production process. The green WF is the volume of water evaporated from the global green water resources (rainwater stored in the soil as soil moisture). The grey WF refers to the volume of polluted water as a result of the production process. However, the grey WF method and data are currently being refined. This categorisation of WF is summarised in Box 4.2.8.1.

WF is crucial in visualising the hidden water use behind products, which helps in understanding the global character of fresh water and in quantifying the effects of consumption and trade on water resource use. Uncovering the hidden link between consumption and water use further helps in the formulation of new strategies of water

governance since new triggers for change are identified. Final consumers, retailers, food industries and traders in water-intensive products have traditionally been out of the scope of those responsible for good water governance, where with WF, these players enter the picture now as potential change agents.

	GREEN WATER is water from precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants. It is particularly relevant for agricultural, horticultural and forestry products.
	BLUE WATER is water that has been sourced from surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time. Irrigated agriculture, industry and domestic water use can each have a blue water footprint.
	GREY WATER is the amount of fresh water required to assimilate pollutants to meet specific water quality standards. This takes into account point-source pollution discharged to a freshwater resource directly through a pipe or indirectly through runoff or leaching from the soil, impervious surfaces, or other diffused sources.

Box 4.2.8.1. Different Composition of Water Footprint

The WF concept is closely linked to the virtual water (VW) concept. VW water is defined as the volume of water required to produce a commodity or service. The concept was introduced by Allan (1993, 1994, 1998) when studying the option of importing virtual water (as opposed to real water) as a partial solution to problems of water scarcity in the Middle East. The intricately-linked concept between WF and VW offers the possibility to analyse the impacts of consumption patterns on water use that is a very flexible solution. The term of WF is usually used in the perspective where the consumers or producers of products are concerned, whereas the term VW is mostly used in the perspective of international or interregional trade. On the other hand, VW focuses mainly on water quantity, while WF also emphasises the environmental impact of water use (Ridoutt *et al.* 2010). Hence, the concept of VW is attractive for water-scarce countries to achieve water security by importing water-intensive products instead of producing all water-demanding products domestically. Reversibly, water-rich countries could benefit from their abundance of water resources by producing water-intensive products for export.

With VW, the WF concept adds a demand- and consumer-oriented indicator in a sector where policy tends to be angled toward supply and production. This transition of management consideration will be a key challenge as the sector rebalances and improves its governance and rationale for infrastructure investment and water allocations. VW trade between nations can be an instrument to increase global water use efficiency. From an economic point of view, it is logical to produce the water-intensive products demanded in this world in those places where water is most abundantly available. This further relieves the pressure on a nation's own water resources and environment especially those countries in water-scarce regions of the

world since countries that are water abundant can export virtual water to countries that are water scarce. In addition, the concept is important as it provides policy makers with a tool to compare the impacts of water use across different sectors, thus acting as a basis for setting objectives. However, further analysis of the concept may be required especially on issues such as the geopolitical importance of VW, the opportunities and threats involved and the associated political processes underlying decision making on the application of the concept.

Reducing water footprints can be done as below:

- Breaking the seemingly obvious link between economic growth and increased water use, for example by adopting production techniques that require less water per unit product. Water productivity in agriculture practice can be enhanced by applying advanced techniques of rainwater harvesting and supplementary irrigation;
- Shifting to consumption patterns that require less water, for instance, reducing meat consumption. Consumption patterns can also be influenced (in the way that will reduce water footprint) via pricing, awareness raising, eco-labelling or introduction of other incentives that will make people change their consumption behaviour; and
- Shifting production from low-water productivity to areas with high water productivity, thus increasing global water use efficiency.

Brief Review of Global Water Footprint Trends

In the past century, the global freshwater use has increased due to diet preferences to fulfil world demand and human population (Liu *et al.* 2008). WF of each nation has been calculated by Hoekstra *et al.* (2007) from 1997 to 2001. The global water footprint is 7450 G m³ per year, which is 1240 m³ per capita in average. The country with the largest footprint is India, with a total of WF is 987 Gm³ per year that contributes 17% from the total global footprint.

However, footprint per person in India only contributes 13% from the total global WF. The USA appears to have the largest footprint with an average of 2480 m³ per capita, followed by European countries such as Greece, Italy and Spain (2300–2400 m³ per capita per year). Malaysia and Thailand have high WF with 2100–2500 m³ per capita, respectively. On the other hand, China has relatively low WF with an average footprint of 700 m³ per capita. The average per capita WF of nations is shown in Figure 4.2.8.1. The WF data for a few selected countries are shown in Table 4.2.8.1.

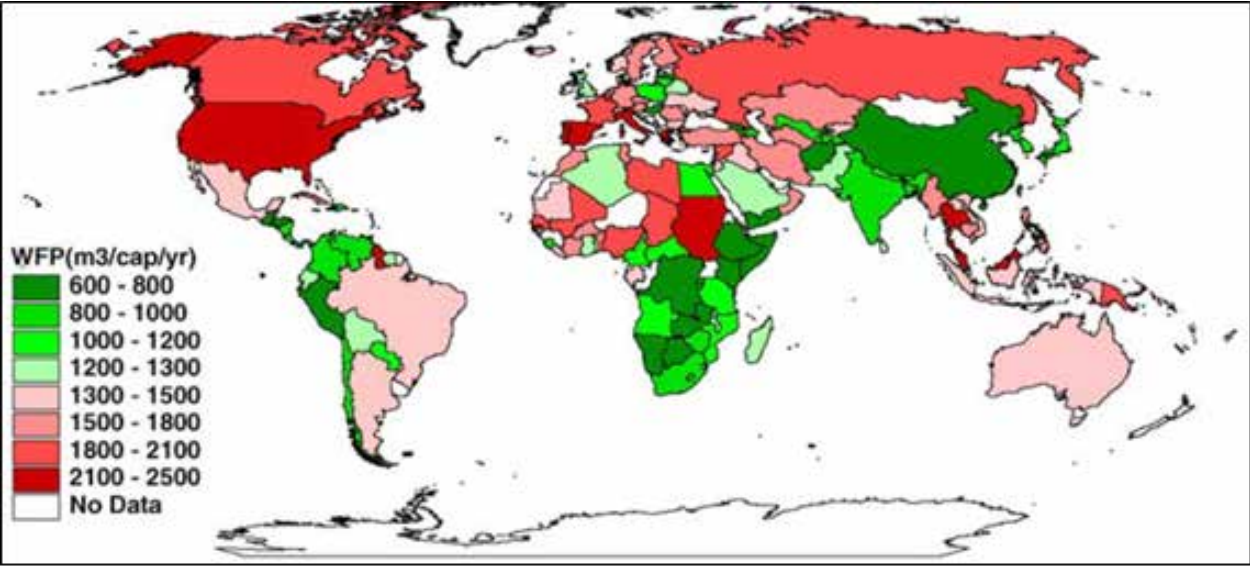


Figure 4.2.8.1. Average national WF per capita (m³ per capita per year)

Note: Green means that the nation’s water footprint is equal to or smaller than the global average. Countries with red have a water footprint beyond the global average (Hoekstra et al. 2007).

Table 4.2.8.1. Composition of the water footprint for some selected countries.

Country	Population	Water Footprint	
		Total (Gm ³ /year)	Per capita (m ³ /capita/year)
Australia	19,071,705	26.56	1,393
Bangladesh	129,942,975	116.49	896
Brazil	169,109,675	233.59	1,381
Canada	30,649,675	62.80	2,049
China	1,257,521,250	883.39	702
Egypt	63,375,735	69.50	1,097
France	58,775,400	110.19	1,875
Germany	82,169,250	126.95	1,545
India	1,007,369,125	987.38	980
Indonesia	204,920,450	269.96	1,317
Japan	126,741,225	146.09	1,153
Jordan	4,813,708	6.27	1,303
Malaysia	22,990,590	53.89	2,344
Myanmar	47,451,298	75.49	1,591
Nepal	22,772,793	19.33	849
Nigeria	125,374,700	248.07	1,979
Pakistan	136,475,525	166.22	1,218
Russia	145,878,750	270.98	1,858
Saudi Arabia	20,503,670	25.90	1,263
South Africa	42,387,403	39.47	931
Thailand	60,487,800	134.46	2,223
Turkey	66,849,750	107.95	1,615
United Kingdom	58,669,403	73.07	1,245
USA	280,343,325	696.01	2,483
Uzbekistan	24,567,500	24.04	979
Vietnam	78,020,938	103.33	1,324

Note: Period: 1997–2001. (Hoekstra & Chapagain 2006)

The size of the global water footprint is largely determined by the consumption of food and other agricultural products (Figure 4.2.8.2). The agricultural products that contribute most to the external WFs of nations are bovine meat, soybean, wheat, cocoa, rice, cotton, and maize. According to this report, there are four major direct factors determining the WF of a country which is the volume of consumption (related to the gross national income), this partially explains high WF in USA, Italy and Switzerland. The second factor comes from consumption pattern, where the countries with high meat consumption will have high WF such as in the USA, Canada, France, Spain,

Portugal, Italy and Greece. The average meat consumption in the United States is for instance 120 kg per year, three times more than the world average meat consumption. The third factor is climate, wherein regions with high evaporative demand, the water requirement per unit of crop production are relatively large. This factor explains why WF is in countries such as Senegal, Mali, Sudan, Chad, Nigeria and Syria. The last factor determining high WF is water-inefficient agricultural practice, which means that water consumption per crop is relatively high. This factor explains why countries such as Thailand, Cambodia, Turkmenistan, Sudan, Mali and Nigeria have high WF.

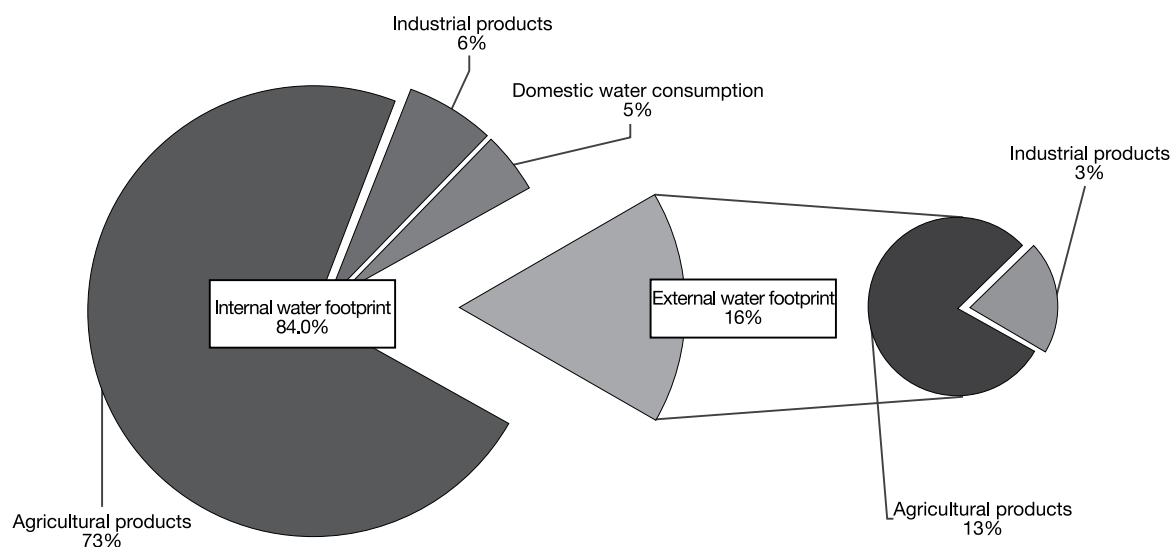


Figure 4.2.8.2. Contribution of Different Consumption Categories to the Global Water Footprint, with a Distinction between the Internal and External Footprint

Source: Hoekstra *et al.* 2007

The aggregated external WFs of nations in the world constitute 16% of the total global WF. However, the share of the external WF strongly varies from country to country. Table 4.2.8.2 summarises the internal and external WF, water scarcity and dependency of several

countries in the world. As seen from the table, despite having quite a number of renewable water resources, Malaysia is quite dependent on imported water at 28%, behind Japan (64%), Korea (62%) and Papua New Guinea (50%). This is probably due to high consumption

of imported industrial goods. On the hand, some countries such as the Kyrgyz Republic, Kazakhstan and Myanmar have hardly any external footprint as they have little import.

WF is an aggregated indicator that shows the total water requirement of a nation as well as a rough measure of the impact of human consumption on the natural environment. Nonetheless, more information about the precise components and characteristics of the total water footprint will be needed before a more balanced assessment of the effects on the natural water system. It is crucial for instance, to look at what is blue versus green water use, because the use of blue water often has greater detrimental effects on the environment compared to the green water. Furthermore, considering the internal versus external water footprint is also crucial. Externalising the water

footprint means externalising the environmental impacts as well. Additionally, it is imperative to realise that some parts of the total water footprint concern the use of water for which no alternative use is possible, while other parts related to the water could have been used for other purposes with higher added value.

International water dependencies are substantial and are likely to increase with continued global trade liberalization such as Trans-Pacific Partnership Agreement (TPPA). Today, 16% of global water is used to create products for export and this trend is rising. Taking this into account, it is recommended that future national and regional water policy studied includes an international analysis or interregional virtual water flows.

Table 4.2.8.2. Water Footprint, Water Scarcity and Water Dependency of Countries in the World.

Country	Total Renewable Water Resources km ³ /year	Internal Water Footprint km ³ /year	External Water Footprint km ³ /year	Total Water Footprint km ³ /year	Water Scarcity %	Water Self-Sufficiency %	Water Import Dependency %
Afghanistan	65.0	16.8	0.5	17.3	27	97	3
Armenia	10.5	2.2	0.7	2.8	27	77	23
Australia	492.0	21.8	4.8	26.6	5	82	18
Azerbaijan	30.3	6.5	1.3	7.8	26	83	17
Bangladesh	1,210.6	112.4	4.1	116.5	10	97	3
Bhutan	95.0	0.7	0.1	0.8	1	88	12
Cambodia	476.1	20.5	0.5	21.0	4	97	3
China, People's Republic of	2,896.6	825.9	57.4	883.4	30	93	7
Fiji	28.6	1.0	1.0	1.0	4	95	5
Georgia	63.3	3.9	0.3	4.2	7	94	6

Table 4.2.8.2. Water Footprint, Water Scarcity and Water Dependency of Countries in the World. (continued)

Country	Total Renewable Water Resources km ³ /year	Internal Water Footprint km ³ /year	External Water Footprint km ³ /year	Total Water Footprint km ³ /year	Water Scarcity %	Water Self-Sufficiency %	Water Import Dependency %
India	1,896.7	971.4	16.0	987.4	52	98	2
Indonesia	2,838.0	242.3	27.7	270.0	10	90	10
Japan	430.0	51.9	94.2	146.1	34	36	64
Kazakhstan	109.6	26.6	0.4	27.0	25	99	1
Korea, Republic of	69.7	21.0	34.2	55.2	79	38	62
Kyrgyz Rep.	20.6	6.6	0.0	6.6	32	100	0
Lao People's Democratic Republic	222.6	7.4	0.2	7.7	2	97	3
Malaysia	580.0	38.9	15.0	53.9	9	72	28
Myanmar	1,045.6	74.4	1.1	75.5	7	99	1
Nepal	210.2	18.7	0.7	19.3	9	96	4
Pakistan	222.7	157.3	8.9	166.2	75	95	5
Papua New Guinea	801.0	5.1	5.1	10.2	1	50	50
Phillipines	479.0	104.4	12.5	116.9	24	89	11
Sri Lanka	50.0	22.1	1.6	23.7	47	93	7
Thailand	409.9	123.2	11.2	134.5	33	92	8
Turkmenistan	24.7	8.8	0.2	9.0	36	98	2
Uzbekistan	50.4	22.8	1.3	24.1	48	95	5
Vietnam	891.2	100.2	3.1	103.3	12	97	3

Note: km³ = cubic kilometre

Source: Hoekstra & Chapagain 2008

Snapshot of Current Status in Malaysia

(i) WF per Capita

With annual water resources of 21,536 m³ per capita per year (The Report 2010), Malaysia has an abundance of water—an essential asset for the basic needs of its people and for economic growth. However, as its economy and population grow, the nation needs to keep a more prudent and efficient eye on its resources and supply management. The current total water demand of the nation is estimated at 15.2 billion m³ per year (Azhar 2000). There are now competitions in the use of water resources for water supply, irrigation, hydropower, and an increase of contamination of water resources that continues to damage the environment. Figure 4.2.8.4 shows the projected total domestic, industrial and irrigation

demand for Peninsular Malaysia from the year 2000 to 2050. The increasing pattern of water consumption seems to be continuous until 2050 although it is expected to reduce. This will lead to water resource problem in this country without any initiatives of incentives from the government. Referring to Water Footprint of Nation Report 2004, Malaysia's total WF is 2344 m³ per capita per year. The data seem similar with reports from Hoekstra *et al.* (2007), where Malaysia's average WF per capita is 2100–2500 m³ per year. It seems that the average of WF in Malaysia has higher WF average than global WF average. One of the factors that lead to this high WF comes from water usage habits, where Malaysians use 70% more water than they should (Minister of Energy, Green Technology and Water 2008).

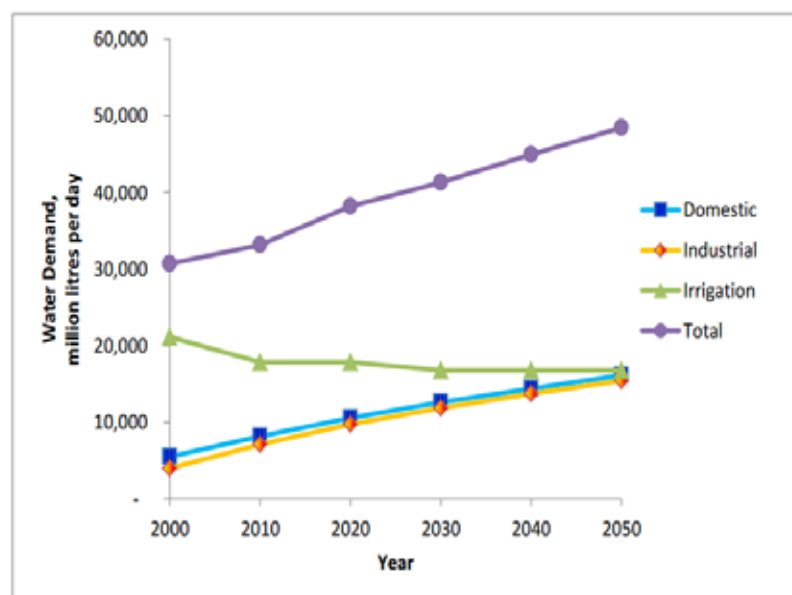


Figure 4.2.8.3. Projection of Total Domestic, Industrial and Irrigation Demand for Peninsular Malaysia

Source: National Water Resources Study, 2000–2050

WF Per Capita of Different Sectors

Globally, there are three main sectors that use high water consumption: domestic, industrial

and agricultural sector (Hoekstra *et al.* 2007) as illustrated in Figure 4.2.8.5 where agricultural sector consumed the largest amount of water at 86% out of the total water usage.

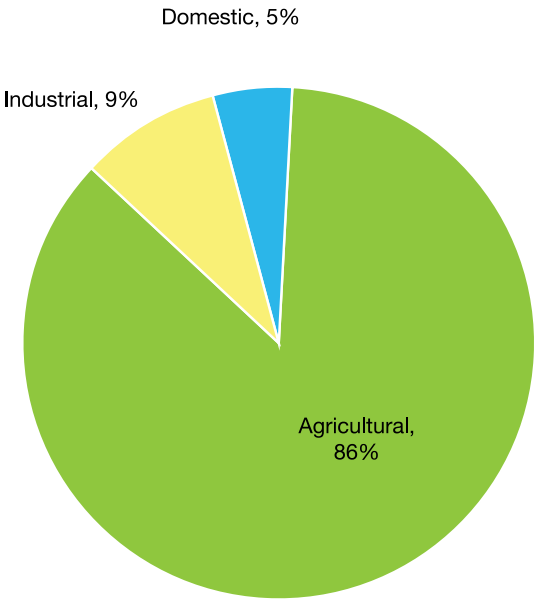


Figure 4.2.8.4. Contributions of Different Consumption Categories to the Global WF

Source: Hoekstra *et al.* 2007

From 1996 to 2005, the global water footprint was 9087 Gm³ per year and agricultural production contributes 92% to this total footprint (Mekonnen & Hoekstra, 2011). In Malaysia’s scenario, agricultural sector contributes 92% from the total Malaysia’s WF 2344 m³ per capita per year. Based on this report, inefficient water use management in agricultural practice, lack of proper water pricing and low awareness of simple water saving among farmers will consequently influence total WFs of the region. The WFs of rich countries consumption of industrial goods has a relatively large contribution to the WF if compared

to developing countries. For example, the USA is partially high because of large meat consumption and high consumption of industrial products with the footprint of 806 m³ per capita per year, equals to 32% from total global WFs, compared to India with WFs in industrial consumption of only 2% (Hoekstra *et al.* 2007).

There are several ways to reduce WF as proposed by the previous report (Hoekstra *et al.* 2007). One of the ways is to adopt production technique that requires less water per unit of product. Water productivity can be improved

by applying advanced techniques of rainwater harvesting, supplementary irrigation and optimising water usage input in the agricultural sector. Shifting the consumption patterns that require less water can reduce WF, for instance by reducing meat consumption. However, this will be challenging because the current trend of meat consumption is increasing. Thus, public awareness of water requirements in producing their goods and services are very crucial. The third way is to shift production from areas with low water productivity to areas with high water productivity, thus increasing global water use efficiency (Chapagain *et al.* 2004). One successful example is Jordan, where the WF is externalised by importing wheat and rice products from the USA, which has higher water productivity than Jordan.

Current Development of WF studies in Malaysia

WF awareness among researchers and government agencies in Malaysia has increased especially in agricultural sectors. There are several ongoing studies of WF in several agriculture products, such as paddy and palm oil plantation (Muhammad-Muaz & Marlia 2014). This is because both are primary crops in Malaysia where they contribute most to external WFs of nations (Hoekstra *et al.* 2007).

These studies are currently carried out by researchers from Universiti Teknologi Malaysia and Universiti Kebangsaan Malaysia. Several relevant agencies such as FELDA, MARDI, MADA and Department of Drainage and Irrigation (DID) are also collaborating as active partners in these studies. Since industrial goods production also contributes towards water footprint of the nation, a WF assessment is also being conducted on the manufacturing of the national car (of a specific model) produced by PROTON.

It is expected that in the very near future, the outputs of these studies will serve as important inputs that will help the government to have better understanding related to the country's water consumption patterns. This will hopefully assist the establishment of better water governance of the country.

Recommended Strategies for Nationwide Implementation of WF

Some strategic thrusts of WF that can be applied nationwide in the water sector include the followings:

(i) Enabling Environment

In implementing and integrating WF at the national level, a set of interrelated conditions that can generate impact on the capacity of development such as legal, organisational, fiscal, informational, political, and cultural need to be developed holistically to support the concept. This can be in the form of the following initiatives:

- a) Using water-pricing policies as an incentive to improve water use efficiency and water productivity;
- b) Market mechanisms versus non-market mechanisms in policy making in the region;
- c) Irrigation water valuation in crop production schemes and allocation policies;
- d) Wise freshwater allocation: water footprint per river basin; water footprint per product; and
- e) Water footprint shares per community.

(ii) Institutional Framework

The WF focuses on human water use. Nonetheless, it is imperative to establish a link between WF with environmental water requirements at global and national levels. Environmental water requirements or environmental flow requirements referring to the water are considered sufficient for protecting the structure and function of a surface or groundwater ecosystem and its dependent species. These requirements are defined by both the long-term availability of water and its variability, and are established through environmental, social, and economic assessment (King *et al.* 2000; IUCN 2003). Obtaining clear data on environmental water requirements would permit comparisons between the actual WF with the theoretical amount of water available for human use (total water available minus environmental water requirements).

This may enable building a transparent, multidisciplinary framework for informing water allocation decisions. It is critically important that a certain volume of water is planned for the maintenance of ecosystem functions and the services they provide to humans. Planning water allocation takes into account the environmental water needs would be helpful to achieve the right balance between allocating water for direct human use (e.g. agriculture, power generation, domestic purposes and industry) and indirect human use (maintenance of ecosystem goods and services) (Acreman 1998). This is one way to approach a win-win situation balancing and harmonising human and environmental water requirements.

In 2000, the European Union (EU) took action to conserve their water resources through the establishment of EU Water Framework Directive (WFD). This is because 60% of European cities over-exploit their groundwater resources and 50% of wetlands are endangered (WFD, 2010). WFD is complemented together with other legislation and specific aspects of water such as The Groundwater Directive (2006), The Environmental Quality Standards Directive (2008), and Two Commission Decisions (2005). In view of these policies, public involvement will be crucial to meet the goals of water reduction and conservation. The WFD which sets a clear objective of achieving the good status, both ecological and chemical, of all water bodies in the EU (surface as well as groundwater) has started to be implemented since 2015. This is particularly relevant since Spain is the first country that has included the water footprint analysis into governmental policy making in the context of the WFD (Official State Gazette 2008).

(iii) Water Policies and Water Governance

Facts about the water crisis demonstrate an incontestable reality as well as the crisis's underlying geophysical, socioeconomic, and political causes. These facts consist of data on supply and demand, constraints on expanding the supply-side, opportunity for influencing demand, new economic parameters that can demonstrate the economic case (e.g. protecting future water sources and abandoning subsidies), and use of embedded water concepts to monitor the case for working toward a global water trade. The water-energy-food nexus is being modelled to assist in describing and quantifying system responses (Bazilian

et al. 2011). These facts should now contribute to formulating both global and national water policies.

Water policies can be important public statements. Therefore, they should be designed to create confidence among affected populations that their water future is safe. It is important to recognise that water policies, when formulated with vision and courage, can stimulate innovations and encourage interaction with the private sector by demonstrating a commitment to deal with water security issues proactively. A sound water policy will provide confidence to prospective investors that their industries can rely on a continued supply of water and energy. In fact, investors' guides have already analysed corporate exposure to water-related risks and advised their clients accordingly, demonstrating the importance of water as a critical factor in investment. Simultaneously, those involved in any element of the water industry will be encouraged to invest in further innovation if the governments send the right signals (e.g. innovation in advanced irrigation systems, decentralised wastewater treatment systems, and geographic information system technology to monitor and manage groundwater use). Although water stress is a global issue, solutions in improved distribution, storage, treatment, and source protection must be implemented locally. A clear, explicit water policy is important to provide guidance and to demonstrate a commitment to local efforts by subnational administrations and the private sector.

An example of water policy being implemented locally can be seen in the case of Australia, California (USA),

Europe and China. For instance, in Australia and California, the water policy is implemented for water consumption at a residential area in which the residents are strictly prohibited from using tap water for washing their vehicles and watering their garden (Department of Housing Australia 2009; Stephanie *et al.* 2013). Unfortunately, this policy is only achievable for low water user whereas study shows that wealthier consumers consume three times higher water (Stephanie *et al.* 2013). This is partial because low-income user group is more affected to pay the penalty by authorities.

Governments must be aware of the needs and benefits of having an explicit water policy that addresses water scarcity. Such an explicit statement will invite investment and provide reassurances to investors that action to achieving water security is occurring. Water governance, as a concept, may need to replace water management as the driving principle. Water governance includes awareness of the socio-political forces that shape decisions to improve water security. Management of resources needs to be improved by developing more efficient institutions, which improves access to knowledge. All this will require combinations of investment, policy, and research.

New approaches to good water governance should incorporate river basin management, and analyse the de facto allocation of water as a means to deliver good water governance. Much attention has been paid to the ideal organisational model for river basin management, particularly on how to make river basin organisations work in concert with existing

government administrative hierarchies of federal and state governments. The key role of river basin management is at the heart of integrated water resources management — to provide a rational basis for allocation between competing water requirements, including those for sustaining ecosystems. Assessment of freshwater allocation: water footprint per river basin needs to be made and incorporated in the development and planning. Various models have been developed, usually working on consensual models, depending on the nature of the main problems as well as social and cultural backgrounds. A critical review of the real impact of past attempts at rational water management or water allocation should inform the design of water governance systems and procedures for the future, when water stress conditions will put greater demands on the efficiency of allocation processes.

effective real-time resource management. It will help stimulate the uptake of new technology. Other promising initiatives that would benefit from enhancements in information technology include soil conservation and aquifer recharge, recycling of used water (for specific low-quality requirements, particularly for local re-use), semi-centralised wastewater treatment (to recover both water and energy, in combination with solid waste), rainwater harvesting in urban settings, localised storage, and so on.

(iv) Investments in Water Infrastructure

The low value attached to water has suppressed investment in water technology by the private sector, compared to investments in information, communication, and transport technology. Explicit statements of water policy, by international agencies and governments, that begin to respond to the urgent need to deal with water stress, may generate investments in new water technology and bring down the cost of technology options. Similarly, in the private sector, the emergence of explicit corporate water risk assessments will stimulate investment in processes that will help mitigate such risks. Advances in information technology may be expected to apply to the availability and behaviour of water resources in all its forms, for more

REFERENCES

- Allan, JA 1993, 'Fortunately there are substitutes for water otherwise our hydro-political futures would be impossible', in *Priorities for water resources allocation and management*, ODA, London.
- Allan, JA 1994, 'Overall perspectives on countries and regions', in *Water in the Arab World: perspectives and prognoses*, eds P Rogers & P Lydon, Harvard University Press, Cambridge, Massachusetts.
- Allan, JA 1998, 'Virtual water: a strategic resource, global solutions to regional deficits', *Groundwater*, vol. 36, no. 4, pp. 545–546.
- Azhar, M 2000, 'Managing Malaysian water resources development', *Buletin Kesihatan Masyarakat Isu Khas 2000*, pp. 40–58.
- Bazilian, M *et al.* 2011, 'Considering the energy, water and food nexus: towards an integrated modelling approach', *Energy Policy*, vol. 39, no. 12, pp. 7896–7906.
- Chapagain, AK & Hoekstra, AY 2004, *Water Footprints of Nations*, vol. 2, no. 16.
- Hoekstra, AY (ed) 2003, 'Virtual water trade', in *Proceedings of the International Expert Meeting on Virtual Water Trade, Delft, The Netherlands*, Value of Water Research Report Series, 12, UNESCO-IHE, Delft, The Netherlands.
- Hoekstra, AY & Chapagain, AK 2006, 'Water footprints of nations: water use by people as a function of their consumption pattern', *Water Resources Management*, vol. 21, no. 1, pp. 35–48.
- Hoekstra, AY & Chapagain, AK 2007, 'Water footprints of nations: water use by people as a function of their consumption pattern', *Water Resources Management*, vol. 21, no. 1, pp. 35–48.
- Hoekstra, AY, Chapagain, AK, Aldaya, MM, & Mekonnen, MM 2011, *The water footprint assessment manual: setting the global standard*, Earthscan, London, UK.
- IUCN 2003, *Flow: the essentials of environmental flows. IUCN, water and nature initiative*, eds M Dyson, G Bergkamp & J Scanlon, IUCN, Gland, Switzerland.
- King, JM, Tharme, RE & DeVilliers, MS (eds) 2000, *Environmental flow assessments for rivers: manual for the building block methodology*, Water Research Commission, Pretoria, South Africa.
- Liu, J, Yang, H & Savenije, HHG 2008, 'China's Move to Higher Meat Diet Hits Water Security', *Nature*, vol. 454, pp. 397.
- Malaysia 2010, The report, Oxford Bussiness Group.
- Mekonnen, MM & Hoekstra, AY 2011, *National water footprint accounts: the green, blue and grey water footprint of production and consumption*, vol. 2, UNESCO-IHE Institute for Water Education.

Muhammad-Muaz, A, & Marlia, MH 2014, 'Water footprint assessment of oil palm in Malaysia: a preliminary study', in *AIP Proceeding 1614*, pp. 803–807.

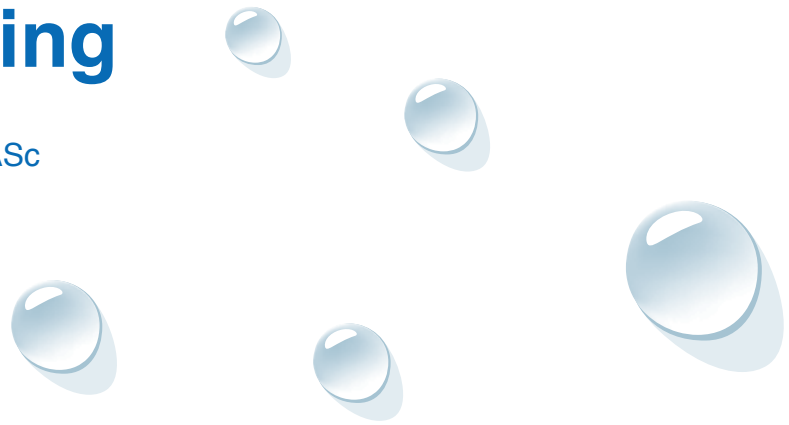
Ridoutt, BG & Pfister, S 2010, 'A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity', *Global Environmental Change*, vol. 20, no. 1, pp. 113–120.

Stephanie, P & Terri, H 2013, 'Residential water consumption in Los Angeles: What are the drivers and are conservation measures working?', PhD Dissertation, the University of California, Los Angeles, CA.

Water Financing

Expert Review

Datuk Ir. Mohd Adnan Mohd Nor FASc



One of the key achievements of the water resources and water sectors up to now that is not obvious to many is the successful delivery of projects by the key water sectors namely Water Supply, Agriculture and Energy (Hydroelectric) within a reasonable time and as planned to meet the projected demands of the respective sectoral needs. This has greatly contributed to the smooth implementation of development projects by all other sectors and the success of economic growth and wellbeing of the nation. This is the Supply Management approach by the respective sector that was necessary in the development phase of the nation.

The supply of water, although important, is not the only aspect of national water resources development and management and covers other non-consumptive use of water such as for drainage, flood, sewerage, ecosystem (environment), navigation, tourism and non-consumptive agriculture activities (e.g. aquaculture).

The past successes of Supply Management are mainly due the availability of land and water resources that were far more than the demands. However, also not obvious, is the fact that the

success of the Supply Management and by the respective sectors (Sectoral Approach) is mainly due to the consistent investment priority and financial support provided by the government since the early days. This, in turn, has provided a long-term opportunity for each sectoral institution to strengthen its capacity to plan, develop, deliver and manage its facilities.

Apart from early days investments in drainage systems for land reclamation for agriculture, investments and financing in other aspects of water resources and water management are more reactive in nature and relatively more recent compared to the experience in Supply Management.

The need for a systematic flood management, for example, was a reaction to the floods of 1971 and impacts are ever increasing as population increases, the economy expands and lands developed in tandem. The systematic approach to urban floods was only introduced in 2001 (*Saliran Mesra Alam*). Solving these issues by retrofitting is financially burdening especially when, by the time needed to implement the projects, land resource constrains the space requirements for

flood flows. The need to increase emphasis and invest in Water Demand Management is a reaction to the water woes in recent years just as river water quality improvements needs and catchment conservation management needs. River navigation is almost all lost in many of the major rivers in the Peninsular. Water management to sustain the wealth of biodiversity is hardly addressed. Reactive actions and solutions are often more expensive, time-consuming to implement and need a longer gestation period to realise the positive impacts especially when many of these are dependent on public participation and support. Implementing the relevant programmes and projects for these are also by the respective sectors and sectoral institutions.

Land and water are common resources for all water sectors and therefore there is a strong connectivity between sectors. Within sector development and management have direct impacts on others. With available land and water resources reducing and investment costs for water-related projects increasing as the country progresses there is an urgent need to adopt new and innovative approaches the National and State water resources and water development and management. The IWRM approach is now promoted worldwide for sustainable development. Within the IWRM approach are the investments and financing elements that could be the driver for the transformation from the present Sectoral approach.

The Need for Revised Approaches to Investment and Financing for IWRM

Whilst the success of the water sectors are commendable, recent events, particularly of water shortages, have exposed that sectoral achievements in supply management are now

not adequate to ensure a high level of National and State water security under the present socio-economic environment. Addressing flood and environmental issues continue to lag behind the pace of development resulting in general disquiet against the effectiveness of investments in these sectors. Of equal concern is the present level of preparedness and resilience of the National and State water management systems if and when a disaster occurs.

Efforts to improve the national water management continue. At the Federal level, the National Water Resource Study of 1981 was the definitive milestone to promote sectoral and inter-sector water management. The Energy Sector was restructured in 1990 for improved services. Following the recommendations of the NWRS 1981 was the formation of the National Water Resources Council in 1998 to coordinate and harmonise national and state water management. In 2004, the water management based institutions were restructured. The NRE was formed to be responsible for resource management and end-user management by the respective Ministries such as MOA and KeTTHA. The WSIA was introduced in 2006 to increase the service levels of the water supply and sewerage industry.

At the State level, integrated institutions for water resources management were formed in some States. The Sabah Water Resources Council was formed in 1998, LUAS, Selangor in 1999 and LSANK, Kedah in 2008.

Whilst these efforts continue, the fact remains that the sectoral approach to water management continues to be dominant. This is despite the general consensus amongst water managers that this approach is now not able to improve water security effectively and support

sustainable water management. The need is to transform towards the Integrated Water Resources Management (IWRM) approach.

The need to transform from the Sectoral to the IWRM approach (Refer Box 3.2.8.2 for IWRM Definition GWP) has been globally endorsed by all signatory nations including Malaysia since the late 1990s. However, in the practical sense, the implementation in this country is still in the state of inertia.

Efforts to overcome this position of inertia and subsequently accelerate the IWRM approach are many. One potential driver is to develop initiatives in the investment and financing structure and approach to National and State water resources and water sector development and management. Setting investment priorities and financing are integral components of water resources development and management and these too have developed in a sectoral manner. A change in the investment and financial policies could well provide the impetus for overcoming the inertia and perhaps even as a catalyst to transform the approach to National and State water management to the IWRM approach.

Investment and Financing as Instruments for IWRM

IWRM is not about the physical integration of all the water-related institutions in the country. In any case, the sectoral structure is well embedded in the present system and that there is strength in the diversity of the water institutions. Attempts to change towards such integration would be challenging, time-consuming and could even be impractical in this country considering the provisions of the Federal Constitution. Instead, IWRM is about the APPROACH towards water management

by each sector that recognises the inter-sector connectivity of land and water resources; that these are finite resources and future development sustainability is threatened if the present sectoral approach remains dominant.

Inducing this change would be to introduce an investment and financial policy that supports and gives priority for future water development and management physical and non-physical programmes and projects that have significant elements of IWRM. These projects could still be initiated and led by the respective sectors but are planned and designed to also benefit the needs of not only other water sectors but non-water sectors as well.

There are already two administrative instruments in place that could be the basis for implementing such policy. These are the National Blue Ocean Strategy (NBOS) and the need for Value Management (VM Circular) under *Pekeliling Unit Perancang Ekonomi, Jabatan Perdana Menteri Bil 1 Tahun 2015* (EPU 2015).

The NBOS encourages innovative approaches for programmes and projects that maximise the sharing of existing resources and assets to reduce investment and management costs yet providing higher levels of cost effectiveness and benefits.

The VM Circular that includes a guideline that specifies the need for Value Management evaluation process for all Government physical and non-physical projects particularly (but not limited to) those costing RM50 million and above. This process is now a condition for implementation approval. The purpose of this process includes resource use optimisation, stakeholders' participation and to encourage creative ideas for project value adding.

Both the principles and approaches of the NBOS and the VM Circular are in-line with the principles of IWRM. As such these are also instruments for the transformation of the water sector from the sectoral approach to IWRM approach. The possibility is that a special guideline for water sector projects is developed for IWRM approach to supplement these two instruments.

Strategic Potential Water Projects for Applications of the IWRM Approach

There are already situations and opportunities to implement projects based on the IWRM approach and in compliance with the NBOS and the VM Circular. These projects need not be stand-alone but certain elements of IWRM such as non-physical aspects could be incorporated into selected physical projects. Potential opportunities for IWRM approach as listed below.

(i) **Non-Physical Programmes and Projects**

- a) *Integrated data and information collection*
Water development and management organisations continuously install data collection instruments such as hydrological and climatic monitoring equipment for rainfall, river flow, sedimentation, sunlight and temperature, evaporation, the wind, waves, water quality and air quality. Many of these are common data and information need by the water managers and therefore integration of that equipment could be cost-effective and for a wider spectrum of users.
- b) *Harmonised water accounting and auditing system*

Water data and information, as well as the water accounting system, are now fragmented by sectors. A common and harmonised system for all sectors is necessary for effective decision-making on water policies and IWRM approaches to water development and management.

c) *Integrated flood and drought warning and forecasting system*

Recent events have shown that there is now a need for a cross-sector flood and drought warning and forecasting system.

d) *Public Participation*

Public participation and support are one of the critical elements in IWRM for all sectors. A concerted Capacity Building programme is necessary to prepare and enable the public and end-users to effectively support IWRM approaches.

(ii) **Physical Projects**

- a) *Conversion from single-purpose large dams to multi-purpose dams*
Existing large dams offers cost-effective potential to increase water security and water management for all sectors (water supply, energy, flood). This would relief the need for the construction of new sectoral dams.
- b) *Multi-purpose dams for new large dam development*
There are already plans for 73 new dams in the future. More are expected to be constructed under the renewable energy programme. All these future large dams too should be planned and designed as multi-purpose dams.

c) *Cross-sector water projects*

The paddy irrigation sector is the biggest water user in the country but still low in terms of efficiency. The demands of the water supply sector continue to increase and satisfying these would entail the development of new dams and water resources facilities. Investments in irrigation and cross-financing from the water supply sector into irrigation systems improvement could also relieve the water supply sectors from developing those new dams and facilities.

Many of the irrigation conveyance and delivery systems that were exclusive for the agriculture sector such as the MADA Granary and the Kerian Granary, have now to function for multi-purpose for water supply, flood management and more diversified agriculture. The existing system will need to be upgraded to accommodate these added functions both in terms of water quantity and water quality management.

A similar trend is also occurring in the agriculture drainage schemes where the agricultural drainage systems have now to cater for urban drainage and flood management needs.

Special structures and dam water bodies (the reservoir) often attract public interests. Large dams especially could be planned and designed for tourism for additional income generation and support for

the local economy. The Hoover Dam in the USA for example is a multi-purpose dam for energy, water supply and irrigation constructed in 1936. From the inception stage, this dam was planned and designed to accommodate tourists for tours of the dam and the surrounding water bodies. Now more than 1 million tourists visit the dam every year.

Financing Models for IWRM Approaches

There already several models for infrastructure and services project financing that encourages private investments and financing that allows for the IWRM approach. The present preference globally is the Public-Private Partnership (PPP) model that is based on investment risk sharing between the public (government) and the private sector but with a higher portion of the risk assigned to the private sector. The World Bank has now a special programme to develop and support PPP projects for all sectors around the world.

In Malaysia and within the water sector, PPP projects are already established in the energy, water supply and sewerage sectors.

PPP for the Agriculture Sector water development and management has yet to be implemented in Malaysia. Such approach is already well established in countries like France where the primary purpose is water for agriculture and the secondary purpose is for water supply, drainage and flood management and even energy production thus applying the IWRM approach. In this approach, farmers are also given the opportunity to invest as one of the shareholders of the PPP entity. This model is now being extended to certain African countries.

The PPP financing approach could also be in combination with the conventional full Government funding. This can be categorised into Cross-sector Financing and Parallel Sector Financing:

(i) **Parallel Sector Financing**

This approach can be applied where there is a distinct physical or quantifiable separation of sectoral water use and management under a single project implementation. A good illustration is the SMART Tunnel Project. In this project, the financing of the highway component is by PPP and the flood and drainage component, considered as a social obligation of the Government, is fully funded by the government. The subsequent operations and maintenance are also separately funded i.e. by the operator for the highway and by the government (DID) for the flood and drainage management component.

There are a number of potentials for other water sector projects. Presently single purpose hydroelectric and agriculture dams, for example, could be re-developed to accommodate the needs of the Water Sector. In this case, the investment cost could be recouped from the private water operator abstracting the reservoir. Similarly, agriculture dams could be re-designed to accommodate the energy sector for hydroelectric production. Hydroelectric dams could be retrofitted to allow for Agriculture sector to tap the reservoir. In this case, the downstream conveyance system installation and operations and management could be part or fully funded by the government, depending on the types of crops produced i.e. strategic or commercial crops.

(ii) **Cross-sector Financing**

This approach is possible for water projects with the IWRM approach that does not have any distinct physical separation or that the water use is not readily quantifiable. In this case, the cross-sector water investor would not be involved in the operations and maintenance of the system. A good potential for this financing plan is the conversion of single-purpose irrigation and drainage conveyance and distribution channels to accommodate multi-purpose uses for floods, water supply, and energy. In this situation, the “incoming” Sector would have to contribute to the conversion works and operations and maintenance. This approach is also a potential for water supply investments towards irrigation efficiency (agriculture sector) improvements. The water savings from irrigation would relief the water supply sector for new water resources development. Present dams and new ones developed and operated by the energy sector could also be designed to accommodate for flood management. In this case, the government could contribute financing for the additional storage requirements.

Cross-sector financing is also possible for a non-physical aspect of water management, particularly for flood management. The cost of flood mitigation projects is rapidly becoming a financial burden for the country. The percentage of land acquisition and compensation to those affected in relation to the total cost of flood mitigation projects is increasing. Also increasing is the social resistance to such physical intrusions. A possible solution would be to consider a flood storage compensation plan to agriculture

landowners such as the paddy lands in the MADA granaries or tree crop areas in low-lying areas. This is in lieu of physical flood mitigation project.

As an illustration, records indicate that on average farmers in the MADA granary are compensated at an average rate of RM1,000 per ha for flood damage over an average area of 4,000 ha. Thus, the average total compensation is RM4 million per year in the MADA granary. Over 10 years this works out to be RM40 million or RM25 million NPV at say, 10% discount rate. This amount is far less than implementing a physical flood management infrastructure project that could be as much as RM200 million (at say RM50,000 per ha including land acquisition) to protect 4,000 ha at 1:20 year ARI (ASM 2015).

The potential in such cases here is to develop a long-term “flood rental” scheme with farmers for the flood-prone paddy lots or in low-lying agriculture areas in lieu of or with lower protection levels through physical flood mitigation project for the affected farms. For urban areas, suitable agricultural areas on the upstream side could be considered for “flood rental” scheme to manage flood flows into the downstream urban areas. In the scheme, the farmers could still continue their agricultural activities. The IWRM approach in this scheme is in terms of land resource conservation from the reduced need for land acquisition as well as in capital investment.

Water-Energy-Food Nexus

Expert Review

Dr Hezri Adnan FASc

Of all natural resources, water, energy and food (WEF) are most needed to sustain life on earth. The three resources are tightly interconnected. In 2050, with a forecast of 9.2 billion people sharing the planet, it is expected that there will be a 70% increase in demand for food and a 40% rise in demand for energy (Hoff 2011). With the current demand, the world will face a water deficit of 40% as early as by 2030. Yet, to produce food and energy we need water. Herein lies the challenge of how the three strategic resources from a policy nexus. If left unchecked, their long-term insecurity can be an impediment to social stability and economic growth.

Against this background, the recent years saw a conceptual surge with the resource nexus idea. The key motives for the growth of the 'nexus industry' are at least four-pronged:

- *Stressed resource system*—world's WEF resources are already experiencing significant shortfalls;
- *Demand rapidly increasing*—growing population, increasing rates of urbanisation, insatiable demands from expanding middle-class lifestyles and diets;

- *Well-being and access*—need to improve the well-being of the poorest and most vulnerable populations by securing access to WEF; and
- *Securitisation*—without considering interconnections, resource allocation may easily become a zero-sum game where intense competition for resource access can easily become a conflict.

Increasing political reference due to the nexus strategic importance was evident when the 2012 YouGov Poll, an online market research agency, placed ensuring continued supply to water, food and energy as second to terrorism as a foreign policy priority in Britain. Although WEF nexus presents new threats, it also offers new opportunities for humankind. *The Global Resource Nexus* report by the Transatlantic Academy argues that the nexus approach allows a systemic consideration of potential impacts from resource utilisation (Andrews-Speed *et al.* 2012, p. 2):

“The range of potential risks and uncertainties relating to a single resource is magnified when the links between different resources are taken into account.”

This chapter situates the Nexus challenge within the context of Malaysia. The international nexus discourse tends to focus on trans-boundary river basins with less attention on countries with smaller river basins such as Malaysia.

Confronting ‘New’ Scarcity

Despite its rich endowment with natural resources, Malaysia has often been touted as an example of where the resource curse did not strike (Sachs and Warner 1995), as rapid development allowed for Malaysia to chart impressive growth rates since its formation. As a result, however, its state-of-the-environment is altered from a pristine nature to a modified human landscape. Consequently, the provision of environmental goods and services by the natural ecosystems is also compromised. The sense of urgency to address regressive environmental conditions with new policy instruments is also echoed by scholars and scientists alike (Aiken & Leigh 2011; Chan 2012b; Anuar 2012; Khalid *et al.* 2012).

Arguably, Malaysia is no longer a resource abundant nation that it once was. It is confronting the challenge of ‘new scarcity’ beyond physical depletion of natural resources, but also with their economic and political cause and effect (Hezri & Alizan 2015). An evident for this new resource realism is our forest wealth which is now a thing of the past. Malaysia is now left with only four major forest islands in the peninsula. Other related trends pointing to a stressed resource system, shifting from one of relative abundance to one of scarcity are summarised below:

- On water availability, the 2010 National Water Resources Study has identified Perlis, Kedah, Penang, Selangor and

Malacca as water-deficit States with increasing frequency of water supply disruptions and droughts;

- Although the Peninsula has a high installed electricity generation capacity, it is increasingly constrained by the availability of fuel. With its natural gas gradually being replaced by coal sources, Malaysia has to purchase coal from producers like Indonesia, Australia, China and South Africa. Accessibility may be a challenge in the long term because the price and supply of coal are fully controlled by suppliers; and
- The land use for agriculture in Malaysia is geared to producing commodities for export rather than to fulfil the food requirements of the nation. As of 2005, only 16.3% of the land was devoted to food crops such as rice, vegetables, fruits and coconuts (Arshad & Hamed 2010). By 2014, agro-food land use declined to 10.7% (Malaysia 2015).

Nexus thinking will require a redefinition of policy framing on natural resources management from two perspectives. First, with receding forests cover, it is important that Malaysia’s residual natural areas are considered as the ‘critical natural capital’ essential for the functioning of life support systems, and for that reason must be duly protected. Second, to accommodate the concurrent and competing demands for human settlements, industries, and conservation, the scarce natural resources require better trade-off mechanisms.

Emerging Risks

Much has been written about the pitfalls of governing resources in a silo. Such an approach may lead to negative trade-offs

impacting policy and technological choices. This section outlines the sub-optimal operation and decisions or questionable trade-offs for not integrating concerns over water, energy, and food simultaneously.

(i) **Social Costs of Hydropower Dams**

Hydropower development presents a quintessential three-way interaction of the nexus security challenge. The establishment and operation of hydropower dam are overwhelmingly complex because the issues are not only confined to the design, construction and operation of dams themselves but embraces the issues of social, environmental and political perspectives. Dam development for hydropower therefore often involves many trade-offs.

Under the Sarawak Corridor of Renewable Energy (SCORE), the state government of Sarawak has in recent years announced plans to develop several large hydroelectric projects. The development spanned over a period of 22 years to generate 28,000 MW of electricity once fully developed. The power generated by SCORE's complete energy nexus would be used to fuel the industrial development of 70,709 km² of Sarawak's central region. The Sarawak Government is using this dam-induced industrialisation strategy as a prospect to attract significant Foreign Direct Investment in an attempt to achieve the Malaysian Government's vision of Sarawak as a 'developed state' by 2020. Amongst the projects to be developed are the Baram dam (1200 MW), Baleh dam (950 MW) and Pelagus dam (770 MW) in the upper reaches of the Rejang river, Sarawak. In 2013 the 944 MW Murum dam was completed whereas the Bakun hydroelectric projects,

was completed earlier with the cost about USD4643 million (Sovacool & Bulan 2011).

The nexus challenge for Bakun is encapsulated in major criticisms from national and international bodies over the issue of the indigenous peoples (mostly Kayan, Kenyah, Lahanan, Kajang, Ukit, and Penan ethnic groups) being resettled by the impoundment of the lake (Gabungan 1999; Choy 2005). In the interest of energy security, hydropower dams such as Bakun have been said to affect the food and water security of indigenous communities (Aiken & Leigh 2011). In terms of ethnic composition among the resettlers, the Kenyah population was the largest group consisting of 5313 peoples, followed by the Kayan, 3995 peoples, with the balance consisting of 910 peoples (Andre 2012). The resettlement site, generally referred to as Kampung Asap is located approximately 40 km from the Bakun Dam site. Some people in some of the longhouses have also decided to move to other sites, not designated by the government.

Most of the indigenous peoples involved were subsistence farmers for generations in a forest land of 107,000 ha with no previous participation in the Sarawak's economy. They also had a strong cultural attachment to the forest they left. Many studies claim that the communities' well-being as a whole was negatively affected. This was due the fact that they have long depended on Sarawak's rivers and forests not only as a main source of livelihood but more importantly as their way of life. An ethnographic study by Choy (2005)

found that the resettled communities had lost all four of the most important types of land: *temuda*, farmland around longhouses, *menoa*, land for game hunting and gathering, damp, cultivated land, and *oipulau*, or protected forest area. He concluded that “the Sungai Asap resettlement area is environmentally unsuited to sustaining the social value and cultural identity of the indigenous communities affected by the Bakun Dam project” (Choy 2005).

(ii) **River Pollution Stressing the Nexus**

River basins in Peninsular Malaysia are confronting increasing water demand, riverbank encroachment, industrial pollution, environmentally damaging sand mining activities, and upstream land clearing projects. Together these challenges present a water security threat to the functioning of river systems and the health of their basin, with knock-on effects on rice production, water supply, and electricity generation sectors.

A case in point is Sg. Kelantan and its role in supplying water resource for three irrigation schemes managed by the Kemubu Agricultural Development Authority (KADA). To irrigate Malaysia’s second largest granary, KADA uses an energy-intensive water pumping system developed in the 1960s with further improvements of their capacity and technology in the decades that follow. The changing river regime currently poses a number of operational challenges in the quest to ensure water and food security. In recent years KADA has been facing the problem of being unable to pump the designed amount many times in the past during dry seasons. The pumps

could not function because the water levels in the major pumping stations are at below critical points for them to operate. For instance on 28 April 2015, with the flow rate of 113 m³/s, the water levels at Kemubu, Lemal and Kasa pump stations were 3.96 m, 0.22 m and 0.4 m respectively. All these readings were lower than the critical level of all three pump houses. The average water levels during drought seasons from 2010 to 2014 were 4.1 m for Kemubu, 0.5 m for Lemal, and 0.8 m for Kasa.

The falling water level in Sg. Kelantan which leads to dropping in water level in the pumping station during dry seasons as well as the sedimentation of the river at the intake point, has indirectly affected the water flow into the paddy production system. Thousands of farmers in KADA are facing the water supply crisis almost yearly due to the drought and irrigation failure. In fact, farmers are faced with the water-rationing problem with their production and income from paddy cultivation significantly reduced. Over 3,000 farmers were affected around Kota Bharu Hulu, Kota Bharu Selatan, Pasir Puteh, Bachok and Pasir Mas with an estimated loss of RM100 million a year (Ismail 2013).

Another risk is the threat of river pollution on thermal energy production that relies on treated water. It is widely known that electricity generation leaves a big water footprint, with different types of thermal electric power plants consuming different volumes of water (Pate *et al.* 2007). TNB Janamanjung or Sultan Azlan Shah Station started its operation to meet the anticipated growth in electricity demand in the Peninsula and

help maintain the required power reserve margin. The plant delivers 2100MW of net power from three units of 700 MW generators. The plant runs on bituminous and sub-bituminous coal as fuel.

The station also depends on the water supply from the Teluk Kepayang water treatment plant which is operated by *Lembaga Air Perak*. The four plants require clean treated water for their boilers. In recent years water treatment plants, especially in Perak Tengah, increasingly have to process raw water with turbidity level exceeding 1000 NTU. This high silt loading scenario has occasionally led to plant shutdowns in order to clean up the sedimentation. A worrying trend is observed when the Teluk Kepayang treatment plant is also facing the threat of shutdowns because of high silt load. In the event of long shut down hours, the operation of Sultan Azlan Shah power station might be interrupted. Given the centrality of this station to the national electricity grid, a severe pollution episode may trigger a national crisis of power supply failure.

Nexus Opportunities

The concept of WEF nexus is arguably still in its nascent stage. Despite the interconnected nature of WEF is widely recognised internationally, “there is a relatively limited understanding of how to tackle these complex relationships when conducting assessments and taking action” (Bizikova *et al.* 2013: 3). Similarly in Malaysia, some of the opportunities to be tapped from the nexus approach are still insufficiently defined. What follows is a cursory analysis of lessons learned from Malaysia’s past and existing experience of

resource management that capitalises on multi-sector optimisation consistent with the nexus approach.

(i) **Energy Capacity and Environmental Footprint**

With an installed capacity of 600 MW, the Pergau (or Sultan Ismail Petra Hydroelectric) Power Station is the largest hydro plant in Peninsular Malaysia. This peaking station is able to generate energy very fast at the rate of 15MW per second. It is a peak load underground station with an average generation of 520 Gwh per year. It features an intelligent design in keeping with the nexus approach whereby large energy capacity is generated using a small lake of about 4.3 km² with minimal environmental impacts. In comparison, the Temengor dam in Perak requires 150 km² lake area support its 348 MW power station. The Pergau scheme consists of an underground power station drawing water from a dam located on the Sg. Pergau just downstream of its confluence with the Sg. Yong. The flow capture of the scheme is enhanced by the pumped transfer of water from adjoining southern catchments through a 24 km long aqueduct. A re-regulating weir on the Sg. Pergau in the vicinity of Kg. Lawa controls outflow from the power station.

(ii) **Creation of Multipurpose Dams**

The 400 MW Sultan Mahmud Power Station and its 155-metre height impounding Lake Kenyir is a multi-purpose hydropower station which incorporates power generation, flood and drought prevention, recreation, tourism and aquaculture (TNB 1993). The other important function it provides is to minimise the interruption of the freshwater supply at Kuala Terengganu. Since the Sg. Terengganu river basin is mainly flat,

it faces the risk of saltwater intrusion into the freshwater supply when high ocean tides coincide with low river flow. The Kenyir hydropower scheme showcases a best-practice attempt of both upstream and downstream Terengganu river basin stakeholders such as TNB and Syarikat Air Terengganu to cooperate about access to water and the regulation of the flow of Sg. Terengganu. The Kenyir scheme will soon upgrade as a cascading scheme with the construction of two dams—Puah (250 MW) and Tembat (15 MW)—geared towards maximising the use of water resources upstream. The Puah dam is 78-metre high with a crest length of 800 metres with a lake size of 6,979 ha. The Tembat dam is smaller in comparison with the height of 36.5 metres and the crest stretching 210 metres in length. Moving forward will require more integrated planning in the operation of dams in Malaysia. Following the 2014 big floods in the East Coast, the government is exploring the possibilities of building two multi-purpose dams that will concurrently serve energy, water and food sectors involving Sg. Lebir and Sg. Nenggiri in Kelantan.

(iii) **Integrated Resource Security Policy**

Malaysia has introduced numerous policies to embolden natural resources management in Malaysia. Comparing the three resources, energy thus far received the highest-level policy attention from a security narrative. Malaysia's rapid economic growth since the 1970s is facilitated by its energy independence as a net exporter. Under this condition, its energy security measures were incrementally and systematically shaped by the policy landscape internationally and nationally.

Malaysia's public policy on food security is modest in comparison with the energy sector but is generally better than policy measures put in place to ensure water security. Following the food crises from 2007 to 2009, the self-sufficiency level for rice production in Malaysia was set to increase to 70% by 2010, aiming for an increase in average yield from 3.47 metric tonnes per ha in 2005 to 4.48 metric tonnes per ha in 2010. The government also announced new paddy farming areas amounting to 23,017 ha in Sabah and 25,583 ha in Sarawak. The national rice stockpile was set to 239,000 metric tonne for 45 days with a distribution of 78% for Peninsular Malaysia, 12% for Sabah and 10% for Sarawak (Tey 2010).

Given that water is crucial in ensuring continuous energy and food production in Malaysia, its relative neglect from a security angle begs a more focused approach in terms of both planning and implementation. Realising this gap, the Malaysian Government in February 2012 has formulated and endorsed the National Water Resources Policy (NWRP). The visionary shift is seen in its focus on *water as a resource*, away from the conventional way of equating water management solely with the water supply industry alone. NWRP outlines the various strategies and action plans to address the problems and concerns for both immediate and long-term to manage water resources availability and demand in the country. With the following policy statement, NWRP provides clear directions and strategies in water resources management to ensure water security and sustainability:

“The security and sustainability of water resources shall

be made a national priority to ensure adequate and safe water for all, through sustainable use, conservation and effective management of water resources enabled by a mechanism of shared partnership involving all stakeholders.”

Be that as it may, despite clear interactions between water, food, and energy that may result in competition, synergies or trade-offs between different sectors or interest groups, the current planning, foresight and implementation of policies are still performed separately. The Eleventh Malaysia Plan (2015–2020) signals the needed shift away from siloed thinking to a governance model that explicitly emphasises the need to move beyond the sector-based approach to advance water, energy and food security:

“In the Eleventh Plan, Malaysia is breaking free from the conventional wisdom of development at all costs to green growth, which is a more sustainable path of growth. This will see Malaysia enter the ranks of advanced economies in 2020 with an economy resilient to the adverse impact of climate change and with a secure and sufficient supply of natural resources such as water, food, and energy. Partnership and shared responsibility across all levels of society, including individuals, will be key to safeguarding the

environment and biodiversity. Successful green growth will not only expand economic opportunities, but also enhance inclusive and reduce disaster risks.” (Malaysia 2015; p. 6–30)

Orchestrating a balanced use of the three resources will require various stakeholders and policymakers to apply the nexus concept and tools which corroborate the need to view water, energy and food as being complex and inextricably entwined. Further, the development and prescription of WEF nexus solutions require innovative policy strategies coupled with appropriate technological infrastructure.

Conclusions

The current international interest on WEF nexus presents a policy window to put in place systemic and cross-cutting changes that embolden integrated resource management. Malaysia too stands to benefit from the nexus approach and the motivations are clear. Not only that it now faces insufficient renewal production of and access to strategic resources such as water, energy and land at the national level, it also has to deal with emerging challenges such as the volatility of market prices, and ambient factors such as climate change and the non-stationarity of hydrological data.

However, mainstreaming the nexus thinking in Malaysia’s public policy will be no easy feat. Information gap, silo-based governance, and technology lock-in are the forces that hinder the translation of water, energy, food nexus into operationalisable objectives and

programmes. To date, there is a dearth of information on nexus input-output. Establishing this 'internal linkages' (among resources) via input-output accounting is an important step in understanding the extent of nexus interaction in Malaysia. Also, large technological systems such as irrigation scheme and hydropower are hard to change because a country or an agency has sunk a lot of time, effort, and money into one of them. This makes the prospect of switching to a new technology incredibly difficult and expensive.

Moving forward, it must be recognised that water, energy and food nexus is a whole-of-society problem whose governance is beyond the expertise of technocrats in the water sector. The 'big picture' synoptic or systems thinking is a requisite in addressing the interconnectedness challenge.

S&T Awareness, Advocacy and Capacity Building

Expert Review

Professor Dato' Dr Mazlin Mokhtar FASc and Dr Rahmah Elfithri

The principles and concepts of IWRM have been widely recognised, but the implementation of IWRM is not satisfactorily progressing in many countries (UNESCO 2010). Among the main causes are because the practitioners responsible for water resources management in the country or basin area encounter difficulties in understanding the concept of IWRM itself, lack of knowledge on how, why, where and when to implement it, as well as limited resources and expertise of applying IWRM fully. To fully implement IWRM, there is a need to build capacity for its implementation. Capacity building is needed to enhance the ability to do or to implement IWRM based on an understanding of environmental potentials and limits and of needs as perceived by the people of the country.

The skills, qualities, and capacities of the human resources employed are vital for the successful performance of the water sector and for the sustained use, adaptation and development of scientific and technological innovations (UNESCO 2016). Existing capacity and capability for the IWRM and development, including technical, technological and institutional capacities and capabilities are crucial to being developed. Such capacity can

consist of several layered and nested levels i.e. the capacity of individuals, organisations, the enabling environment and civil society (UNDP 2008; 2009).

Among areas needed in IWRM related to capacity building involves Advocacy, Training and Education, Policy Formulation, Awareness Raising or Community Involvement, Participatory Management, Effective Legislation and Enforcement, Restructuring and Institutional Framework. This requires a paradigm shift in its implementation, which meant to be more participatory, integrated, adaptive, ecosystem-based management of water, land and related resources (Groot & Lenders 2006).

Awareness, advocacy and capacity building are the key success in implementing IWRM at all levels. Raising public awareness is about providing knowledge and information for public related to IWRM to change their perception about the use of water and situation or facts related to water. Community stakeholders may not be familiar with the concept of water management and their role in this. Therefore it is crucial to raise awareness of public concerns about water use and availability, with

clear relevance of climate change and other external forces, reminding them of the necessity and limitations of water resource for human existence in accessible ways such as through media, education and participatory processes, then translates it into more sustainable and meaningful development outcomes. Advocacy is a process of supporting and enabling people to be able to implement IWRM which includes expressing their views and concerns, access information and services, defend and promote their rights and responsibilities, explore choices and options towards better implementation of IWRM. Capacity Building is a most important tool in order to develop the capacity of various stakeholders and to make sure a certain level of improvement and enhancement of knowledge, experience and expertise in the specific field were obtained, in this case, is on water resources and river basin management.

Capacity building is essential in community participation. At many levels in the process, even at the governmental level, stakeholders lack the necessary knowledge and skills for full application of effective participation. Capacity building categories include education and awareness raising about community needs, information resources for policy making, regulations and compliance, basic infrastructure and market stability.

Water resource management requires a minimal level of capacity at all levels, including that of decentralised local governments. Functional capacity at community level builds resilience to hazards, and facilitates the use of knowledge and technologies, innovation and education, thereby creating a culture of safety and resilience at all levels. Local capacity development and training priorities should be expressed as a regional agenda, to enable many partners to buy in along the research-to-development continuum, and to

form collaborations where consortia, alliances, networks, and individual organisations may all find their place to both fund and benefit from it. Regional training priorities are best expressed in terms of problems of water functions that need to be addressed locally but regional synergies are possible.

Brief Review of Global Trends

For over 30 years active awareness, advocacy and capacity building programmes and projects had been conducted worldwide including within Malaysia, in the Southeast Asia Region and beyond regarding water resources in nexus with energy, food and climate change. This is a process of transformation from the inside, based on nationally determined priorities, policies and desired results. It encompasses areas where new capacities have to be introduced and hence, the building of new capacity is also supported. However, despite many capacity development efforts, in practice, it remains challenging to strengthen knowledge and capacity across the board, in multiple government institutions, civil society, the private sector and knowledge institutes (Wehn & Alaerts 2013).

Several published documents, based on case studies, have revealed that IWRM implementation has been facing difficulties in different developing countries (Biswas 2004; Funke *et al.* 2007). The challenges faced by developing countries in their struggle for economic and social development are increasingly related to water. Many countries are shifting their attention to the city level as the locus for sustainable development. Companies are measured in terms of their social and environmental performance and are under public pressure to deliver services at affordable prices, while consumers are beginning to

understand that they, too, have a role and may need to become more responsible consumers. Revisiting frameworks such as IWRM in order to resonate with these new complexities will be essential. Moreover, stronger and better-interlinked institutions are required to handle the increased level of complexity.

Some countries have already embarked on developing and implementing such strategies (i.e. Uganda), while others are only beginning to deliberate on their necessity (i.e. Indonesia). In some countries, capacity development strategies are (at least in principle) integrated into their national IWRM Policy (i.e. Colombia), but their implementation remains challenging. Lessons with the conceptualisation, as well as the implementation, of such sector-wide strategies, are starting to emerge (UNESCO 2016).

Recently, the term of capacity development is being used which referring to much more than only supporting training programmes and the use of national expertise. Training and expertise are important, but it also include response and support strategies for accountable leadership, investments in long-term education and learning, strengthened public systems and voice mechanisms between citizen and state and institutional reform that ensure a responsive public and private sector that manages and delivers services to those who need them most (UNDP 2007). Such sector, wide capacity development strategies can help to ensure that the knowledge and skills to maintain water services and water resources are strengthened where needed (i.e. locally), and that new system expansion avoid the failures of the past when the focus was entirely on infrastructure.

Some questions popped up in mind like how did the more relatively successful countries implement the policies related to IWRM, especially the ones with a higher number of population and a greater number of provinces or districts and local authorities. Government ministries and agencies have good water policies, knowledge and capability of their top officials are quite high in implementing IWRM, but how did they obtain the buy-in and commitment and dedication of experts and equally if not more knowledgeable or of more experiences on the ground of practitioners and professionals from the business and in the industry, the indigenous knowledge and wisdom of communities, researchers and innovators especially from universities and academia.

Snapshot of Current Status in Malaysia

Awareness, Advocacy and Capacity building for IWRM in Malaysia has gone through an interesting journey of phases since about two decades ago under various big umbrella initiatives of entities such as the Malaysian Water Partnership (MyWP), the Malaysian Capacity Development Network or formerly known as Malaysian Capacity Building Network for IWRM, UNESCO-IHP Malaysia, Academy of Sciences Malaysia, which implements its agenda by involving important agencies and ministries in Malaysia, universities, professional bodies, NGOs, CBOs, Business Associations and as such.

Nevertheless, after over two decades, the overall implementation of IWRM in Malaysia is still very slow and lack of understanding over the concept is still apparent between departments. GWP (2004) has reported that like in many countries sectoral approach in Malaysia proved unable to effectively allocate scarce water, control flooding or pollution and protect

the environment. Therefore, immediate attention should be given to the implementation of IWRM and specific efforts have to be made to develop a strategy for IWRM implementation at the local level so that effective water governance is evolved. Salmah (2007) suggested that capacity building is vitally needed to raise operational and implementation skills to match IWRM theory. Tan and Mokhtar (2009) argued that although policy mechanism and guidelines are available in Malaysia, no department has effectively implemented and enforces them. Thus, what is required is a strong political will and commitment of both Federal and States governments to move things ahead.

Some updates and ongoing regarding this in the sphere of natural resource and environment in Malaysia include some of the good initiatives related to UN-related agencies which implement its initiative directly in Malaysia such as Global Water Partnership (GWP), International Network for Capacity Development in Sustainable Water under UNDP, Hydrology for the Environment, Life and policy (HELP) and Ecohydrology Programme of UNESCO, etc.

International bodies and newer integrated and holistic approaches are also taking water issues as central matter in their respective frameworks, for examples UNESCO Global Geopark of Langkawi, UNESCO Biosphere Reserves of Tasik Chini and Crocker Range, UNESCO-IHP HELP of Langat River Basin, UNESCO-IHP Ecohydrology of Putrajaya Lake and Wetlands, UN Education for Sustainable Development, FAO Framework of Ecosystem Approach to Fisheries Management (EAFM) in Langkawi.

The progress and success had been encouraging and achieving certain levels of expectations and standards, depending on who and which institution is measuring. The

grand issue of IWRM, IRBM, ILBM, and ICZM puts water in the main tenets of their approach and these have now been often being looked at and implemented via the vision of nexus of water with food, energy, climate and good governance. It became more fantastic now with greater involvement of experts, professionals, policy makers, educators, researchers and community leaders.

A network of networks is also an important reason for some of the way forward and upward for IWRM in Malaysia. Multi-, inter- and trans-disciplinary approaches are also the common basis of planning and doing or implementing by the various stakeholders from many sectors.

Sustainability science is now key to finding solutions to key water issues and problems in Malaysia and the region, where the science are coming from STEM (science, technology, engineering, and mathematics) and social sciences and humanities including economics, law and even religion. One of the main outcomes of Sustainability Science events held in Kuala Lumpur, Malaysia in 2013 and 2015 by the Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia in partnership with the United Nations Educational, Science and Cultural Organization were to implement sustainability science demonstration site on restoring and managing Langat HELP River Basin, Malaysia and sustainability science demonstration site on water and environmental sustainability education in Langkawi Geopark, Malaysia (Elfithri *et al.* 2015).

The challenges facing are on how to convince everyone in Malaysia that each one of them is capable of contributing towards the 169 targets of the 17 SDGs and perhaps all are already contributing by doing and sharing it but did not realise it or do not know how to contextualise it.

There is a need to raise awareness that it is not only for the government to think and do SDGs, but it is for all of us. None of us is as perfect as all of us in implementing and contributing towards IWRM for SDGs.

Climate change mitigation and adaptation and Disaster Risk Reduction principles and embedment into IWRM approaches are also happening in Malaysia's capacity building for IWRM initiatives nowadays.

For example in 2005, MyWP and some institution partners have contributed towards IWRM skills training by initiating the Masters of Environmental Science in IWRM at the Open University of Malaysia (OUM). The other achievement is done through a project called MyIWRM, what can I do? Developing Capacity for the Practical Implementation of Integrated Water Resources Management in Malaysia initiated by LESTARI-UKM and CapNet in 2007–2009. Under this project, specific capacity development activities for practical implementation of IWRM by NGOs, academia, government officers and private sectors in Malaysia were done. The formation of MyToolbox in 2001 has also supported training and promoted the application of IWRM.

Many other capacities building programmes and activities were done in the form of practical implementation through conducting a series of training and education, as well as awareness programmes for different stakeholder groups by various entities and in partnership in Malaysia. Annex 1 shows some examples of capacity building programmes and activities on IWRM that have been carried out in Malaysia.

Particularly for Langat River Basin, some IWRM capacity building modules and manuals, including the concept of "training of trainers"

for different levels of stakeholders have been developed to schematically and systematically introduce IWRM and its subsets. In term of education, even though IWRM is not specifically taught as a subject or offered in any faculty programme, some innovative approaches in introducing and implementing IWRM have been made. It includes promoting IWRM concept in any programmes, during lectures or classes, or encouraging Masters and PhD students to do their thesis related to IWRM. It shows that education can be accomplished through formal, non-formal and informal approaches. In term of awareness, several initiatives were taken especially in improving the level of awareness and understanding of various stakeholders in water resources and river basin management. These have been done through interactive dialogue with specific target groups of stakeholders, talkative campaigns as well as the enthusiastic promotion of sustainable and integrated concepts and approaches. In some cases, the results have been used in assisting the government and other stakeholders to develop educational and awareness packages for different levels of society.

Recommended Strategies for Nationwide Implementation

(i) Awareness Raising

Awareness-raising activities are needed to help inform and sensitise decision-makers outside the water community (e.g. agriculture, energy, health and safety, and finance) about water-related challenges and their implications for and interrelations with these sectors (UNESCO 2016). Some recommended strategies for awareness raising of IWRM implementation in Malaysia are discussed below:

- a) *Water awareness for students, public and at large*
Hold water saving campaigns in residential colleges where students and the college management community can get together to discuss and learn about 'water saving', conduct water saving competitions among colleges in universities, public awareness on water minimisation and water care.
 - b) *Awareness programmes for decision makers*
Specific awareness programmes, workshops, seminars, consultations at National, State, and District level need to be conducted to give more awareness, knowledge and information for decision makers related to water.
 - c) *Information dissemination*
Awareness for people in charge of disseminating information and drawing attention to the issues of water conservation is important including on materials to be disseminated and method of disseminations.
 - d) *Continuous reminders/reinforcement*
Set up continuous reminders/ reinforcement of awareness to students by teachers/lecturers, e.g. through core-competencies.
 - e) *Keep Updating information*
Maintain a database of a comprehensive assessment of all water resources (traditional and alternative) and water demand by sectors at local, basin, state and national scales.
 - f) *Access to water information*
Have access to decision support systems including use of physical and socio-economic models and techniques for water allocation at various scales.
 - g) *Recognising role of academia in water management*
Make sure that the academe's different actors, operating at different levels. Comprehend the issues in order to understand the stakes involved and to accept and implement the required attitudinal changes.
 - h) *Stakeholder engagement*
Engage stakeholders to resolve conflicts and broker trade-offs.
 - i) *Make SDGs implementation work*
Make SDGs implementation work in the country especially at local levels.
 - j) *Leadership at various levels*
Develop SDGs leaders at all levels that can work with all kinds of people. Leadership at various levels of the pyramid must be active.
- (ii) **Advocacy**
There is a need to use the IWRM awareness raising strategy to serve as a key method for informing policymakers, the public and the academy of the benefits of IWRM and for suggesting possible ways the target groups could contribute to its implementation. It is important to advocate the entirety of the environmental and socio-economic issues relating to water management. Below are some recommended strategies for advocacy of IWRM implementation in Malaysia:
- a) *Creating an enabling environment*
Creating an enabling environment

- with appropriate policy and legal frameworks, institutional development, including stakeholder participation
- b) *Need for organisational change*
Need critical mass for organisational change at catchment level and commitment from all levels towards IWRM Implementation in Malaysia.
 - c) *Comprehensive review of legal framework*
Need to strategise water management, strengthened legal and institutional arrangements.
 - d) *Data sharing amongst agencies for effective planning*
Need to promote data sharing mechanism among agencies for effective planning of IWRM
 - e) *R&D or pilot projects to showcase/ demonstrate the best management practices*
Undertake R&D programmes pertaining to water security and sustainability as well as success stories case studies to share the best management practices with many stakeholders.
 - f) *Water resources management technologies/model*
In some instances, water resources management technologies or suitable models can be used such as real-time catchments and river flow computer modelling, MLSharing, etc that can be adopted and adapted to help implement various activities at local, State, Federal, national and even regional levels effectively for SDGs at those levels and scales, by bringing experts and players from many disciplines and sectors, and not only government bodies.
 - g) *Develop and enhance networking within regional and international bodies*
Develop and enhance networking within regional and international bodies to support IWRM implementation as a practical approach toward sustainable water resources management and river basin management.
 - h) *Flexible and long-term education funding/financing*
Financing should be flexible, including to build core operational capacity. Flexible funding is instrumental in allowing for experimentation, learning, and growth: governments and donors that focused on agreed-upon results to achieve but are flexible and have trust in the implementer about the best way to achieve them. This includes investments in activities that were most needed to support the scaling process at various points, which frequently required developing core operational capacity.
- (iii) **Capacity building**
Capacity building, training, and education in a more general sense, the generation and dissemination of knowledge, can take place through formal, non-formal and informal education and training. Some recommended strategies for capacity building of IWRM implementation in Malaysia including:
- a) *IWRM capacity building links with SDGs, DRR and SS for SD*

There is a need to develop more capacity building programmes in IWRM link with Sustainable Development Goals (SDGs), Disaster Risk Reduction (DRR) and Sustainability Science (SS) for Sustainable Development (SD) especially with regards to the following:

- The interconnection of SD & Sustainable Energy.
- Energy and Sustainability in the world, issues, challenges and opportunities.
- Renewable energy and Sustainability as a solution for climate change.

b) *Relook at academic curricular contents at universities*

In order to reflect the cross-cutting nature of water, there is a need to broaden academic curricula, e.g. providing courses on energy and agriculture to water professionals, and on water resources management and water operations to science and engineering students in other fields of study (UNESCO 2016). There is a need to relook at curricular contents at universities/ tertiary education institutions in Malaysia to produce future human beings who are talented and competent to think of greener ways of working and business and in providing services that are truly aligned to 17 SDGs and 169 targets of SDGs. And these leaders and professionals and business captains and practitioners must always think of how to influence and help transfer

knowledge and expertise to their respective downlines and chain suppliers and partners.

c) *One stop training centres*

Develop training modules at one stop training centres involving three related ministries together to allow IWRM training conducted for all. There is a need to include a blend of common IWRM module for water-related personnel, prior to streaming them into specialised training in accordance to their sectoral management and service delivery needs. IWRM courses to be conducted with IWRM lecture introduced in an existing course.

d) *Creating technical expertise in new area*

Pool all the relevant skills and make them available for the training of all related stakeholders in IWRM to attain the goals of IWRM.

e) *Strengthening of IWRM resource centres and training courses*

Develop and enhance IWRM resource centres and training courses.

f) *Development of capacity building networks*

Develop capacity building networks in IWRM amongst relevant ministries, agencies and universities to make sure capacity building for IWRM is easily developed.

g) *Recognising role of young leaders in water management*

Young leaders are important stakeholders in Water Management as enablers for IWRM and play a crucial role in water for the future. IWRM principles have to be

- introduced to them from earlier in schools such as secondary school students in Malaysia.
- h) *Redefine the role of academia in water management*
Conduct continual on-the-job training for teaching staff e.g. workshops and related training activities. Experts and professionals in academia are needed to educate other academic are needed staff as their contribution to capacity building. There is a need to promote the empowerment of academia in water management to be the focused in dealing with paradigm changes.
- i) *IWRM training for teachers*
Conduct Training of Trainers, forum, and other programmes on IWRM as well as providing IWRM training for teacher trainers and pre- and in-service teachers, so that they will be able to teach their students in schools. Foster collaboration between water professionals, curriculum specialists, and educational material developers in order to produce quality materials that provide this very broad and at times both complex and technical information in a language that can be understood by teachers and in ways that will enable them to present this to their students.
- j) *Human resource development/ personnel training*
Human resource development is also important as it will strengthen the managerial systems and arrange the funding. Thus, individuals who need to master the skills need to be identified in order for the

organisation to function effectively.

- k) *Competent resource managers*
Develop competent resource managers at all levels through capacity building programmes supported by complementary advocacy and awareness programmes targeting all stakeholders (users and communities).

Conclusion

Malaysia, a country with abundant water resources, needs a good water management system to ensure the source is well managed and governed for sustainability. Awareness raising, advocacy, and capacity building (AACB) are needed to understand the broad issues related to IWRM implementation. It includes all the rules, laws, policies, legislation, power relations and social norms which govern civic engagement.

Current AACB is sectoral based and not extended to reach all personnel at the various hierarchical levels. 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 among communities and the public is minimal.

The success of the national IWRM agenda over the long term requires a mindset change among public, private and community stakeholders.

Awareness-raising of water issues, challenges and integrated solutions that extend 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 sectoral management and service delivery needs.

Currently, water-related training is mainly provided by NRE, KeTTHA, MOA 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 one-stop training centres at the national level and 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.

REFERENCES

- Biswas, AK 2004, 'Integrated water resources management: a reassessment', *Water International*, vol. 29, no. 2, pp. 248–256.
- Elfithri, R, Mohd Ekhwan, BT, Mazlin, BM & Hafizan, BJ 2011, 'Perspectives and initiatives on integrated river basin management in Malaysia: a Review', *The Social Sciences*, vol. 6, no. 2, pp. 169–176.
- Elfithri, R, Mokhtar, MB & Taha MR 2015, 'Applying sustainability science approach through demonstration sites/projects in Malaysia', in *Proceeding of the International Symposium "Integrated Actions for Global Water and Environmental Sustainability"*, Commemoration of the 70th Anniversary of UNESCO, Medan, Indonesia.
- Funke, N, Oelofse, SHH, Hattingh, J, Ashton, PJ & Turton, AR 2007, 'IWRM in developing countries: lessons from Mhlathuze catchment in South Africa', *Physics and Chemistry of the Earth*, vol. 32, pp. 1237–1245.
- Robinson JP, Winthrop, R & McGivney, E 2016, *Millions learning scaling up quality education in developing countries*. The Brookings Institution, NW Washington, D.C., <www.brookings.edu/universal-education>.
- Global Water Partnership 2004, *Catalyzing change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies*, Technical Committee, Stockholm, Sweden, <[URL:http://www.un.org/esa/sustdev/csd/csd13/documents/bgground_5.pdf](http://www.un.org/esa/sustdev/csd/csd13/documents/bgground_5.pdf)>.
- Groot, WTD & Lenders, HJR 2006, 'Emergent principles for river management', *Hydrobiologia*, vol. 565, pp. 309–316.
- Mazlin, BM, Rahmah, E, Mathew, D & Wan Nur'ashiqin, WM (eds) 2009, *Training module on developing the capacity of NGOs for the practical implementation of IWRM in Malaysia*, Institute for Environment and Development (LESTARI), Malaysian Capacity Building Network for IWRM (MyCapNet) and International Capacity Building Network for IWRM (CapNet).
- Mazlin BM, Rahmah, E, Mathew, D & Wan Nur'ashiqin, WM (eds) 2009, *MyIWRM: What can i do? Manual for NGOs*, Institute for Environment and Development, Malaysian Capacity Building Network for IWRM and International Capacity Building Network for IWRM.
- Tan, KW & Mokhtar, M 2009, 'An institutional framework towards IWRM in Pahang River Basin, Malaysia', *European Journal of Scientific Research*, vol. 27, no. 4, pp. 536–547
- UNDP 2008, *UNDP practice note: capacity development*, United Nations Development Programme, New York, USA, <www.capacity.undp.org>.
- UNDP 2009, *Capacity development: a UNDP primer*, United Nations Development Programme, New York, USA, <www.capacity.undp.org>.

UNESCO 2010, *IWRM guidelines at river basin level – Part 1: principles*, UNESCO and NARBO.

UNESCO 2016, *Water and jobs*, The United Nations World Water Development Report 2016, The United Nations Educational, Scientific and Cultural Organization, Paris, France.

Zakaria, S 2007, *IWRM and regional capacity building program in Southeast Asia*, K-Water and UNESCAP Leadership Workshop on IWRM.

Annex 1

S&T AWARENESS RAISING, ADVOCACY, AND CAPACITY BUILDING PROGRAMMES AND ACTIVITIES RELATED TO IWRM IN MALAYSIA

No.	Initiatives	Example of Programmes/Activities
1.	Awareness Raising	• “Love Our Rivers” Campaign (DID since 1993) • “Wira Alam” Programme (DOE 1998) • National consultation on water sector mapping and visioning (MyWP 1999) • National consultation on water sector mapping and visioning (MyWP 1999) • National consultation “From Vision to Action” (MyWP 2000) • National consultation on gender analysis in the water sector (MyWP 2000) • National consultation towards realising the National Water Vision (MyWP, ESCAP and FAO 2000) • National Conference on Sustainable River Basin Management (MyWP 2000) • Living Waters Programme (WWF 2002) • Workshop on Strategic Planning and Management of Water Resources (MyWP 2003) • National Dialogue on Effective Water Governance (MyWP 2003) • National Dialogue on Water for Food and Environment (MyWP 2004) • National Dialogue on Water Financing (MyWP 2005) • Dialogue on Gender and IWRM (MyWP 2007) • Dialogue on IWRM Agenda in the 9th Malaysia Plan: Walking the Talk (MyWP 2007) • IWRM Dialogue with Malaysian NGOs (MyWP 2007) • Technical Talk on Water Related Issues (UNESCO-IHP Malaysia, DID and MHS since 2009-now) • World Water Day Celebration (UNESCO-IHP Malaysia, DID, NRE since 2009-now) • Round Table Dialogue on IWRM Research Direction Towards Sustainable River Basin Development and Management in Malaysia (UKM 2009) • Symposium on Harmonising Environmental Considerations with Sustainable Development Potential of River Basins (LESTARI-UKM and UNESCO 2010) • Stakeholder Dialogue on Decision Support System IRBM Langat (UKM 2010) • Water Saving Campaign, Exhibition and Competition (LESTARI-UKM 2010) • World River Day Celebration (UNESCO-IHP Malaysia and DID 2011) • Promoting Green Lifestyle to Broader Community (UKM 2011-2012) • River Care Programme (GEC since 2012) • National River Forum (NRE, DID, GEC and GAB Foundation 2012) • River of Life Public Outreach Programme (DID and GEC 2012 – now) • Round Table Dialogue with Campus Community on Water Resources Management (UKM 2012) • Integrated Water Resources and River Basin Management: Sharing Experience at the Global Level (LESTARI-UKM and UNESCO 2012) • Environment, Ecosystem and Educational Programme (3EP) & Healthy Community Healthy Ecosystem (HCHE) (PPj and LESTARI-UKM 2013 – now) • River Cleaning Campaign (LESTARI-UKM, Canon, UNESCO-IHP Malaysia 2013) • Malaysia Water Resources Management (MyWRM) Forum (MyWP, DID, NRE ASM, NAHRIM, LESTARI-UKM, MyCWP and LUAS 2013-2015) • River, Water and Environmental Awareness Programme (WWP 2013) • Focus Group Discussion with Community for Water Information Access (UKM 2013) • Stakeholder Consultation Workshop with Langat Community (UKM 2014) • River Awareness and Education Programme (WWP and Salcon Berhad 2014–2015) • Water Information Access Carnival “Water: Know to Care” (UKM and MPKj 2014) • Water Conservation and Environmental Programme for Schools in Malaysia (HSBC and GEC 2014–2017) • National Forum on Sustainability Science in River Basin Management (UKM 2014) • Workshop on Sustainability Science Demonstration Site: Framework for Action “Water and Environmental Sustainability in Langkawi” (LESTARI-UKM and UNESCO Office Jakarta 2015) • National World Water Day Dialogue on Water and Jobs (LESTARI-UKM, UNESCO-IHP Malaysia and DID 2016)

2.	Advocacy	▪ Formation of National Water Resources Council (NWRC 1998) ▪ National Water Vision and the Formation of state apex water resources management organisation in Selangor and Sabah (LUAS and SWRE 1999/2000) ▪ Conducting various Research and Development (R&D) Projects related to IWRM & special focus on Ecosystem Health of Langat River Basin (LESTARI-UKM since 1999 – now) ▪ Urban Stormwater Management Manual for Malaysia (MSMA) 1st Edition (DID 2001) ▪ The formation of MyToolbox (MyWP 2001) ▪ National sewerage project and National strategic plan for solid waste management (2002) ▪ National Study on Effective Implementation of IWRM in Malaysia (2005) ▪ Water Services Industry Act and formation of the National Water Services Commission (2007) ▪ Establishment of Integrated Water Resources Management Research Group in UKM (UKM 2007) ▪ Implementation of IWRM BMP pilot projects (2009) ▪ Review and updating of the 1982 National Water Resources Study (2009/2010) ▪ National Water Resources Policy (NRE 2012) ▪ Urban Stormwater Management Manual for Malaysia (MSMA) 2nd Edition (DID 2012)

3.	Capacity Building	▪ Non-formal Education Course: Water and River Basin Management related Studies offered in various faculties and institutes in UKM, as well as in co-curriculum subjects (UKM 2000–now) ▪ National training workshop to introduce GWP ToolBox and train Malaysians in developing IWRM case studies (MyWP 2002–2009) ▪ Formal Education Course: Master of Environmental Science (IWRM) at Open University of Malaysia (OUM 2005–2010) ▪ IWRM Training Course for senior executives in the public sector (MyWP and MyCapNet 2005) ▪ Training courses on community-based river management and assessment (GEC 2005) ▪ Training programme for Government agency and community leaders on community-based river management (GEC 2006–2008) ▪ SMART (Start Managing All Resources Today) Ranger Training (GEC since 2008–now) ▪ MyIWRM, what can I do? Developing Capacity for the Practical Implementation of Integrated Water Resources Management in Malaysia (LESTARI-UKM and CapNet 2007–2010) ▪ Developing Capacity of NGOs for the Practical Implementation of Integrated Water Resources Management in Malaysia (LESTARI-UKM, MyCapNet, CapNet, MyWP, WWF and MNGOs 2008) ▪ Developing Capacity of Academia for the Practical Implementation of Integrated Water Resources Management in Malaysia (LESTARI-UKM, MyCapNet, CapNet, MyWP, WWF and MNGOs 2009) ▪ Training Workshop on IWRM in River Basin (MyWP 2009) ▪ Series of Water Watch Programme for Young Leaders (UNESCO-IHP Malaysia and partners since 2009–now) ▪ RIVER Ranger Training (GEC and DID since 2009–now) ▪ Training of Trainers for Community participation in River Management under DID 1 State 1 River programme (GEC and DID since 2009–now) ▪ Workshop on river auditing (GEC since 2009–now) ▪ Workshop on water auditing (GEC since 2010–now) ▪ Developing Capacity of Government Officers for the Practical Implementation of Integrated Water Resources Management in Malaysia (LESTARI-UKM and UNESCO-IHP Malaysia 2010) ▪ Workshop on Water and Media: Rising Up to the Challenge (LESTARI-UKM and UNESCO-IHP Malaysia 2011) ▪ Training of Trainers Course: Managing Water Pollution (LESTARI-UKM, MyWP and GEC 2012) ▪ Training of Trainers Course: Ecosystem Services and Integrated Water Resources Management (GEC, MyWP and LESTARI-UKM 2012) ▪ Learning for Change Workshop: Education for Sustainable Development in Malaysia (LESTARI-UKM, Gotland University, GAP, UNESCO-IHP Malaysia 2012) ▪ Short Course on Integrated Lake Basin Management Plan (PPj, MWA and NAHRIM 2013–2015) ▪ Training Needs Assessment Workshop for Water Education (LESTARI-UKM, GWP, MyWP, UPM and EcoKnights 2014) ▪ Southeast Asia (SEA) Water Footprint Training Course (UNESCO-IHP Malaysia, UNESCO Jakarta, WFN, MyCDNet, LESTARI 2015) ▪ Training of Trainers on Water Security and Safety Planning (MyCDNet, ASM and DID 2015) ▪ Training of Trainers on Sustainable Sanitation and Water (MyCDNet and IWK 2015) ▪ Workshop on Integrated Water Resources Management Success Stories and Lessons Learned: Case Studies in Malaysia (LESTARI-UKM, GWP, MyWP and HTCKL 2015)

International Networking and Collaboration

Expert Review

Dr Salmah Zakaria FASc

The nature of managing water resources is clearly trans-boundary, both land-based and atmospheric-based. Networking and collaboration be it national or global, are crucial and critical for a holistic and integrated water resources management in ensuring sustainable development. This is especially so because of the complexities of water resources management, compounded by the many water sub-sectors and the multiple sources of water resources such as rivers, lakes, groundwater and rainfall. The study of each of these sources of water and the sub-sectors of service provision is a science in itself and many have developed tremendously, globally. The rapid population growth, rapid urbanisation, worsening water bodies' pollution and impact of climate change, further add to the complexities of managing water resources for wealth creation for a sustainable economic development. Moreover, there are potential solutions to water challenges to be learned from similar climatic zones. Networking and collaborating with other agencies provide an essential conduit to learn and harvest the global rapid and cutting edge knowledge development in water technology and innovation elsewhere, without reinventing the wheels.

This Brief, however, focuses on International Networking and Collaboration in IWRM Development.

Review of Global Trends

While there were many water organisations before the first earth summit in Rio de Janeiro in 1992, (UNCED 1992), the years after this summit saw the proliferation of water-based and water-related organisations. Chapter 18 of Agenda 21 (a blueprint to rethink economic growth, advance social equity and ensure environmental protection) is on the "Protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources".

The World Water Council (WWC), an NGO founded in 1996, has since become very influential in mainstreaming water at the top of the global political agenda. The series of World Water Fora from 1WWF (Marrakesh 1997) to the coming 8WWF (Brasilia 2018) has been co-organised by the WWC and the respective host countries. As of December 2015, WWC has memberships of more than 300 organisations.

Members of WWC are cross-cutting in nature, from resource management to services such as intergovernmental institutions, governments and government institutions, professional and academic organisations, enterprises and facilities, civil societies and water user institutions and members from both developed and developing countries. Singapore PUB is a member but none came from Malaysia. The series of world water fora also spawned other water-related organisations, one of which is the Asia-Pacific Water Forum (APWF). Mooted at the 3WWF in Kyoto Japan, and called for its formation at the 4WWF in Mexico by the region's water ministers, the APWF sought to establish an effective mechanism to encourage more collaborative efforts on water resources management and to accelerate the process of effective integration of water resources management into the socio-economic development process of the Asian and Pacific region.

Almost concurrently with the development of WWC, Global Water Partnership (GWP) was formed in 1996 as a global action network focusing on supporting social change processes that further the sustainable management and development of water resources. GWP sees its role as having the technical expertise and convening power to bring together diverse stakeholders who can contribute to the social and political change processes that help bring the vision of a water secure world closer to reality. Networking within GWP is organised into various country water partnerships (CWPs), 85 countries to date, including Malaysia. These CWPs are then grouped into 13 Regional Water Partnerships (RWP). These RWPs have a special function; to ensure sharing across national boundaries, and are expected to have an open, inclusive and gender sensitive membership policy for bringing together as wide a group of stakeholders as possible.

ASEAN Leaders established the ASEAN Working Group on Water Resources Management (AWGWRM) under ASEAN Ministerial Meetings of Environment and ASEAN Senior Officials on Environment. Through AWGWRM, a report on the "State of Water Resources Management In ASEAN" was produced in 2005, highlighting a number of issues associated with water management in the region, anticipated to become increasingly important within the coming 20–50 years due to increasing populations and the consequent competition for water resources. The "ASEAN Strategic Plan of Action on Water Resource Management" was later developed. This report highlighted the ASEAN Long-term Strategic Plan of Action on Water Resources Management Challenges and Actions as of 2005 which included the shared vision of "the attainment of sustainable water resources to ensure sufficient water quantity of acceptable quality to meet the needs of the people in Southeast Asia in terms of health, food security, economy and environment".

The plan highlighted five challenges namely:

- Improve access to safe drinking water and challenges;
- Managing water resources efficiently and effectively;
- Moving towards integrated river basin management;
- Translating awareness to political will and capacities; and
- Moving towards adequate and affordable water services.

Within the UN organisations, after Rio 1992, the UN organisations consolidated their focus on water with the formation of a loosely coordinated body, the UN-Water, an inter-agency coordination mechanism for all freshwater related issues. UN-Water currently

has 31 Members and 38 Partners. Members are UN entities including those responsible for major funds and programmes, specialised agencies, regional commissions, conventions, etc. Many global-based organisations outside of the UN system are Partners of UN-Water. Among the 31 members of the UN-Water are water related UN agencies such as UNESCO, UNEP, UNDP, FAO, WMO, UNISDR and UNU while the partners include ICID, IWMI, IUCN, IWA, WWC, RAMSAR, GWA, GWP, and WaterLex, a cross-cutting of all sub-sectors of water.

While UNCED, Rio de Janeiro 1992 pushed forward Agenda 21, twenty years later, the United Nations Conference on Sustainable Development (UNCSD), Rio de Janeiro, 2012 (Rio+20) focuses on practical measures for implementing sustainable development—“to meet the needs of the present without compromising the ability of future generations to meet their own needs”. This guiding principle for long-term global development consists of three pillars: economic development, social development, and environmental protection. UNCSD launched a process to develop a set of Sustainable Development Goals (SDGs), adopted guidelines on green economy policies, saw the formation of further new partnerships and the endorsement of the outcome document “The Future We Want”. UNCSD focused on two themes: (a) A green economy in the context of sustainable development and poverty eradication; and (b) The institutional framework for sustainable development in seven priority areas—decent jobs, energy, sustainable cities, food security and sustainable agriculture, water, oceans and disaster readiness. On 25 September 2015, at the UN General Assembly in New York, countries adopted the set of goals, “The Sustainable Development Goals” to end poverty, protect the planet, and ensure prosperity for all, as part of a new sustainable

development agenda. Each goal has specific targets to be achieved over the next 15 years, 2015–2030. Malaysia is a signatory to this historic agreements and endorsement.

Concurrently, besides the overarching integrated water resources management and sustainable development, over the years, there have been heightened development trends and networking, in the various water sub-sectors as well, such as water supply and wastewater management, climate change, agriculture water services, disaster risk reduction, research and development, advocacy, awareness creation and capacity building.

Malaysia's Current Networking with Global and Regional Agencies

Malaysians have always been networking with the global water fraternity in various sub-sectors. Being a member of the UN, naturally, there is a government to government relationship, especially in the early days of developing Malaysia, when there was a bigger UN mission located in Kuala Lumpur. Malaysia joined UNESCO in 1958 and her networking with UNESCO is on various fronts. Two Category 2 Centres of UNESCO-IHP has set out in Kuala Lumpur, namely, the Humid Tropical Centre (HTC-UNESCO) and ISTIC-UNESCO. Malaysia has two Natural World Heritage sites (Gunung Mulu National Park and Kinabalu Park) and two Cultural World Heritage sites (the historical sites of George Town and Malacca). Lately, there have been programmes with UNESCO-Jakarta in Ecohydrology research and development of Sungai Langat with LESTARI, UKM and Lake Basin management with PutraJaya Local Authority. A branch of UNU (UN University), UNU-IIGH (International Institute for Global Health) has been set up at the HUKM campus.

While our mission in New York continues to be actively engaged with the UN General Assembly (UNGA), there are possibilities for Malaysia to capitalise on improved networking and collaborative programmes within the UN regional commission for Asia and the Pacific, ESCAP, Bangkok, and all the Asia Pacific countries. This is especially important as the water challenges are generally regional in nature. In particular, challenges such as impact of climate change, disaster risk management, rapid urbanisation, water pollution, Water-Energy-Food nexus, water and green growth are regional-based and are being discussed actively, as the search for a sustainable development model continues. Many of these programmes are sponsored by other member countries such as Japan, South Korea, and other developed countries. As Malaysia is being considered as near developed, Malaysian participants need to be sponsored by our own agencies. This must be taken into considerations when agencies prepare their annual budget. Even better, if the Malaysian government can develop its own foreign aid programmes with ESCAP, working with the many Malaysian water experts, in a programme that can be a win-win for both Malaysia and the countries we may want to support.

The Asian Development Bank (ADB) began working with Malaysia since 1966 with cumulative lending and technical assistance, amounting to over USD2 billion, providing loans, grants and technical assistance to grow Malaysia's economy and improve the lives of people, particularly the poor, women, children and other vulnerable groups. As Malaysia developed ADB's support in Malaysia shifted to advancing regional cooperation and integration, catalysing private investments through public-private partnerships, and developing knowledge partnerships. To drive regional integration, ADB supports and facilitates Malaysia's

active partnership with the Association of Southeast Asian Nations (ASEAN), the Brunei Darussalam–Indonesia–Malaysia–The Philippines East ASEAN Growth Area (BIMP-EAGA), the Indonesia–Malaysia–Thailand Growth Triangle, and the Coral Triangle Initiative on cross-border infrastructure projects, energy cooperation, and coordination of sustainable management of coastal and marine ecosystems. These regional partnerships, since it is economic in focus, will invariably have water within its context, particularly in the current situation of regional climate change and rapid urbanisation.

Going by sub-sectors, in agriculture, Malaysia has been active with International Commission on Irrigation and Drainage (ICID), setting up its own local chapter, MANCID (Malaysian National Committee on Irrigation and Drainage). ICID was established in 1950 and is dedicated to enhancing the global supply of food and fibre. ICID encourages public-private partnership in development and management of water resources. Malaysia's involvement in ICID culminated in the election of Malaysians as President of ICID, twice, the first being the first chair of ASM Water Committee. Malaysia has also been actively involved with the Food and Agricultural Organisation of the UN.

Another agency that Malaysia has work closely over the years is IWMI, a member of CGIAR, a global research partnership for a food-secure future. CGIAR was established in 1971 and IWMI started as IIMI (International Irrigation Management Institute) in 1982. During the period 1996–2000, IIMI transformed itself into a “strong science-based organisation concerned with the more effective and productive use of water as a key resource for improved food production” giving birth to the concept of “More Crop per Drop” and changing its name to the “International

Water Management Institute” (IWMI) with a new mandate to “contribute to food security and poverty eradication by fostering the sustainable increases in the productivity of water through the management of irrigation and other water uses in the river basin.” The research programmes began to address water management and irrigation issues at the basin scale with a focus on regional water scarcity. “More Crop per Drop” focused on water productivity, but the years 2000–2008, IWMI expanded its mission to “Improve the management of water and land resources for food, livelihoods and nature” incorporating four themes: basin water management, land, water and livelihoods, agriculture, water and cities, and water management and the environment. IWMI launched the CGIAR Research Programme on Water, Land and Ecosystems in early 2012. IWMI works through collaborative research with many partners in the North and South and targets policy makers, development agencies, individual farmers and private sector organisations.

While IIMI was transformed in 1996 to IWMI and expanded into water and land management, GWP, formed in 1996, focused on IWRM and IRBM from the very beginning. Malaysians were part of the group that developed the Southeast Asia RWP. The first chair of ASM Water Committee was among those who were instrumental in the development of Southeast Asia RWP and the CWP within the region. A number of ASM fellows and other Malaysians actively participated in this network, developing its own local chapter, MyWP. In its earlier years, MyWP actively organised the GWP partners meeting and exhibition and international workshops and conference in Kuala Lumpur. Together with CapNet-UNDP, it also organised the CapNet managers meeting in Kuala Lumpur. AguaJaring, a capacity building network for

Southeast Asia was founded together with other Southeast Asian Partners in NAHRIM. It is affiliated to CapNet-UNDP and was/is active in the capacity building development of the Southeast Asian Region. A number of ASM Fellows were and are active in its development and activities.

The Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to prepare, based on available scientific information, assessments on all aspects of climate change and its impacts, with a view of formulating realistic response strategies. Currently, the IPCC’s role is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. The scientific evidence brought up by the first IPCC Assessment Report of 1990 underlined the importance of climate change as a challenge requiring international cooperation to tackle its consequences. The international political response to climate change, supported by the findings of IPCC, began at the Rio Earth Summit in 1992, where the ‘Rio Convention’ included the adoption of the UN Framework on Climate Change Convention (UNFCCC). This convention set out a framework for action aimed at stabilising atmospheric concentrations of greenhouse gases (GHGs) to avoid “dangerous anthropogenic interference with the climate system.” The UNFCCC which entered into force on 21 March 1994, currently has a membership of 195 parties. The main objective of the annual Conference of Parties (COP) is to review the Convention’s implementation. The first COP took place in Berlin in 1995 and significant meetings since then have included COP3

where the Kyoto Protocol was adopted, COP11 where the Montreal Action Plan was produced, COP15 in Copenhagen where an agreement to succeed the Kyoto Protocol was unfortunately not realised and COP17 in Durban where the Green Climate Fund was created. Malaysians have been active in the IPCC, UNFCCC and the COPs.

Another organisation that Malaysians participated actively is the IWA (International Water Association), with many Malaysians serving as members of the board of Director over the years. IWA was founded in 1999 with the local chapter MWA (Malaysian Water Association) being a corporate member of IWA. MWA inclusiveness brings together practitioners in the water service industries value chain as members; from water supply and sewerage utilities, manufacturers, consultants, contractors, suppliers, regulators, and academicians. With the strength in its memberships, MWA is financially stable and able to put forward views of its members on strategic issues to the authorities. Besides IWA, internationally, MWA maintains linkages with related organisations abroad to establish networking in order to realise the water industry's common universal goals.

Malaysia, through the Department of Irrigation and Drainage (DID) was a founding member of NARBO (Network of Asian River Basin Organisations). Currently, DID and LUAS or SWMA Selangor Water Management Authority, focusing on river basin management, continue to be active in NARBO. NARBO is supported by the Japanese government and Asian Development Bank (ADB) continues to support water activities, including the activities of APWF and the Water Knowledge Hubs. When the APWF-Knowledge Hubs was launched on 26 June 2008 at PUB Singapore's WaterHub, NAHRIM was among the initial six agencies

accepted. Each hub is a centre of excellence committed to improving water security in the Asia-Pacific region by promoting knowledge sharing and championing feasible solutions for its priority water topic. Together, the hubs are to collaborate to generate and share knowledge and develop capacity in more than a dozen water knowledge domains. But each hub is also independent to chart its own development forward.

The International Association for Hydro-Environment Engineering and Research (IAHR) was founded in 1935. It is a worldwide independent organisation of engineers and water specialists working in fields related to the hydro-environmental sciences and their practical application. Activities range from the river and maritime hydraulics to water resources development and eco-hydraulics, through to ice engineering, hydro-informatics and continuing education and training. IAHR stimulates and promotes both research and development, and by so doing strives to contribute to sustainable development, the optimisation of world water resources management and industrial flow processes. IAHR accomplishes its goals by a wide variety of member activities including working groups, research agenda, congresses, specialty conferences, workshops and short courses; Journals, Monographs, and Proceedings; by involvement in international programmes such as UNESCO, WMO, IDNDR, GWP, ICSU, and by co-operation with other water-related (inter)national organisations. NAHRIM is an active member of IAHR, organising the international conference of the Asia Pacific Division, of IAHR in 1997 in Langkawi and the coming 37th IAHR World Congress in August 2017 at the PWTC in Kuala Lumpur.

Few countries are without dams. Malaysia has dams for hydropower generation, for domestic,

industrial and agriculture water supply and for flood mitigations. Many of the dams in our early development stage were single purpose. Lately, however, many are multipurpose, incorporating flood mitigation as part of the dams' objectives. Consequently, Malaysia has long been a member of International Commission on Large Dams. Tenaga Nasional Berhad is the focal point and Chair of the National Committee. Members of the National Committee include owners of other dams such as the DID and Water Supply Department.

ASM is a member of the Inter-Academy Panel (IAP), the global network of science academies. IAP currently has a membership of 111 scientific academies from around the world; these include both national academies/institutions and regional/global groupings of scientists. A number of other scientific organisations participate in IAP meetings and activities as observers. ASM water committee has been active with IAP-Water, supporting their events around the world such as in Trieste, Barnaul, Beijing and Sao Paola. Through the works of the ASM Task Force on Lake Management, Malaysian was brought into contacts with International Lake Environment Committee and the ILBM fraternity.

Recommendations

Networking and collaboration are exciting ways in developing our human resource, sharing information platforms, getting updates on cutting edge technology and help developing other countries as we sharpened and enhanced our own expertise, as well as perhaps developed new businesses and jobs. And these are generally at shared costs. Below are five potential areas for networking and collaboration in water-related areas.

(i) **Enhancing collaboration with United Nation Agencies**

Being a member of the United Nations, Malaysia has been signatory to many of the international, government to government agreements on water related issues and have alliances with international organisations as highlighted in three above, in areas covering policy, operational needs, Research and Development and Capacity Building. Category 2 UNESCO centres are funded by the Member States to contribute to the achievement of UNESCO's objectives by way of global, regional, sub-regional or interregional activities. Malaysia may want to review the role of ISTIC-UNESCO and IHP-UNESCO, in further developing regional collaboration. There is also the UNU-IIGH in the HUKM campus. Malaysia also participated in IPCC, UNFCCC and COPS activities.

(ii) **Working together within ASEAN member countries**

With the increasing of water crisis, many countries have forged ahead to further developed their expertise either through national initiatives or regional organisations such as APWF or ASEAN. In ASEAN, besides the Ministries of Environment and Natural Resources, the Ministries of Science, Technology also pursue joint initiative as in the Krabi Initiative, the outcome of "The 6th Informal ASEAN Ministerial Meeting on Science and Technology: IAMMST" and "The 60th ASEAN COST", organised in December 2010 at Krabi (Figure 4.2.12.1). The Initiative is a framework for the "ASEAN Plan of Action on Science, Technology, and Innovation: APASTI 2015–2020". Among the thematic tracks is "Water Resources Management", to be led by Thailand.

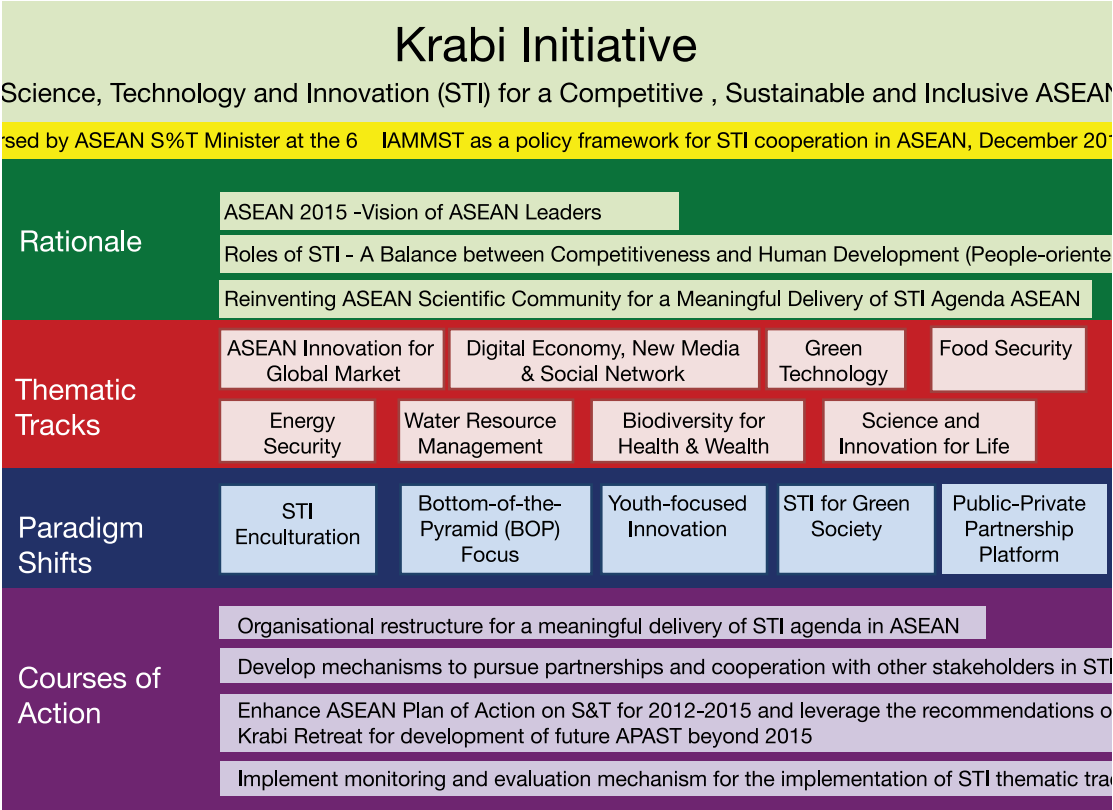


Figure 4.2.12.1. Krabi Initiative, the outcome of "The 6th Informal ASEAN Ministerial Meeting on Science and Technology: IAMMST" and "The 60th ASEAN COST" (2010)

Source: Kanchana Wanichkorn, MOST, Thailand

(iii) **Networking with the wider Asia Pacific Communities**

Malaysia has been working with ADB since 1966. Current ADB supports on the many ASEAN collaborative works such as BIMP-EAGA and the IMT-GT on various initiatives, afforded Malaysia the opportunity and space for creative sub-regional collaborative works. The ADB has also been supporting the Asia Pacific Water Summit which came out with the Chiang Mai Declaration focusing on water

issues and challenges, from “...water at the core of sustainable development ..” to the need for “...enhancing international cooperation on sharing, exchange and dissemination of scientific and technical knowledge, as well as best practices, related to integrated water resources management”. The 7th World Water Forum Ministerial Declaration, Gyeongju, Republic of Korea, reaffirmed the UNCSD-Rio 2012 outcome document on “The Future we want”. Amongst others, it

also reaffirmed that “...water is one of the major issues in tackling climate change”, “ ...IWRM and land management at the basin level are crucial to sustainable water management and planning” as well as “....the importance of international cooperation and partnership between developed and developing countries...”

(iv) **Developing Malaysia’s own Water Programme in a South-South initiative**

For a time, the Economic Planning Unit under the South-South International Aids did organise courses on irrigation management, with local facilitators, sponsoring participants from Latin America to ASEAN. Such courses create an opportunity to network that has allowed the professional relationship to flourish and develop over the years. With Malaysia’s increasing expertise in other water-related areas, it is an opportunity for Malaysia to further developed a foreign aid programme, not only in a South-South solidarity and helping to develop these countries, but also to create a network and collaborative opportunities for our experts and businesses.

(v) **Specialised Collaborative Water Areas**

There must be other alliances which have not been highlighted above. It would be interesting to compile a record of the water international alliances of all our universities and water-related agencies such as DOF, DOA, DOE, DID, DMG, DSS, Met Malaysia, etc. review and follow through the activities in the light of current water challenges. The internet has made it easier to connect and exchange information, knowledge and ideas. These include in areas of water legislations, water quality, environment, land use, urban water management, climatology, hydrology, groundwater, gender alliance, water and green growth, Water-Energy-Food nexus, water in the circular economy etc. Each water sub-sectors can develop its own network. Some of these other networks are provided in the references.

REFERENCES

ASEAN on AWGWRM, <<http://environment.asean.org/asean-working-group-on-water-resources-management-awgwrn/>>.

Asian Development Bank, <<http://www.adb.org/sectors/water/main>>.

Asian Development Bank. Malaysia Fact Sheet 2015, <<http://www.adb.org/sites/default/files/publication/27778/mal-2015.pdf>>.

ASEAN Strategic Plan of Action on Water Resources Management 2005, <<http://environment.asean.org/files/ASEAN%20Strategic%20Plan%20of%20Action%20on%20Water%20Resources%20Management.pdf>>.

Asia Pacific Water Forum, <<http://www.apwf.org/>>.

Asia Pacific Water Knowledge Hubs, <<http://www.apwf-knowledgehubs.net/>>.

Asia Pacific Water Summit 2013, <http://www.apwf.org/weblog/public_html/weblog/information/archives/201305/000082.php>.

Chiang Mai Declaration 2013, <http://www.maff.go.jp/e/nousin/kaigai/inwepf/i_news/pdf/chiang_mai_declaration.pdf>.

Food and Agriculture Organization of the UN, <<http://www.fao.org/home/en/>>.

Gender Water Alliance, <<http://genderandwater.org/en>>.

Global Water Partnership, <<http://www.gwp.org/>>.

Ground Water, <<http://www.groundwater.org/>>.

Inter-Academy Panel, <<http://www.interacademies.net/>>.

International Association for Hydro-Environment Engineering and Research, <<https://www.iahr.org/site/cms/contentChapterView.asp?chapter=1>>.

International Association of Hydrogeologists, <<https://iah.org/>>.

International Commission on Irrigation and Drainage, <<http://www.icid.org/>>.

International Commission on Large Dams, <<http://www.icold-cigb.org/home.asp>>.

International Lake Environment Committee, <<http://www.ilec.or.jp/en/>>.

International Office for Water, <<http://www.oieau.fr/?lang=en>>.

International Rivers, <<http://www.internationalrivers.org/>>.

International Water Association, <http://www.iwa-network.org/>.

International Water Management Institute, <<http://www.iwmi.cgiar.org/>>.

International Water Resources Association (IWRA), <<http://www.iwra.org/>>.

IRC, <<http://www.ircwash.org/>>.

Malaysian National Committee on Irrigation and Drainage, <<http://www.mancid.org.my/>>.

Malaysian Water Association, <<http://www.mwa.org.my/>>.

Network of Asian River Basin Organisations, <<http://www.narbo.jp/>>.

Rural Water Supply Network <<http://www.rural-water-supply.net/en/>>.

Tenaga National Berhad, <<https://www.tnb.com.my/>>.

The Intergovernmental Panel on Climate Change, <<http://www.ipcc.ch/>>.

The 7th World Water Forum Ministerial Declaration, 2015, <http://www.worldwatercouncil.org/fileadmin/world_water_council/documents/press_releases/Ministerial_Declaration_7th_World_Water_Forum_1304_Final.pdf>.

UNCSD 2012, *Outcome document “The future we want”*, <http://www.un.org/disabilities/documents/rio20_outcome_document_complete.pdf>.

United Nations Sustainable development 1992, *Agenda 21*, <<https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>>.

UN-Water, <<http://www.unwater.org/about/en/>>.

WaterAid <<http://www.wateraid.org/uk>>.

Water Law and Policy Framework <<http://www.waterlex.org/>>.

World Bank – Water <<http://www.worldbank.org/en/topic/water>>.

WorldWater Congress <<http://www.worldwatercongress.com>>.

World Water Council, <<http://www.worldwatercouncil.org/>>.

Integrated Urban Water Management

Expert Review

Dr Low Kwai Sim FASc

Defining Integrated Urban Water Management (IUWM)

There is a host of the generally accepted definition of the term Integrated Urban Water

Management (IUWM) of which five are selected here to depict the range of interpretations and appreciation of the subject (Table 4.2.13.1).

Table 4.2.13.1. Definitions of the Term Integrated Urban Water Management (IUWM)

Source	Definition
Anderson and lyaduri 2003	A structured planning process to evaluate concurrently the opportunities to improve the management of water, sewerage and drainage services within an urban area in ways which are consistent with broader catchment and river management objectives.
United Nations Environment Programme (UNEP) 2003	The practice of managing freshwater, wastewater and storm water as links within the resource management structure, using an urban area as the unit of management.
Tucci <i>et al.</i> 2009	The practice of managing freshwater, wastewater, and storm as components of a basin-wide management plan. It builds on existing water supply and sanitation considerations within an urban settlement by incorporating urban water management within the scope of the entire river basin.
World Bank 2009	A holistic mode of strategic planning which takes a landscape view of water challenges by looking at competing water users in an urban area, catchment or river basin. It needs to be implemented through coordinated and flexible planning among water using sectors, allowing for optimal sequencing of traditional and new infrastructure with alternative management scenarios that leverage on efficiencies and conservation.

International Council for Local Environmental Initiatives 2011	A flexible, participatory and iterative process which integrates the elements of the urban water cycle (water supply, sanitation, storm water management, waste management) with both the city’s urban development and the surrounding basin’s management to maximise economic, social and environmental benefits in an equitable manner.

While the literature is replete with definitions, IUWM is basically an approach that provides a guidance format for planning and managing urban water within which, the interactions of environmental, economic and social elements are duly incorporated. IUWM therefore comprises all parts of the water cycle as integral to urban water management in relation to water demands and supply for residential, industrial, agricultural and ecological consumptions. Furthermore, IUWM is an iterative process that requires integration of all relevant water institutional entities, water sector infrastructure, water quality and quantity components in the governance process. This is amplified by Mitchell (2004) that IUWM takes a comprehensive perspective to urban water services, viewing water supply, stormwater and wastewater as components of an integrated physical system and recognises that the system sits within an organisational framework and a broader natural landscape.

In the context of Malaysia, the approach towards IUWM emerged largely from the positive and negative experiences achieved by the traditional or conventional approach of ‘doing what is necessary’ when a problem arises. Indeed, because of this, the governance structure for water management in the country is fragmented and the responsibilities of institutions unconsolidated and eclectic.

This Expert Review and the ongoing Study on IUWM, focusing on four major conurbations in Peninsular Malaysia (Phase 1), will forward a case for decision-makers towards an integrated approach where the advantages are inevitably obvious when the traditional and conventional approach is aligned with an integrated approach as defined by Pinkham (1999) as shown in Table 4.2.13.2:

Table 4.2.13.2. Four Major Conurbations in Peninsular Malaysia—Phase 1

Criteria	Traditional/Conventional Approach	Integrated Approach
Overall Approach	- Integration is by accident. - Water supply, wastewater and stormwater may be managed by the same agency as a matter of historical happenstance but physically, the three systems are separated.	- Physical and institutional integration is by design. - Linkages are made between water supply, wastewater and stormwater, as well as other areas of urban development, through highly coordinated planning and management.
Collaboration with Stakeholders	- Collaboration = public relations. - Other agencies and the public are approached when approval of a pre-chosen solution is required.	- Collaboration = engagement. - Other agencies and the public work together for effective solutions.
Choice of Infrastructure	Infrastructure is made of concrete, metal or plastic.	Infrastructure can also be green including soils, vegetation and other natural systems.
Choice of Technological Solutions	Complexity is neglected and standard engineering solutions are employed to individual components of the water cycle.	Diverse technological and ecological solutions as well as new management strategies are explored that encourage coordinated decisions between water management, urban design and landscape architecture.

In short, it is foreseen that IUWM will change the impact of urban development on the natural and man-induced water cycle. It will enable better coordination and planning of the urban water sector providing equitable allocations all water users and closes the water cycle loop (from source to use and reuse) to derive maximum benefits for all demands.

Brief Review of Global Trends

Freshwater in all its forms, is a limited resource (only 2.5% of the world's water is freshwater). The physical availability of water resources on

a sustainable basis (and access to technologies suited to that environment) limits efforts to increase sustainable access to water and sanitation. It is widely accepted that one of the major challenges of the 21st century is to provide safe drinking water and basic sanitation for all, a feature that has been over expressed and under implemented.

Globally, the need to ensure clean water supply to an ever growing population and water hungry sectors (agriculture, industry, energy generation, etc.) is taxing existing infrastructure resulting in water-deficits in many parts of the

world. Currently, close to 1 billion people still lack access to improved water sources, and over 2.6 billion people lack access to basic sanitation, and nearly all of these people live in developing and underdeveloped countries. Sanitation coverage in developing countries (49%) is only half that of the developed world (98%). The number of deaths attributable to poor sanitation and hygiene alone may be as high as 1.6 million in a year. Statistics on wastewater treatment reveal that almost 85% of global wastewater is discharged without treatment from urban and rural areas, leading to serious impacts on public health and the receiving water's ecosystems. This underscores the fact that wastewater collection, stormwater drainage and solid waste collection services are inadequate in most of the developing countries. The vagaries of the weather coupled with climate change will likewise increase

uncertainties in water resources planning and management.

Water scarcity comes in two forms: physical and economic water scarcity (Food and Agriculture Organisation and UN-Water). Nations facing the former have limited water resources as they have utilised nearly all their available water resources to unsustainable levels. The latter often occurs in water abundant areas but due to circumstances such as poor economic growth and limited investments in water infrastructure they are unable to fully utilise their available water resources. In this context, by 2025 it has been forecasted that developed countries are expected to face little or no water scarcity while most of the poorer and less developed countries will face the brunt of the water scarcity pressures in meeting water needs of their population (see Figure 4.2.13.1).

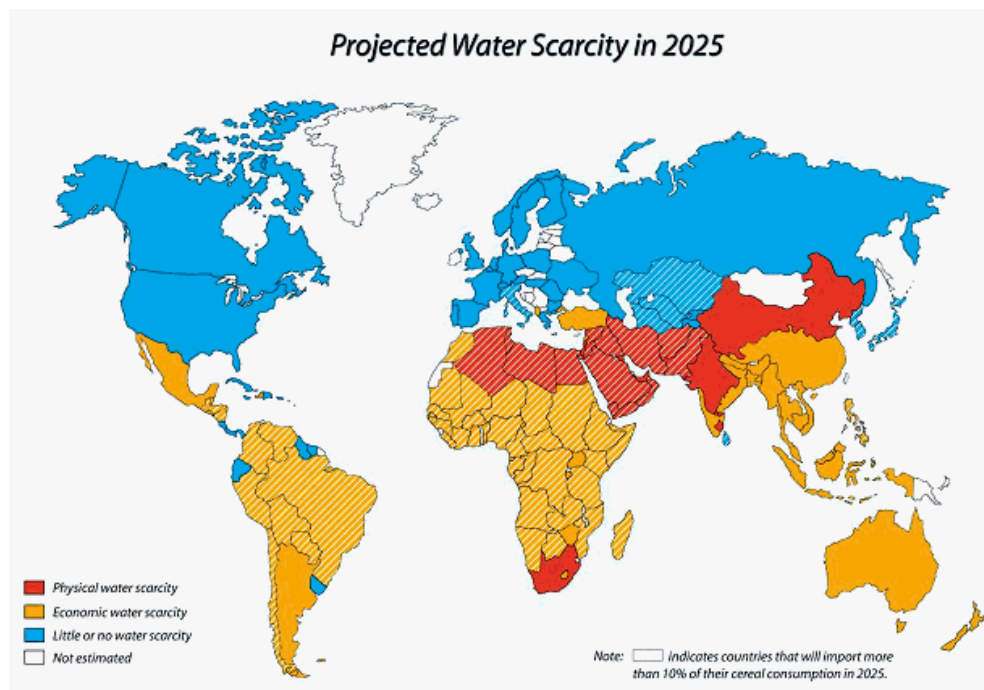


Figure 4.2.13.1. Projected Water Scarcity in 2025
(International Water Management Institute)

Source: International Water Management Institute

In urban areas, achieving environmentally acceptable water and sanitation solutions is a major technical challenge. Cities offer unique challenges in urban planning, encompassing large areas with a high population density requiring a complex network of infrastructure and services and at the same time generate pollution and wastes which affect the land, water and atmosphere.

The rapid urbanisation and growth of cities mean that provisions of basic infrastructure and utilities alone are not adequate to ensure sustainability. To ensure a more sustainable future, there is a need to do things differently. This should be based on key concepts of IUWM that include: (a) Interventions over the entire urban water cycle; (b) Reconsideration of the way water is used (and reused); and (c) Greater application of innovative approaches, and (d) The integration of institutions in water management. Furthermore, there is a need to recognise the high-level relationships among water resources, energy and land use in an urbanising world. More is needed than simply improving the performance and efficiency of the component parts of the built environment. It is the sum of the component parts to effect a change that is needed at a system-wide level; and hence the impetus for adoption of IUWM.

The foundation for IUWM lies in the concept of Integrated Water Resource Management (IWRM), which gained attention in 1990, and aspires to achieve an integrated management of available water resources within a catchment. A critical review on IWRM was provided by Biswas (2004). The concept of IUWM is fast gaining recognition for its importance as part of urban planning, development and management.

Since the beginning 2000 the concept of IUWM has been implemented in Australia as a result of water reform initiative to address increasing water scarcity (Anderson and Lyaduri 2003; Coombes & Kuczera 2002). A review of its practices and implementation of IUWM in respect to the total water cycle integration shows that IUWM was able to provide more sustainable solutions and cost savings (Mitchell 2004). Similarly, total water management (IUWM) in Brazil led to the establishment of a modern water resources management system.

Braga (2000) reported the successful implementation of IWRM and planning in an urban watershed should consider decision support systems (DSS) as well as stakeholder participation. An integrated approach for urban water management was also developed in the recently completed European Union 6th framework of project 'SWITCH – Managing Water for the City of the Future'. The concept of SWITCH approaches the design and management of the urban water system based on an analysis and optimisation of the entire urban water system (Institutional arrangements and infrastructure such as water supply, sanitation, stormwater, etc.) that led to more sustainable solutions than optimisation of separate elements of the system.

The concept was verified based on the results from research and demonstration activities in the eight cities around the globe with two African examples: Alexandria and Accra (van der Steen & Howe 2009; Visscher & Verhagen 2011). First experiences with IUWM implementation in South Africa were also reported by Carden *et al.* (2009), with a focus on resolving problems in service provision and water resources management caused by neglecting of interactions in urban water management.

Since then, the IUWM approach has advanced sufficiently and recognises possibilities to satisfy the water needs of a community at the lowest cost whilst minimising adverse environmental and social impacts. In addition, it enables understanding of the interactions that take place between different components of the urban water system. Therefore, it is important to consider these interactions in order to maintain an effective, efficient and safe service of water and sanitation (e.g. this can help in developing control measures to minimise the risks associated with pollution of drinking water, and improve management of water quality in water distribution systems). Hence, an IUWM is necessary to managing freshwater, wastewater, and stormwater as links within the resource management structure, using an urban area as the unit of management (Vairavamoorthy *et al.* 2007).

In most case studies, IUWM is increasingly considered as a strategy to manage the limited water resources in ever growing cities, even if it is still not fully embraced and adopted.

Snapshot of Current Status in Malaysia

It is through the global context that we now relook at how our own country has been managing its water resources in tandem with urban growth. The total Population in Malaysia is currently 28 million (2010 Census) and is projected to reach 42 million by 2050. Malaysia's population is also growing more urban with nearly 71% living in cities (2012) and is expected to reach 80% in 2050. This change in population patterns and growth of cities will impact the way urban water is and will be managed presently and in future. The challenge now is to ascertain whether our existing and future cities can achieve water sustainability or will they face water deficits in future as they continue to grow.

A look at the current water consumption versus availability of water resources in Malaysia has indicated that while Malaysia is not at risk of any water scarcity due to our abundant rainfall, the uneven distribution of these resources and high water consumption has resulted in water deficits in several States, namely Perlis, Kedah, Pulau Pinang, Selangor and Melaka (see Table 4.2.13.3). Georgetown and Kuala Lumpur, two of the largest cities in Malaysia are thus located within water deficit areas and as they continue to grow, will likely face increasing challenges in securing adequate clean water for its population.

Table 4.2.13.3. Water Consumption for States in Malaysia (2010 – 2050)

State	Land Area sq km	Total consumptive Water demand (MCM)					Effective rain (MCM/Year)	Excess/deficit (MCM) - Unregulated Flows				
		2010	2020	2030	2040	2050		2010	2020	2030	2040	2050
Perlis	821	306	299	286	284	281	60	(246)	(239)	(226)	(224)	(221)
Kedah	9,500	2,922	2,976	2,842	2,873	2,876	1,070	(1852)	(1906)	(1772)	(1803)	(1806)
Pulau Pinang	1,048	765	829	835	874	894	130	(635)	(699)	(705)	(744)	(764)
Kelantan	15,099	1,632	1,619	1,586	1,600	1,604	2,650	1018	1031	1064	1050	1046
Terengganu	13,035	884	975	970	999	1,026	3,310	2426	2335	2340	2311	2284
Perak	21,035	1,949	1,923	1,798	1,801	1,811	3,140	1191	1217	1342	1339	1329
Selangor	8,396	2,238	2,491	2,570	2,760	2,922	960	(1278)	(1531)	(1670)	(1800)	(1962)
Pahang	36,137	726	946	897	911	959	6,460	5739	5514	5563	5549	5501
Negeri Sembilan	6,686	340	361	358	366	374	640	300	279	282	274	266
Melaka	1,664	323	366	376	409	439	140	(183)	(226)	(336)	(269)	(299)
Johor	19,210	715	881	1,033	1,164	1,301	3,290	2575	2409	2257	2126	1989
Pen Malaysia	132,631	12,800	13,664	13,551	14,040	14,488	21,170	8370	7506	7619	7130	6682
Sabah	73,631	912	1,356	1,392	1,442	1,469	16,210	15298	14854	14818	14768	14741
Sarawak	124,450	1,054	2,162	2,125	2,175	2,247	27,440	26386	25278	25375	25265	15193
WP Labuan	91	18	24	26	28	29	30	12	6	4	2	1
East Malaysia	198,172	1,985	3,541	3,542	3,645	3,745	53,190	51205	49649	49648	49545	49445
Total Malaysia	330,803	14,785	17,205	17,093	17,685	18,233	74,350	59565	57145	57257	56665	56117

Source: Review of the National Water Resources Study 2010 – 2050, Department of Irrigation and Drainage, 2012.

Two of the most recent concepts in urban development are for cities to head towards achieving eco/green cities or water sensitive cities status (UNEP 2013). Both concepts advocate rethinking on how cities functions and how best to optimise the limited resources available to achieve sustainability while ensuring good quality of life for its population. Malaysia's Federal Territory of Kuala Lumpur scored below average in a recent survey for Water Usage Study in Eco-Green Cities Concepts (Siemens AG 2011) due to a combination of high water consumption and high water leakage rates. Low water tariffs were cited as the main reason for the high water demand. Water governance scored better in terms of legislations, standards and enforcement of water quality standards and pollution control.

The Academy of Sciences Malaysia which is a think tank for the nation on matters related to science, engineering, technology and innovation, has recently embarked on a water sector study entitled *Integrated Urban Water Management in Malaysia*. This study will be in line with the United Nations' "Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all" but with the added urban dimension with the aims at linking the international and national agenda towards sustainable water management.

Through this study, it is hoped to better define IUWM and how best to incorporate the concepts into our existing water resources management and urban development framework towards achieving sustainability and long-term water sector growth. The main focus would be to

identify policy directions and strategic outlook for IUWM through feedbacks from relevant stakeholders, both government and non-governmental regarding the governance of urban water sector and how best to ensure sustainable quality water for these urban areas. In line with the National Physical Plan-2 NPP-2 by the Department of Town and Country Planning, the focus shall be on the four cities in each of the major urban conurbations of Peninsular Malaysia; Georgetown, Kuala Lumpur, Johor Bahru and Kuantan and on four key themes – water supply; water pollution; flood management; and planning and development controls (see Figure 4.2.13.2).

As part of Study, the 1st Stakeholder Consultation on IUWM was held in ASM's office on 3 March 2016, attended by 40 participants ranging from government policy makers to non-governmental organisations. The outcome indicated that the majority of participants agreed in total that IUWM is required in Malaysia as the way forward towards managing our existing urban water. Apart from improving our legislations, there is also a need to address specific issues related to urban water, integration and coordination of efforts by agencies to improve enforcement. As water is critical to all, the involvement of the public too needs to be amplified to enable implementation of IUWM strategies to be effective. Funding also plays an important role especially for capacity development and creating awareness of the key concepts and conceptual framework of IUWM.

The stakeholder consultation also revealed that some best practices are already being employed to tackle urban water issues in an integrated manner. One example would be the Hybrid Off-river Storage, which is used for both flood mitigation and for water supply. It also has the potential to be made into a wetland or even recreational space in the future. Other appropriate technologies and innovative approaches of IUWM that will be suitable for our cities are needed to demonstrate how the IUWM framework can be operationalised.

The study is continuing and four Focus Group Discussions will be held at each of the conurbations identified to garner further feedbacks from the stakeholders as well as to obtain examples of the best management practices and recommendations (road map) for the implementation of IUWM approach, which can be adopted and implemented in other cities in the country in the future.

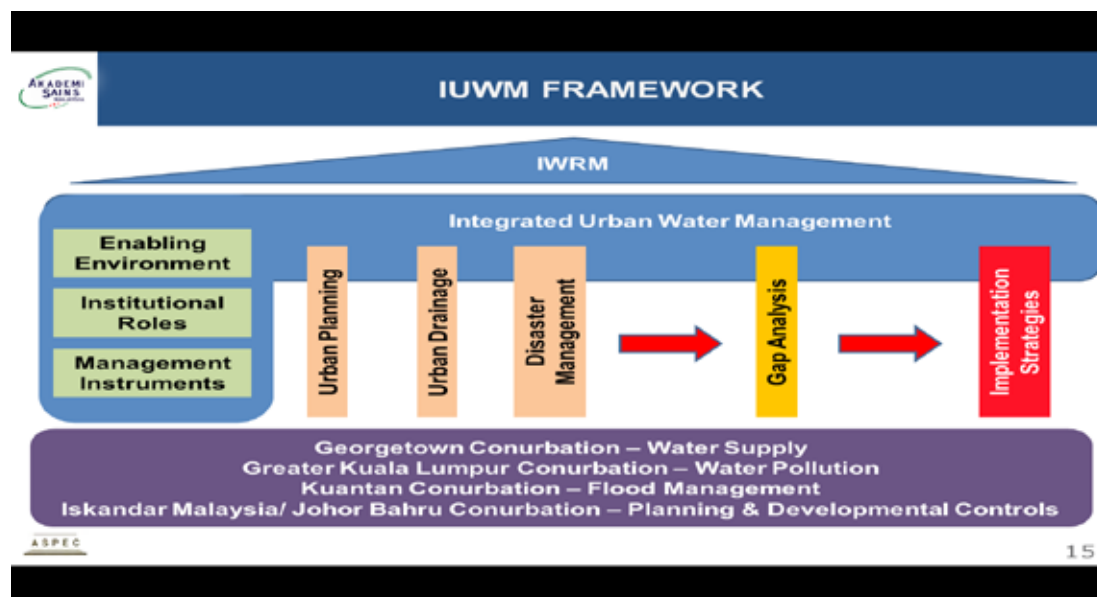


Figure 4.2.13.2. Study Framework for IUWM in Malaysia Study

Recommended Strategies for Implementation

Among the key findings based on stakeholder feedbacks during the *1st Stakeholder Workshop* in regards to enabling environment, institutional framework, management instruments and investments in water infrastructure are:

(i) Enabling Environment

- a) Water Resources Act has to be legislated by Parliament as soon as possible.
- b) Improvement of Federal-State relationship on matters pertaining to land and water management. This is especially so in States which share the same sources of water, such as trans-boundary rivers, but with different political alliances.
- c) Pre-National Water Resources Council (NWRC) meeting may need to be established to manage conflicting priorities and enable issues to be deliberated in detail prior to the actual NWRC. The pre-NWRC meeting can be chaired by the Water Resources Commission and meet more frequently i.e. four times a year, and attended by working level personnel of the relevant State and Federal agencies. This will prevent issues of high priority from being hastily discussed during the NWRC, which only meets once a year.
- d) Treated wastewater (from sewerage treatment plants) needs to be recognised as an alternative source of water. With proper investments and enforcement, the discharge of good quality treated water can be used for non-potable usage i.e.

- irrigation, landscaping, industrial cooling.
- e) The use of natural treatment systems (NTS) should be mandated for all new developments. These technologies use natural processes to improve water quality to maintain the natural environment and to recharge depleting groundwater sources. For example, NTS are increasingly being used to treat and retain stormwater, wastewater and drinking water flows. NTS have the advantage of being able to remove a wide variety of contaminants at the same time, which makes them a total treatment system on their own and they are increasingly being used for water reclamation.
 - f) Laws need to allow for discharges to be quantified in terms of load instead of concentrations. The key for the application of the most of the new treatment technologies is the separation of the different flows of wastewater according to their pollution load.
 - g) There are already adequate policies, legislations and guidelines to address many of the existing issues in water management. What is lacking is in enforcement efforts to address such problem areas e.g. Non-revenue Water, pollution discharge and inefficient use of water resources.
 - h) Use of innovative technological solutions for urban water systems should be encouraged and incentivised. The potential of more efficient reuse of water and nutrients and the recovery of energy is a major advantage of new treatment technologies (Bieker *et al.* 2010).

(ii) Institutional Framework

- a) A Water Resources Commission needs to be established and it has to be empowered by law to manage water resources, implement policies and have a strong representation/voice on all other facets impacting the implementation of IUWM.
- b) This commission is to be mandated proper funding and manpower to sustainably undertake its function.
- c) Suitable platforms for the public and non-governmental stakeholders must be established within existing and new decision-making bodies to ensure that all stakeholders are represented.
- d) Research institutions should focus on IUWM as a key area of R&D as part of the IWRM.

(iii) Management Instruments

- a) Short-, medium- and long-term strategies and plans pertaining to implementation of IUWM in all urban areas are required and assigned to relevant agencies for implementation.
- b) Key performance Indices (KPIs) should be derived for or by the agencies that will implement these strategies, so that they can plan the necessary resources (manpower and funding) to meet the desired outcome. Each agency will present the status of the KPI to the Water Resources Commission and clarification requested if KPI's are not met. For agencies that meet the KPI, additional funding allocations should be proposed as an incentive.
- c) Education and awareness are essential to building capacity among

all stakeholders. The dissemination of new ideas and technologies takes the time to convey and become integrated within a society, thus it is essential to spur further efforts towards capacity building at all levels of government and society.

(EDCs) needs to be recognised and existing legislations/guidelines updated to reflect so that new water infrastructures are able to manage and treat such contaminants.

Summary

(iv) Investments in Water Infrastructure

- a) Quantifiable available water resources (water audit) and water demand are required to develop effective water governance. This should be maintained by the Water Resources Commission.
- b) Whole of the life cycle cost and a sustainable funding model is required for implementation and continued maintenance of the proposed water infrastructure.
- c) Address water loss and improve efficiency through new technologies and monitoring tools. This includes taking a risk-based approach when replacement of ageing existing infrastructure.
- d) Smart and water sensitive design should be made mandatory for all new development. This can be in various scales i.e. from landed property to condominiums and large complexes. For old establishments that modify their existing systems to embrace IUWM, tax incentives should be provided to promote conversion.
- e) Climate change impacts need to be recognised and embedded into the design of water related infrastructures.
- f) Emerging contaminants such as pharmaceutically active compounds, endocrine disrupting compounds

This Expert Review Paper has set forth the current scenario, both globally and within Malaysia, in which IUWM is becoming a necessary element for decision- and policy-makers to incorporate into the planning and design of existing and future urban areas and cities.

The issues related to water resources management are magnified as cities grow larger and a growing rural population finds their way to the cities. Already strains can be seen in the few large and medium cities in Malaysia, requiring a rethinking of our current practices, towards a more integrated water management system.

The IUWM Study has obtained the view of the various stakeholders during the *1st Stakeholder Workshop* held on 3 March 2016 and the salient findings are synthesised in this Review.

With the upcoming FGD's, it is hoped that these recommendations can be further detailed to include case studies and examples of IUWM strategies utilised in the country to allow for them to be replication throughout.

REFERENCES

- Anderson, J & Iyaduri, R. 2003, 'Integrated urban water planning: big picture planning is good for wallet and the environment', *Water Science and Technology*, vol. 47, no. 7–8, pp. 19–23. IWA Publishing.
- Bieker, S, Cornel, P & Wagner, M 2010, 'Semi-centralised supply and treatment systems: integrated infrastructure solutions for fast growing urban areas', *Water Science and Technology WST*, vol. 61, no. 11, pp. 2905–2913.
- Biswas, AK 2006, 'Water management for major urban centres', *Water Resources Development*, vol. 22, no. 2, pp. 183–197.
- Biswas, AK & Tortajada C 2009, *Water supply of Phnom Penh: a most remarkable transformation*, Lee Kuan Yew School of Public Policy, Singapore.
- Carden, K, Winter, K & Armitage, N 2009, 'South Africa sustainable urban water management in Cape Town, South Africa: is it a pipe dream?', in *34th WEDC International Conference*, Addis Ababa, Ethiopia.
- Coombes, PJ & Kuczera, G 2002, 'Integrated urban water cycle management: moving towards system understanding', in *2nd National Conference on Water Sensitive Urban Design*, 2–4 September, Brisbane.
- ICLEI 2011, *SWITCH training kit module 1*, SWITCH.
- Mitchell, VG 2004, *Integrated urban water management – a review of current Australian Practice*, CSIRO & AWA report CMIT-2004-075.
- Peter van der Steen & Howe, C 2009, 'Managing water in the city of the future: strategic planning and science', *Rev. Environ. Sci. Biotechnol.*, vol. 8, pp. 115–120.
- Peter van der Steen, Labite, H, Machdar, E, Lunani, I & Lens, P 2011, 'The SWITCH experience with strategic planning for sustainable and integrated urban water management, using quantitative microbial risk assessment in Accra', in *SWITCH Scientific Meeting*.
- Pinkham, R 1999, *21st century water systems: scenarios, visions and drivers*, Rocky Mountain Institute, Snowmass, Colorado.
- Tucci, C, Goldenfum, JA, Parkinson, JN 2010, *Integrated urban water management, humid tropics, urban water series*, UNESCO-IHP, Taylor and Francis, CRC Press.
- Vairavamoorthy, K 2011, 'New urban leaders for sustainable cities of the future', in *NARST Annual International Conference*, 3–6 April, Orlando, Florida.

National Water Resources Policy (NWRP) Action Plan

Summary Report

Dato' Ir. Haji Hanapi Mohamad Noor

The National Water Resources Policy (NWRP) was presented in the 6th National Water Resources Council Meeting (MSAM) in 2011 that unanimously agreed to the adoption of the policy at the Federal and State levels. Subsequently, the NWRP was presented and approved by the Cabinet on 22nd February 2012 for implementation. The formulation and adoption of the Policy were long overdue because prior to that, there was no clear comprehensive policy, direction and guidelines in managing the nation water resources.

The NWRP, which was developed based on IWRM approach, emphasises on the security and sustainability of the nation's water resources. It contains three principles, five objectives, four key core areas, nine thrusts, 18 targets, 28 strategies and 69 strategic action plans.

The commitment by the Government to addressing water resources can be seen from the Policy Statement as stated below:

"The security and sustainability of water resources shall be made a national priority to ensure adequate and safe

water for all, through sustainable use, conservation and effective management of water resources enabled by a mechanism of shared partnership involving all stakeholders".

The NWRP is intended to serve as a directional focal point to help bring together stakeholders including government agencies, non-government organisations, academia, research institutions, the private sector and communities to help translate the strategic action plans into actions. The time frame for the implementation of the strategic plans ranges from short to medium term, as the policy is expected to be reviewed from time to time. This will help ensure that the policy stays dynamic and flexible enough to adjust to changing conditions. The Ministry of Natural Resources and Environment (NRE) will facilitate the collaboration of key government authorities and other related stakeholders in executing the strategic action plans.

Review of Current Status and Needs Assessment

The NWRP recognises the fact that the Federal Constitution of Malaysia provides that water insofar as it remains within a State, lie within the legislative purview of that State. However, water resources too can be associated with various aspects that fall within the legislative purview of both the federal and State governments. It also leverages on the already established National Water Resources Council which serves as a platform to help bring the Federal and State governments together to identify means and measures to address issues and capitalise on opportunities related to water resources.

Based on concerns raised by various stakeholders and the need for better water resources management and conservation, four guiding tenets underpinning government efforts have been maintained, that is:

- Water for people: all to have access to safe, adequate and affordable water supply, hygiene and sanitation;
- Water for food and rural development: provision of sufficient water that will ensure national food security and promote rural development;
- Water for economic development: provision of sufficient water to spur and sustain economic growth within the context of a high income economy; and
- Water for the environment: protection of the water environment to preserve water resources (both surface and groundwater) and natural flow regimes, biodiversity and cultural heritage, along with mitigation of flood related hazards.

The NWRP is based on three principles as follows:

- *Water Resources security:* Water resources must be secured to ensure their availability to meet the needs and demands of both man and nature, through optimisation of their potential and minimisation of damaging impacts;
- *Water Resources Sustainability:* Water resources are the catalyst for environmental wellbeing and national development, and thus need to be sustained for present and future uses. It also opens up to opportunity to explore the use of alternative sources and address the aspects related to demand management; and
- *Collaborative Governance:* Stakeholders inclusiveness and collaboration are essential towards ensuring the security and sustainability of water resources as well as achievement of common goals towards addressing multiple water resources governance concerns and priorities.

Under the NWRP, a total of nine thrusts have been proposed based on the above principles and key core areas, that is:

- Water intelligence;
- Water resources integrity;
- Use of alternative water resources and sources;
- Water related disaster risk reduction, preparedness and response;
- Criteria for water resources characterisation;
- Conservation and protection of water resources and bodies, both natural and artificial;

- Stakeholder inclusiveness and engagement; and
- Capacity building and awareness.

NWRP Implementation Mechanism

A total of 69 Strategic Action Plans has been outlined in the NWRP for implementation, in which NRE and DID Malaysia play the leading roles. The first consultative workshop involving relevant stakeholders was held in Penang on 30-31st May 2012 to discuss and detailed the specific plans of action based on the 69 strategic action plans in the NWRP.

Three main committees have been set up to ensure effective implementation of the NWRP, that is:

- *Jawatankuasa Penyelarasan dan Pemantauan Pelaksanaan* DSAN, chaired by the Secretary General NRE;
- *Jawatankuasa Pasukan Petugas Pelaksanaan* DSAN, chaired by the Director General, DID Malaysia; and
- *Jawatankuasa Peneraju Kumpulan Kerja Pelaksanaan* DSAN, chaired by the Director of Water Resources Management and Hydrology Division, DID Malaysia.

Five task forces have also been formed to look into the implementation of specific action plans as follows:

- *Water Governance;*
- *Water Resources Information;*
- *Investigation and Research;*
- *Standards and Quality; and*
- *Capacity Building and Awareness.*

The flow chart for the NWRP implementation mechanism is as shown in Figure 4.2.14.1 below:

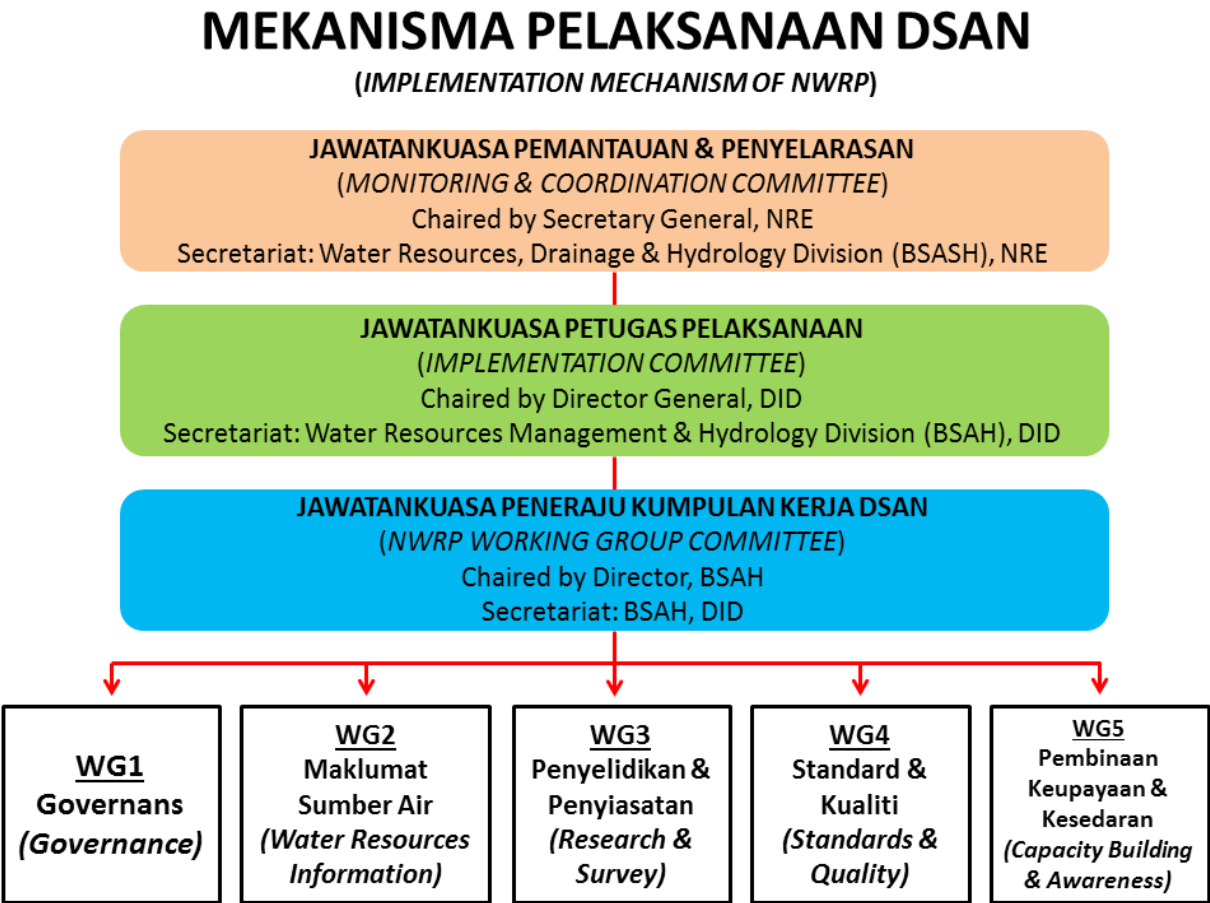


Figure 4.2.14.1. The NWRP Implementation Mechanism

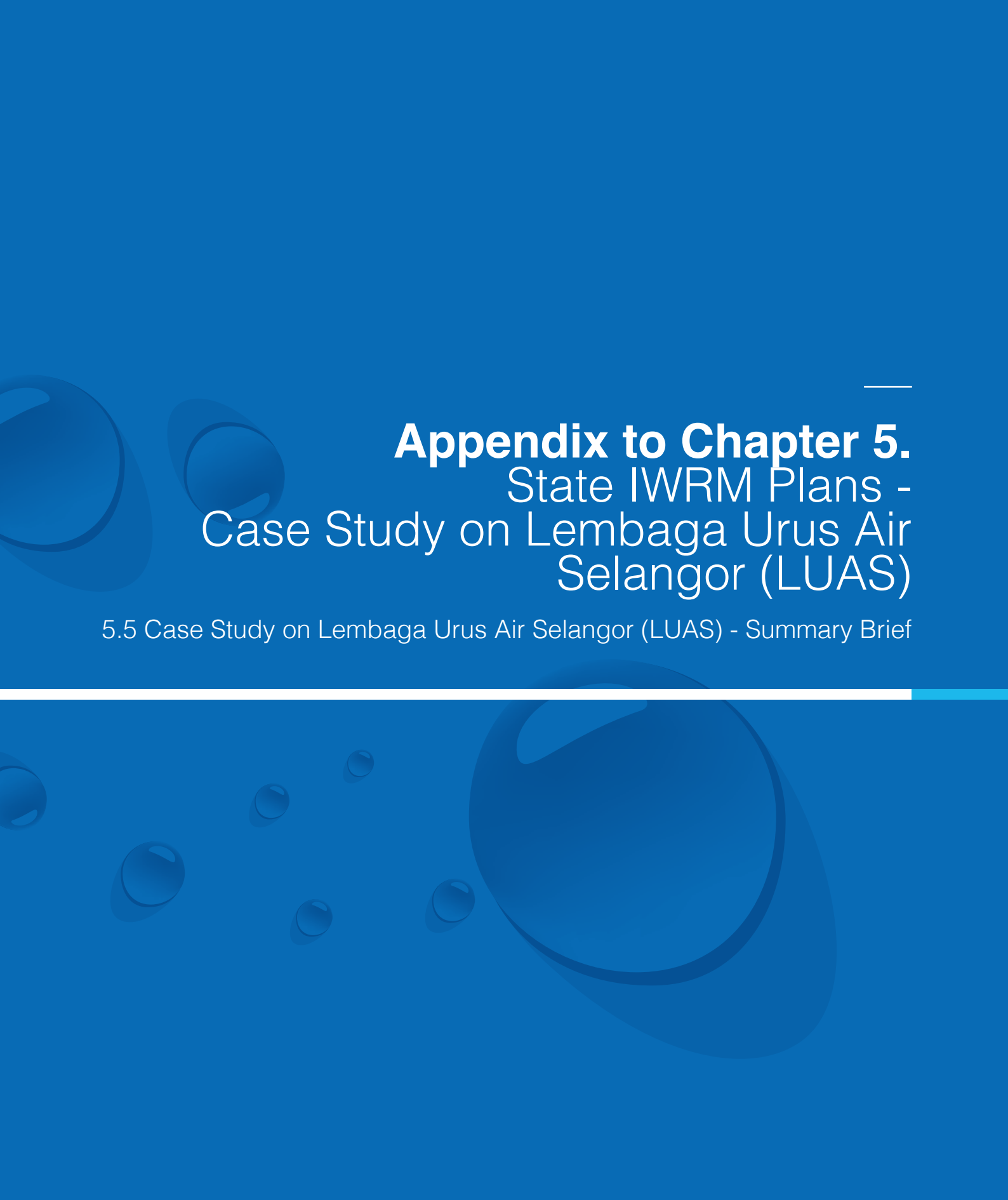
Each working group is headed by relevant government departments and Ministry Division as shown in Figure 4.2.14.2 below.

Kumpulan Pasukan Kerja DSAN (*NWRP Working Group*)

No.	Pasukan Kerja (<i>Working Group</i>)	Peneraju (<i>Lead Agency</i>)	Setiausaha (<i>Secretariat</i>)
1	Governans (<i>Governance</i>)	BSASH, NRE	BSASH, NRE
2	Maklumat Sumber Air (<i>Water Resources Information</i>)	JPS (<i>DID</i>)	Bahagian Korporat, JPS (<i>Corporate Division, DID</i>)
3	Penyelidikan & Penyiasatan (<i>Research & Survey</i>)	NAHRIM	NAHRIM
4	Standard & Kualiti (<i>Standards & Quality</i>)	JAS (<i>DOE</i>)	JAS (<i>DOE</i>)
5	Pembinaan Keupayaan & Kesedaran (<i>Capacity Building & Awareness</i>)	BSASH, NRE	BSAH, JPS (<i>DID</i>)

Figure 4.2.14.2. Working group by relevant government departments and Ministry Division





Appendix to Chapter 5. State IWRM Plans - Case Study on Lembaga Urus Air Selangor (LUAS)

5.5 Case Study on Lembaga Urus Air Selangor (LUAS) - Summary Brief

Case Study on Lembaga Urus Air Selangor (LUAS)

Summary Brief

Nor Zamri Sondor, Haslina Amer and Md. Khairi Selamat

In July 1997, the Federal Cabinet requested the Ministry of Agriculture and the Selangor State Government to set up an agency to be responsible for managing river and water sources in an integrated manner using the Sg. Selangor as a pilot project. This led to the establishment of the Lembaga Urus Air Selangor (LUAS) in September 1999, legally constituted following the passing of the Selangor Waters Management Authority (SWMA) Enactment by the Selangor State Legislative Assembly in April 1999.

Vision, Mission and Objectives

The vision of LUAS is “to be an excellent organisation in integrated water resource management to advocate the Selangor State vision”, while its mission is “to manage Selangor State water resource in a holistic manner towards universal well-being”. LUAS carries a slogan “Water for All” and its objectives as extracted from its website are as follows:

- To ensure the water resources and its environment are in a sustainable condition, in order to support the socio-economic development of a progressive State;
- To undertake the function of planning,

research, facilitator, coordinator, operation, enforcement, supervision in the development of integrated management of water resources and the environment;

- To provide an environment that is conducive for public and private sector participation in the development, utilisation, and management of water resources and environmental surroundings taking into consideration the interests of the public and the State Government; and
- To create the public awareness and the participation of the public on the importance of water resources and in caring and enhancing the quality of water.

Management Structure and Vested Powers

As provided under the SWMA Enactment 1999, the “Selangor Waters Management Authority” is a body corporate whose membership shall consist of a Chairman, a Deputy Chairman and not less than ten other members constituted as follows:

- The *Menteri Besar* who shall be the Chairman;
- The State Secretary who shall be the Deputy Chairman;
- The State Legal Advisor or his representative;
- The State Financial Officer or his representative;
- Two members of the State Executive Council appointed by the *Menteri Besar*;
- The Director General of the Federal Drainage and Irrigation Department;
- Not more than five other members to be appointed by the State Authority who shall have substantial expertise in matters pertaining to the management and conservation of river basins, groundwater, and water sources; and
- The Director who shall be the secretary of the Authority.

The Authority appoints the Director with the prior approval of the State Authority. The Office of the Director is hence responsible for the day-to-day operations of LUAS, namely:

- The proper administration and management of the Authority;
- The preparation of policies, plans, programmes, schemes or projects for the consideration of the Authority;
- Putting into execution, supervision, and

control of all policy decisions, plans, programmes, schemes and projects approved by the Authority;

- Supervision and control over all other officers and servants of the Authority; and
- Such duties and exercise such powers, as may from time to time be determined or delegated by the authority or as the Chairman may direct.

The SWMA Enactment has vested powers with the authority to administer and exercise control over the following matters, namely, finance; protection and development of water source; declaration of river basins, groundwater and water body; resource use efficiency and conservation; mitigation measures; protection of the environment; privatisation; activities on the surface of the water bodies; and enforcement. The enactment empowers the Authority to establish offices or sub-offices and form committees or sub-committees as deemed necessary.

Current Status

Since its formation in 1999, LUAS has managed to implement a number of activities to achieve its objectives. They are summarised below and organised under following the four elements of the IWRM General Framework:

(i) Enabling Environment:

a) Policy

The National Water Resources Policy, endorsed by the National Water Resources Council was formally launched in March 2012. For the State of Selangor, the implementation of the Policy will be monitored by the LUAS Technical Committee that is chaired by the Selangor State Secretary and LUAS as the secretariat.

The LUAS Policy paper regarding river management (IRBM) in the State was adopted by the Selangor State Executive Council on 23 May 2012 while a Policy paper on lake management (ILBM) in the State was approved by the LUAS's Board on 18 June 2013.

b) Legislation

The SWMA Enactment 1999 was passed by the Selangor State Legislative Assembly and gazetted on 9 April 1999. Implementation began in 11 May 2000.

c) Regulations

In accordance with the provisions of the SWMA Enactment 1999, and to facilitate the proper exercise of its prescribed functions, the following regulations for specific purposes have been legislated and gazetted to date:

- Notification of charges for abstraction of water from any water source (Selangor G.N. dated 30 June 2005);
- Selangor Waters Management Authority (Compounding of Offences) Regulations 2006 effective 9 March 2006 (Sel. P.U. 8);
- Zone of protection (declared area and restriction) notification 2009 (G.N. 2171);
- Sungai Selangor Basin Management Plan 2007–2012, which has been duly approved for implementation by the State Authority on 1 August 2007 (Sel. G.N. dated 10 September 2009);
- Port Klang Coastal Strategy Implementation Plan, which has been duly approved for implementation by the State Authority on 24 July 2007 (Sel. G.N. dated 10 September 2009);
- Zone of Protection (Declared Area and Restriction) Notification 2010 (Sel. G.N. dated 29 April 2010);
- Notification of charges for diversion of water from any water source (Sel. G.N. dated 11 November 2010);
- Zone of Protection (Declared Area and Restriction) Notification 2010 (Sel. G.N. dated 2 December 2010);
- Navigation in inland waters (Sel. P.U. 44) 2012;
- Zone of protection (Declared Area and Restriction) Notification 2013 (Sel. G.N. dated 5 December 2013);
- Diversion of Water for Electricity Generation (Selangor) Regulations 2014 (Sel. G.N. dated 27 March 2014);
- Zone of Protection (Declared Area and Restriction) Notification 2014 (Sel. G.N. dated 10 April 2014) - No.1589. Additional resources for water supply; and
- Zone of Protection (Declared Area and Restriction) (no. 2) Notification 2014 (Sel. G.N. dated 10 April 2014) – No.

1589 Additional resources for water supply.

d) *Finance*

LUAS depends on the State and the revenues from its regulatory activities for its finances. While some 20% of its annual operating expenditure comes as a grant from the State Government, the larger 80% is derived from revenues generated through fees for registration, licences, charges for offences, and compounds.

The Federal Government has provided support to LUAS with regard to IRBM activities. To date, River Basin Management Studies for Sg. Selangor and Sg. Langat have been completed from Federal funds undertaken by Federal DID under the NRE Ministry. However, the preparation of IRBM Plans for both of these rivers was undertaken by LUAS using State funds. The “Master Plan Study on Flood Mitigation and River Management for the Bernam River Basin” was completed from Federal DID funds. Being a shared river, LUAS is currently working with the Perak State Government to prepare a IRBM Plan for Sg. Bernam. The IRBM Plan for Sg. Klang is also currently being undertaken by LUAS funded from a State grant. Consistent with its Strategy Plan 2012–2016, LUAS has targeted to complete the preparation of IRBM plans for all the major river basins in the State and the State government has allocated RM10 million under

the 11th Malaysian Plan for this purpose.

LUAS has adopted the concept of “Payment for Environment Services (PES)” in the implementation of IRBM.

(ii) **Institutional Framework**

a) *State*

As elaborated in *Section: Management Structure and Vested Powers* above, the Board of Directors (BOD) of LUAS chaired by the *Menteri Besar* is the highest water resources authority in the State. The BOD constituted legally with vested powers provided under the SWMA Enactment is answerable to the State Executive Council, with day to day implementation handled by the Director of LUAS, who also acts as Secretary to the Authority. With regard to the directive by MSAN 08 to all States to establish MSANG in their respective States, the Selangor Government decided to recognise the BOD of LUAS as the equivalent, noting that they are already performing similar functions.

The Deputy Chairman of LUAS, the Selangor State Secretary, chairs the LUAS Technical Committee comprising members from relevant State departments such as DID, JPBD, and Department of Forestry. The Technical Committee deliberates on all matters pertaining to water resources and river basin management. It oversees and coordinates the implementation

of all programmes and decisions including those directives issued by MSAN.

In addition, the following special purpose committees have been formed to date to assist in streamlining the management and monitoring of activities:

- Selangor State Groundwater Management Committee chaired by the Director of LUAS;
- Selangor State Water Resource Pollution Emergency Committee chaired by a State EXCO for Tourism, Environment, Green Technology and Consumer Affairs meets on a need basis especially when pollution causes disruptions to WTP operations; and
- Selangor State Alternative Water Resources Task Force led by the LUAS Director.

b) Basin

River basin units have been established for the Selangor, Langat and Klang rivers. Bernam river basin unit is yet to be formed since it is a shared river with the State of Perak. Smaller river basins such as Sg. Buloh and Sg. Sepang have been amalgamated with Sg. Klang and Sg. Langat respectively. There are no separate lake basin management units. LUAS considers them as integral part of their respective RBUs.

Task Forces have been set up for the Sg. Klang, Sg. Langat, and Sg. Selangor river basins which are chaired by LUAS and meet every quarterly.

c) Local

Local issues encountered are dealt with through meetings held with respective Government agency, NGOs and the aggrieved parties.

(iii) Management Instruments

a) Information Management

- Development of LUAS's SCADA system known as the "Integrated Water Resources Information Management System (IWRIMS)" for real-time data monitoring at seven dams in the State;
- Development of LUAS's GIS system known as E-LUAS for monitoring of activities in river basins;
- Development of a "Decision Support System (DSS) for Sg. Selangor Basin" to support LUAS in its decision-making on water resources management in the Sg. Selangor basin. The DSS would be replicated for the other basins. It entails the sharing of data from internal systems such as IWRIMS with data from other agencies such as DID and MMS and applicable for resources assessment under all situations be it flood, drought or normal;

- Installation of radar sensor flow equipment at Jalan Raja Muda Musa, Bestari Jaya, Kuala Selangor (in cooperation with DID Malaysia) for the monitoring of river water level and flow for Sg. Selangor; and
- Release of triennial State of River Reports for Sg. Selangor (2006, 2008, 2011), Sg. Langat (2008, 2011), Sg. Kelang (2008, 2011).

b) Planning

Five-year strategy plans have been formally announced and published by LUAS, the current one being for the period 2012 to 2016.

River basin studies on Sg. Selangor, Sg. Bernam, and Sg. Langat had been undertaken earlier by Federal DID. Subsequent to these studies, LUAS with funding from the State of Selangor has completed river basin management plans for Sg. Selangor (2007–2012) and Sg. Langat (2015–2020). They have been passed by the LUAS's BOD, prior to seeking approval by the State Government, followed by gazetting and implementation. It is in the process of preparing a similar RBM Plan for Sg. Klang. IRBM plan for Sg. Bernam is in the process of preparation jointly with State Government of Perak.

Integrated Coastal Management (ICM) Plans have also been prepared by LUAS for the following

areas and which have been gazetted:

- ICM Plan Port Klang covering the coastal areas of the Klang district and extending to a part of the Kuala Langat district;
- ICM Plan Kuala Selangor and Sabak Bernam covering the coastal areas of both these districts; and
- ICM Plan Sepang covering the coastal areas of Sepang district and a part of Kuala Langat district.

c) Economic and Financial Instruments

- Fees for licences have been prescribed and gazetted for the issuance of licences required for the following activities: Water Resource Abstraction; Resource Alteration Activity; Diversion of Water for Generating Electricity; Emission or Discharge of Pollutants; Inland Waterway Navigation; and Recreation;
- Similar penalties and fines for various offences and breaches under the enactment have also been gazetted to facilitate enforcement proceedings; and
- Adoption of Payment of Ecosystem Services (PES) in river basin management.

d) Legal Instruments

- Gazetting of Protected Areas
To date, the following have

been gazetted as protected zones/areas:

- Tidal areas as protection zone for fire-flies habitat – G.N. dated 2 July 2009 and 29 April 2010;
 - Zone of protection for wetlands, river reserves and environmentally sensitive coastal areas: G.N. 1189 dated 29 April 2010;
 - Catchment areas of the Sg. Selangor, Sg. Tinggi, Sg. Langat, Sg. Semenyih, Batu, Tasik Subang dams – G.N. dated 2 December 2010; and
 - Alternative water sources – five ponds, namely Kolam Saujana Putra, Daerah Kuala Langat; Kolam Labohan Dagang MC8 dan MC9, Daerah Kuala Langat; Kolam Petaling Tin, Bukit Cheding dan Kolam Agro-Tech, Olak Lempit; Kolam Sungai Rawang-Serendah, Daerah Hulu Selangor; and Kolam Taman Desa Anggerik, Daerah Hulu Selangor. – G.N. dated 2 November 2013.
- Gazetting of river reserves is progressively being undertaken since 2013.
 - Issue of Licences
Licences issued by LUAS are required for the following activities: Water Resource Abstraction; Resource Alteration Activity; Diversion of Water for Generating Electricity; Emission or Discharge of Pollutants; Inland Waterway Navigation; and Recreation. The prescribed forms for the necessary licensing process have since been gazetted.
 - Penalties for Offences
Imposition of fines and penalties for various types of breaches and offences under the SWMA Enactment and quantum has been gazetted.
- e) *Operation and Maintenance*
- Quarterly meeting of the Water Source Pollution Task force consisting of members from different government agencies is chaired by Director of LUAS;
 - Quarterly meeting of the State's River Basin Management Committee is chaired by the Hon. State Secretary, with LUAS as the Secretariat; and
 - Meeting of Water Source Emergency Committee to implement integrated action involving emergency stoppage of water treatment plants due to water source pollution or other causes.
- f) *Technical Studies and R&D*
- Ongoing studies since 2006 on monitoring of Sg. Selangor

- firefly population;
- Studies pertaining to use of ex-mining ponds to serve as detention storage for flood overflows from Sg. Selangor;
- Groundwater exploration studies;
- Development of guidelines and BMPs to support water resources management in the State in accordance with SWMA Enactment;
- Studies pertaining to prawn aquaculture in Selangor; and
- Sanitary study on Sg. Damansara.

g) Participatory Management

- Joint programme on rehabilitation firefly habitat—State project involving FRIM, AEON CO. (M) Bhd., LUAS, PTD Kuala Selangor, and MDKS; and
- Firefly conservation project involving the Kg. Kuantan community in Kuala Selangor—UKM and TNB Research Project with support by MDKS and LUAS.

h) International cooperation

LUAS has gained some international recognition for its adoption of IRBM and ICZM in implementing and managing river basin programmes and activities in the State of Selangor, Malaysia. LUAS was selected by the Network for Asian River Basin Organisations (NARBO) to participate in NARBO's 2013–2014 "River Basin Organisations

Performance Benchmarking" programme. The main objectives in performance benchmarking are to identify the strength of organisation and the areas for improvement.

(iv) Investments in Water Infrastructure

As a water resources management organisation, investments in water infrastructure from State funds has mainly been utilised for the following projects:

- a) Progressive development of telemetric stations along river basins for real-time water quantity and quality monitoring for integration into the existing IWRIMS;
- b) Replication of the Selangor river DSS on the Langat and Klang rivers which together would be referred to as LUAS Intelligent Support System (LISS);
- c) During prolonged droughts caused by the El Nino phenomenon, LUAS has assisted in pumping from gazetted alternative ponded storages to augment raw water supplies to meet the needs of WTP up to as much as 800 MLD to 1000 MLD. An annual State grant of RM16 million has been allocated for this purpose; and
- d) LUAS has also been involved in cloud-seeding operations undertaken by nominated specialist contractors. In the year 2015, some 415 cloud-seeding flight operations were executed, while in 2016, some 50 flight operations have been done to date.

Selangor State IWRM Plan and Implementation Road Map

A Strategies Implementation Road Map over a period covering three Malaysia Plans until 2030 is attached comprising four appendices as follows:

- (i) Appendix 5.5.1 (Enabling Environment);
- (ii) Appendix 5.5.2 (Institutional Framework);
- (iii) Appendix 5.5.3 (Management Instruments); and
- (iv) Appendix 5.5.4 (Investments in Water Infrastructure).

Appendix 5.5.1. NIWRM Strategy Plan and Implementation Road Map (LUAS): Enabling Environment

Water as a Resource							
Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Policy	National Water Resources Policy	State	Selangor State Secretary	LUAS	Launched in 2012	-	LUAS as the secretariat for LUAS Technical Committee to monitor the implementation of policy
	Policy Paper on Integrated River Basin Management	State	Selangor State Secretary	LUAS	Approved in 2012	-	Sg. Selangor IRBM Plan (2007–2012) has gazetted on 10 Sept 2009. Sg. Selangor IRBM Plan has been reviewed (2015–2020) in 2014. Sg. Langat IRBM Plan (2015–2020) has been developed 2014 for implementation and LUAS in progress to prepare Sg. Klang IRBM Plan
	Policy Paper on Integrated Lake Basin Management	State	Selangor State Secretary	LUAS	Approved in 2013	-	ILBM is a part of management in river basin. Task Force of Water Alternative is the platform to monitor the management of water alternative in Selangor chaired by LUAS's Director. Lake Management Strategy has been endorsed by <i>Majlis Mesyuarat Kerajaan Negeri</i> on 26 Mei 2014
Legislation	Selangor Waters Management Authority Enactment	State	Selangor State Secretary	LUAS	Gazetted in 1999	-	To be reviewed

Appendix 5.5.1. NIWRM Strategy Plan and Implementation Road Map (LUAS): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Regulation	Notification of charges for abstraction of water from any water source	State	Selangor State Secretary	LUAS	Effective since 2005	–	Gazette the raw water charges effective from 1 July 2005. Raw water charge is RM0.05/m ³ for commercial and RM0.01/m ³ for utility. Total premises have been licensed for surface water abstraction is 367 and for ground water abstraction is 380
	Selangor Waters Management Authority (Compounding Of Offences) Regulations 2006	State	Selangor State Secretary	LUAS	Effective since 2006	–	
	Zone of protection notification 2009	State	Selangor State Secretary	LUAS	Effective since 2009	–	Gazette for establishment zone of protection for river reserve, buffer zone for Sg. Selangor in Mukim Pasangan. (referring to Policy 4: Conservation of Fireflies)
	Sg. Selangor Basin Management Plan 2007-2012	State	Selangor State Secretary	LUAS	Effective since 2009	–	Gazette on 10 Sept 2009. Review plan in 2014
	Port Klang Coastal Strategy Implementation Plan	State	Selangor State Secretary	LUAS	Effective since 2009	–	Gazette on 10 Sept 2009
	Zone of Protection (Declared Area and Restriction) Notification 2010	State	Selangor State Secretary	LUAS	Effective since 2010	–	Establishment zone of protection to protect wetland area, river reserve and environmentally sensitive coastal area in Mukim Kapar, Klang
	Notification of charges for diversion of water from any water source	State	Selangor State Secretary	LUAS	Effective since 2010	–	Gazette the river diversion charges for electricity generation RM50,000/MW

Appendix 5.5.1. NIWRM Strategy Plan and Implementation Road Map (LUAS): Enabling Environment (continued)

Category	Strategy	Hierarchical Level	Lead Authority	Implementing Agency	Current Status	Target Completion	Remarks
Regulation	Zone of Protection (Declared Area and Restriction) Notification 2010	State	Selangor State Secretary	LUAS	Effective since 2010	–	Gazette for seven dam water catchment in Selangor
	Navigation in inland waters (Sel. P.U 44)	State	Selangor State Secretary	LUAS	Effective since 2012	–	The licensing and charges depend on weight of the vessel
	Zone of protection (Declared Area and Restriction) Notification 2013	State	Selangor State Secretary	LUAS	Effective since 2013	–	Establishment zone of protection to protect and preserve the availability of water for additional resources for water supply
	Diversion of Water for Electricity Generation (Selangor) Regulations 2014	State	Selangor State Secretary	LUAS	Effective since 2014	–	Regulation for the licence for river diversion for electricity generation
	Emission or Discharge of Pollutant	State	Selangor State Secretary	LUAS	Effective since 2012	–	LUAS implemented the Emission or Pollutant Discharge Regulation (Selangor) 2012 for seven categories. Its include fresh water aquaculture, marine prawn aquaculture, development/ earthworks, Non-pig farming, pig farming, pets, mining related activities
	Resource Alteration Activities	State	Selangor State Secretary	LUAS	Effective since 2014	–	Written approval for resource alteration activities related to water resources
Finance	State Government Grant	State	Selangor State Secretary	LUAS	Ongoing	11MP and beyond	30% of the annual budget
	Revenues from Regulatory Activities	State	Selangor State Secretary	LUAS	Ongoing	11MP and beyond	LUAS revenue from the charges that has been imposed from regulatory activities RM14M collected annually from regulatory activities
	Federal Government (NRE) Funding	National	Selangor State Secretary	LUAS	Ongoing	11MP and beyond	River Basin Management Plans for Sg. Bernam, Sg. Langat, Sg. Selangor, and Sg. Klang

Appendix 5.5.2. NIWRM Strategy Plan and Implementation Road Map (LUAS): Institutional Framework

Water as a Resource							
Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Establishment of MSANG	State	LUAS	Chaired by Chief Minister	Oversees the propose policy on water resources management in Selangor	–	Completed	
Establishment of LUAS Technical Committee	State	LUAS	Deputy Chairman of LUAS and Selangor State Secretary	Oversees and coordinates the implementation of all programmes and decisions including those directives issued by MSAN	–	Completed	
Formation of Selangor State Groundwater Management Committee	State	LUAS	Chaired by the Director of LUAS	Streamlining the management and monitoring of activities	–	Completed	
Formation of Selangor State Water Resource Pollution Emergency Committee	State	LUAS	Chaired by a State EXCO member and Chair of the <i>Jawatan Kuasa Tetap, Infrastruktur and Kemudahan Awam</i>	Streamlining the management and monitoring of activities	–	Completed	
Formation of Selangor State Alternative Water Resources Task Force	State	LUAS	Chaired by the Director of LUAS	Streamlining the management and monitoring of activities	–	Completed	

Appendix 5.5.2. NIWRM Strategy Plan and Implementation Road Map (LUAS): Institutional Framework
(continued)

Strategy	Hierarchical Level	Lead Agency	Composition	Functions	Current Status	Target Completion	Remarks
Management at the River Basin Level has been decentralised to Task Forces in each river basin	River Basin	LUAS	All relevant stakeholders	To discuss issues related to water resources in each river basin	Ongoing	–	The Task Force meets four times a year
Local level communities at the sub-basin level and coastal area	Local	LUAS	All relevant stakeholders	To discuss issues pertaining to each sub-basin and coastal area	Ongoing	–	As per needs and requirement Example: River and Beach adoption programmes

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
1. Information Management	Development of LUAS's SCADA a.k.a. "Integrated Water Resources Information Management System (IWRIMS)"	LUAS	SPLASH, PNSB Waters, KASB, ABASS, MET Malaysia, DID	Ongoing	–	For real time data monitoring at seven dams in the state. Phase V for more upgrading
	Development of LUAS's GIS system known as E-LUAS	LUAS	Consultant, JPBD, JUPEM	Ongoing	–	For monitoring of activities in river basins
	Development of a "Decision Support System (DSS) for Sg. Selangor Basin"	LUAS	Met Malaysia	Ongoing	–	To support LUAS in its decision-making on water resources management in the Sg. Selangor basin
	Installation of radar sensor flow equipment at Jalan Raja Muda Musa, Bestari Jaya, Kuala Selangor	LUAS	DID Malaysia	Replace with water level sensor at Barrage Bestari Jaya and rainfall station	–	For the monitoring of river water level and flow for Sg. Selangor
	Release of triennial State of River Reports for Sg. Selangor (2006, 2008,2011), Sg. Langat (2008, 2011), Sg. Kelang (2008, 2011)	LUAS	All water related agencies	Ongoing (SOR 2015 for Sg. Selangor, Sg. Langat, Sg. Klang dan Sg. Bernam)	–	To identify the current status of the rivers

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
2. Planning	Five year strategy plans (2012–2016)	LUAS		Ongoing	–	Review plan for 2017–2021
	River basin management plans on Sg. Selangor, Sg. Bernam, and Sg. Langat	LUAS	DID Malaysia and all water related agencies	Ongoing	–	Inprogress preparing the Sg. Klang IRBM Plan. Sg. Bernam IRBM Plan in discussion stage with Perak
3. Economic and Financial Instruments	Fees for licences have been prescribed and gazetted for the issuance of licences	LUAS		Ongoing	–	For the following activities: Water Resource Abstraction; Resource Alteration Activity; Diversion of Water for Generating Electricity; Emission or Discharge of Pollutants; Inland Waterway Navigation; and Recreation
	Penalties and fines for various offences and breaches under the enactment have also been gazetted to facilitate enforcement proceedings	LUAS		Ongoing	–	
	Adoption of Payment of Ecosystem Services in river basin management	LUAS		Ongoing	–	Adoption also polluters pay principal in Emission or Discharge Pollutant License

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
4. Legal (Licences & Penalties)	Gazetting of Protected Areas: Tidal areas as protection zone for fire-flies habitat Zone of protection for wetlands, river reserves and environmentally sensitive coastal areas Catchment areas of the Sg. Selangor, Sg. Tinggi, Sg. Langat, Sg. Semenyih, Batu, Tasik Subang dams Alternative water sources — Five ponds, namely Kolam Saujana Putra, Daerah Kuala Langat; Kolam Labohan Dagang MC8 dan MC9, Daerah Kuala Langat; Kolam Petaling Tin, Bukit Cheding dan Kolam Agro-Tech, Olak Lempit; Kolam Sungai Rawang-Serendah, Daerah Hulu Selangor; and Kolam Taman Desa Anggerik, Daerah Hulu Selangor	LUAS		—	Completed: G.N dated 2 July 2009 and 29 April 2010 G.N. 1189 dated 29 April 2010 G.N. dated 2 December 2010 G.N. dated 2 November 2013	Alternative water resource at Bestari Jaya has been used for the operation of pumping from ex mining pond to Sg. Selangor to ensure sufficient water for the intake and also to optimise the release from dam
	Issue of Licences	LUAS		—	Completed	Licences issued by LUAS are required for the following activities: Water Resource Abstraction; Resource Alteration Activity; Diversion of Water for Generating Electricity; Emission or Discharge of Pollutants; Inland Waterway Navigation; and Recreation. The prescribed forms for the necessary licensing process have since been gazetted
	Penalties for Offences	LUAS		—	Completed	Imposition of fines and penalties for various types of breaches and offences under the SWMA enactment and quantum have been gazetted

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
5. Operation and Maintenance	Quarterly meeting of the Water Source Pollution Task force	LUAS	Various Government agencies, stakeholders with LUAS as the Secretariat	Ongoing	—	
	Quarterly meeting of the State's River Basin and Coastal Management Committee				—	
	Meeting of Water Source Emergency Committee to implement integrated action involving emergency stoppage of water treatment plants due to water source pollution or other causes				Completed	Referring to the "Manual Tumpahan Minyak dan Bahan Pencemar Ke Sumber Air"
6. Research and Development	Studies since 2006 on monitoring of Sg. Selangor firefly population	LUAS	FRIM	Ongoing	—	Continues study has been conducted by FRIM with LUAS until 2016. Firefly also an indicator of river's health.
	Studies pertaining to use of ex-mining ponds to serve as detention storage for flood overflows from Sg. Selangor		Various government agencies and stakeholders	—	Completed	Ex-mining pond as a storage during high flow and release to Sg. Selangor during low flow
	Groundwater exploration studies		Various government agencies and stakeholders	—	Completed	Planning to gazette the WHPA for ground water well
	Development of resources alteration activities charges and guidelines and BMPs to support water resources management in the state in accordance with SWMA enactment	LUAS	Various government agencies and stakeholders	Ongoing	—	
	Studies pertaining to prawn aquaculture in Selangor		Various government agencies and stakeholders	Ongoing	—	Reference for review of Emission or Discharge of Pollutant Regulation in 2016
	Sanitary study on Sg. Damansara		Stakeholders in basin and related agencies	Ongoing	—	The sanitary survey conducted in-house by LUAS staff

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
7. Awareness, Advocacy and Capacity Building	World Water Day Celebration	LUAS	Various government agencies and stakeholders	Yearly programme	1 programme yearly	Organised with co-operation of each participating local councils and district offices
	Qua-Qua Program	LUAS	NGO, IHLs, Schools, Public	Yearly programme	3 programmes yearly	Educating participants on the easiest way to measure the quality of river water
	River Cleaning Programme	LUAS	NGO, IHLs, Schools, Public	Yearly programme	3 programmes yearly	Conducted together with Qua-Qua Programme
	Mangrove Replanting Programme	LUAS	NGO, IHLs, Schools, Public	Yearly programme	3 programmes yearly	Educating participants on the importance of Mangrove as buffer on coastal area
	Beach Cleaning Programme	LUAS	NGO, IHLs, Schools, Public	Yearly programme	3 programmes yearly	Conducted together with Mangrove Replanting Programme
	River Adoption Programme	LUAS	Local councils, district offices, local communities	Yearly programme	1 programme yearly	To instil sense of belonging towards river preservation on the nearby communities

Appendix 5.5.3. NIWRM Strategy Plan and Implementation Road Map (LUAS): Management Instruments (continued)

Category	Strategy	Lead Agency	Collaborating Partners	Current Status	Target Completion	Remarks
7. Awareness, Advocacy and Capacity Building (continued)	Beach Adoption Programme	LUAS	Local councils, district offices, local communities.	Yearly programme	1 programme yearly	To instill sense of belonging towards beach preservation on the nearby communities
	Human Resource Strategic Plan 2013–2016	LUAS	JPA, SUK Selangor (BPSM), international collaboration	Ongoing	–	Human Resource Training Policy for Public Sector (Secular No. 6 of 2005) seven day per year. (Internal or external training)
	Conducting a review of the organisational structure every two years.	LUAS	BPO JPA, SUK Selangor (BPSM)	Ongoing	–	Career development and leadership for LUAS staff according Regulations Public Officers (Appointment, Promotion and Termination of Service) 2012 / P.U. (A) 1/2012
	Strategic Plan for the Prevention of Corruption	LUAS	SPRM, SUK Selangor (<i>Unit Integrity</i>)	Ongoing	–	Educating and increasing awareness of integrity
8. Participatory Management	Organisation Integrity Plan	LUAS	SPRM, SUK Selangor (<i>Unit Integrity</i>)	Ongoing	–	Educating and increasing awareness of integrity
	Firefly conservation project involving the Kg. Kuantan community in Kuala Selangor	LUAS	UKM and TNB Research Project with support by MDKS and LUAS		–	Completed
9. International Collaboration	Participation in the Network for Asian River Basin Organisations	LUAS		Ongoing	–	Participated in the NARBO's 2013–2014 “River Basin Organisations Performance Benchmarking” programme

Appendix 5.5.4. NIWRM Strategy Plan and Implementation Road Map (LUAS): Investments in Water Infrastructure

Water as a Resource							
Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
1.	Development of Information Management System and Decision Support System: i) Installation Online Water Quantity and Quality Monitoring ii) Integrated Water Resources Information Management System iii) LUAS Intelligent Support System	LUAS	Water operators and line agencies (MET and DID)	Based on Priority: i) Sg. Selangor ii) Sg. Langat iii) Sg. Bernam/Sg. Tengli iv) Sg. Klang v) Sg. Buloh	RM4M per river	11MP and beyond	The installation of water quantity and quality monitoring of Sg. Selangor to be completed in 2016 Development of IWRIMS and LISS have been completed and ongoing for updates
2.	Development of IRBM Plan	LUAS	Water operators and line agencies (MET and DID)	Based on Priority: i) Sg. Selangor ii) Sg. Langat iii) Sg. Bernam/Sg. Tengli iv) Sg. Klang v) Sg. Buloh	RM1M per river basin	11MP and beyond	Sg. Selangor IRBM Plan has been completed and reviewed Sg. Langat IRBM Plan has been completed and will be implemented Sg. Bernam IRBM Plan is in negotiation with the State of Perak Study of Sg. Klang IRBM Plan is ongoing Completed IRBM Plans will be reviewed every 5 years
3.	Review of LUAS Enactment	LUAS	State LAs, Water operators and line agencies (MET and DID)	Review of Enactment	RM100k	11MP	Will be reviewed as required

Appendix 5.5.4. NIWRM Strategy Plan and Implementation Road Map (LUAS): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
4.	Unregulated Flow Storage System	LUAS	UPEN, Water operators and line agencies (MET and DID)	HORAS 3000 Project (Hybrid Off River Augmentation System) Implementation of HORAS i) Sg. Langat ii) Sg. Klang	RM700M RM800M –	11MP	Implementation of HORAS as detention storage for flood overflows from Sg. Selangor HORAS Sg. Langat to be implemented in 11MP. HORAS Sg. Klang study has been completed
5.	Water Sector Related Studies	LUAS	UPEN, Water operators and line agencies (MET and DID)	i) State of the River Report ii) Water Footprint Study iii) Guideline design for Jetties iv) Water Allocation Study v) Guidelines for the Development of Coastal Zone	RM250k for each river basin RM1M RM500K RM1M RM500k	11MP and beyond 11MP 11MP 11MP 11MP	Reviewed every 2–3 years
6.	Gazettement of River Reserves and Groundwater Resources	LUAS	UPEN, JUPEM, JMG, Land Office	i) River Reserves ii) Groundwater wellhead Protection	RM1M per year RM200k per MP	11MP and beyond	Gazettement of all river reserves up to 5th Tier Tributaries Groundwater protection by phases

Appendix 5.5.4. NIWRM Strategy Plan and Implementation Road Map (LUAS): Investments in Water Infrastructure (continued)

Item	Water Infrastructure Development Programme	Lead Implementing Agency	Collaborating Partners	Entry Point Projects	Estimated Cost	Target Completion	Remarks
7.	Awareness Raising, Advocacy and Capacity Building	LUAS	UPEN, line agencies, NGOs, Water Operators, IHLs, Schools, Communities	i) Qua-Qua Programme ii) Beach and River Cleaning Programmes iii) Beach and River Adoption Programmes iv) Mangrove Replanting Programme v) State Level World Water Day Celebration vi) Human Resources Capacity Building vii) Organisation Structure Review viii) Organisational Integrity Plan	RM100k per year	11MP and beyond	Human Resources Strategic Plan 2013 - 2016 Including strategic plan for the prevention of corruption
8.	Projects involving Participatory Management	LUAS	UKM, TNB, MDKS, FRIM, Local Community, Resort operators	Firefly conservation project in Kuala Selangor	RM300k per year	11MP and beyond	In accordance to the IRBM Plan for Sg. Selangor
9.	Flood and Drought Mitigation	LUAS	Line agencies (DID)	i) Structural and non-structural flood mitigation works ii) Developdrought infrastructure and alternative water sources	RM 1,000,000 per year	11MP and beyond	Installation of new hydrological monitoring station will be implemented by stages according to priority. Its complement the existing station by DID and DOE. However, structural and non-structural measure for flood mitigation still under DID
10.	Rehabilitation Programmes	LUAS	Line agencies (DID)	i) Rivers and Lakes Rehabilitation projects ii) Conservation projects iii) Urban landscape projects	RM 100,000 per year	11MP and beyond	



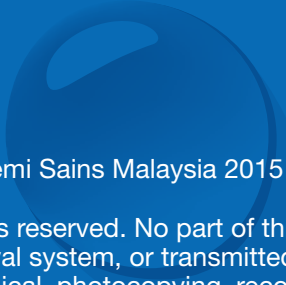
Appendix to Chapter 6.

Transforming the Water Sector: National Integrated Water Resources Management Plan – Strategies and Road Map

6.5 National Key Priority Area (NKPA) on Water

A NATIONAL KEY PRIORITY AREA (NKPA) ON WATER

FULL REPORT



©Akademi Sains Malaysia 2015

All rights reserved. No part of this publication may be produced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior permission of the Copyright owner.

ADVISORY REPORT 1/2015

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ASM Advisory Report 1/2015 : A NATIONAL KEY PRIORITY AREA (NKPA)
ON WATER.

ISBN 978-983-2915-18-8

1. Water resources development--Research--Malaysia.
 2. Water quality management--Research--Malaysia.
 3. Water-supply--Malaysia. I. Akademi Sains Malaysia.
- 333.91009595

CONTENTS

	Original Report Page Number	Vol 2 Report Page Number
FOREWORD	i	359
PREFACE	ii	360
ACKNOWLEDGEMENT	iii	361
EXECUTIVE SUMMARY	iv	362
LIST OF ANNEXES	xi	369
LIST OF TABLES	xi	369
LIST OF FIGURES	xi	369
LIST OF ABBREVIATIONS	xi	369
 PREAMBLE	 1	 371
1.0 Introduction	2	372
2.0 Objectives	3	373
3.0 The Water Agenda	3	373
3.1 The Malaysian Water Vision	3	373
3.2 The Malaysian Water Mission	4	374
4.0 Water NKPA Initiative	4	374
4.1 Global Investment Water Sector Scenario	5	375
4.2 The Malaysian Water Sector Scenario	6	376
5.0 The Government Transformation Programme (GTP)	8	378
6.0 The Economic Transformation Programme (ETP)	8	378
7.0 Economic Valuation of Water	9	379
8.0 A Water NKPA	11	381
9.0 Entry Projects (EPs) for Water Resources	12	382
9.1 Flood/ Drought Mitigations	13	383
9.2 Integrated Water Resources Management (IWRM)	13	383
9.3 Water Research and Innovation Cluster	14	384
9.4 Ecosystem Services	15	385
9.5 Climatic Change Adaptation	17	387

	Original Report Page Number	Vol 2 Report Page Number
9.6 Water Pollution Monitoring and Rehabilitation	17	387
9.7 Integrated Coastal Zone Management (ICZM)	18	388
9.8 Meetings, Incentives, Conference and Exhibition (MICE)	19	389
9.9 Water-based Recreation and Tourism	20	390
9.10 Waterfront and Water-sensitive City	20	390
10.0 EPs for Water Utilities	22	392
10.1 Water Supply Sector	22	392
10.2 Water, Wastewater and Energy Sector	24	394
10.3 Groundwater Development	25	395
10.4 Agricultural Water Management	26	396
10.5 Commercial Water to Shipping	27	397
11.0 Transformation Roadmap	28	398
12.0 The Way Forward	33	403
REFERENCES	34	404
ANNEX	37	407

FOREWORD

The Academy of Sciences Malaysia (ASM) is an independent think-tank providing strategic advice to the Government on matters relating to Science, Technology and Innovation (STI). Since 2008, ASM has been undertaking studies pertaining to the water sector in view of the importance of water as a resource and for livelihood.

Water is undeniably essential for economic development and societal well-being. Water as an important resource for agriculture and energy production has given rise to the Water-Food-Energy Nexus which has gained global recognition. In Malaysia, although water is recognised as an important natural resource, it is often not valued in a commensurate manner. One contributing factor could be the perception that water is readily available due to the country's abundant rainfall. However, given the increase in population, urbanization, industrial development and occurrence of extreme climates, there is an urgency to look into sustainable management of water in line with the internationally accepted Integrated Water Resources Management (IWRM) approach.

In support of the Government's efforts in providing sufficient water for the people and economic growth, ASM has prepared this Advisory Report for the consideration

of the Government. This report advocates that water be considered as a National Key Priority Area (NKPA) to not only duly recognise the role of water but more importantly, enable the uptake of STI interventions for water to significantly contribute to economic growth. A synthesised set of recommendations is also presented on how water, if recognized as a NKPA, can lead to the creation of more water sector market opportunities as well as collaborative partnerships to tackle water related challenges through STI, while safeguarding the country's water resources.

I would like to take this opportunity to congratulate the Working Group on Water as a NKPA for their dedicated efforts in producing this Advisory Report. I also wish to thank all stakeholders for their valuable input. I hope the recommendations in this report will be given due consideration towards enhancing Malaysia's water economy and security.



Tan Sri Dr. Ahmad Tajuddin Ali FASc
President
Academy of Sciences Malaysia

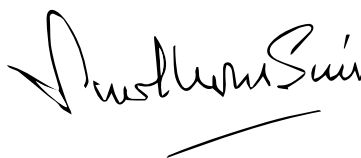
PREFACE

In 2010, the Economic Transformation Programme (ETP) was launched to propel Malaysia to a high income nation, targeting a gross national income (GNI) per capita of US\$15,000 by 2020. In order to achieve this target, twelve National Key Economic Areas (NKEAs) were selected as key prioritisation areas for the nation to promote investment and job opportunities. Water underlies all of the 12 NKEAs to varying degrees and scale. Some of the areas like agriculture rely heavily on the availability of water for growth and yet water was not explicitly recognised as NKEA.

As 2020 draws closer, it may be too late for 'Water' to be adopted as the thirteenth NKEA. Even so, ASM recognises the need for 'Water' to be prioritised perhaps as a National Key Priority Area (NKPA) to safeguard our water resources while promoting more investment and new jobs for 2020 and beyond.

Participation of representatives from various ministries, agencies and industries was instrumental in developing this Advisory Report. The successful completion of this Advisory Report would not be possible without the participation of these stakeholders in a series of strategic consultations and interviews organised by ASM. I would also like to take this opportunity to thank the Working Group members for their support and commitment.

We are confident that the 72 Entry Projects (EPs) recommended in this report would play a role in contributing to a higher gross national income (GNI), more investment opportunities and creation of new jobs for both public and private sectors in Malaysia, while providing a water secured future.



Dr Low Kwai Sim FASc

Chairperson

Working Group

National Key Priority Area for Water

ADVISORY AND WORKING GROUPS

The Academy of Sciences Malaysia (ASM) wishes to acknowledge the contribution of the following towards the Advisory Report on "A National Key Priority Area for Water".

ADVISORS

ASM Science, Technology & Innovation Policy Advisory Committee (STIPAC)

Academician Datuk Fateh Chand FASc

ASM Senior Fellow and Chair of the ASM Water Committee (until July 2015)

Academician Tan Sri Dato' Ir Hj Shahrizaila Abdullah FASc

ASM Senior Fellow and Founding Chair of the ASM Water Committee

WORKING GROUP

Dr. Low Kwai Sim FASc

ASM Fellow and Chair of the Working Group

Datuk Ir Mohd Adnan Mohd Nor FASc

ASM Fellow

Prof. Dr. Jamal Othman

Universiti Kebangsaan Malaysia (UKM)

The Working Group also appreciates the efforts of **Dr Engr Jamie Chong Li Yean** and **Chong Sim Chung**

ASM ANALYSTS AND COMMUNICATION TEAM

Nitia Samuel

Senior Analyst (Science Policy)

Vinod Gangatharan

Senior Executive (Science Communication & Information)

P. Loganathan

Research Fellow

Loh Chia Hur

Analyst (Science Policy)

Amirul Ikhzan Amin Zaki

Executive (Science Communication – Publications)

Mariatul Kibtiyah Silahudin Jarjis

Executive (Science Communication – Editor)

EXECUTIVE SUMMARY

Academy of Sciences Malaysia (ASM), an independent think-tank providing strategic advice to Government on Science, Technology and Innovation (STI) matters, has since 2008, been undertaking studies pertaining to the water sector considered strategic for the country's economic development. The studies have been overseen by a dedicated ASM Water Committee. Adopting IWRM as the central thrust and noting that Integrated Water Resources Management (IWRM) *per se* is a rather abstract concept, the Committee has for practical application in the Malaysian context, broken down IWRM into discrete subsets or sub-themes. Each of these subsets or sub-themes is then subjected to in-depth studies culminating in the preparation of a strategy plan or advisory report for consideration and adoption by the relevant authority or agency responsible for their implementation. The studies also undergo a process of strategic consultations with relevant institutional, community and private sector stakeholders.

This Advisory Report is prepared to underpin the Malaysian Water Vision and the Malaysian Water Resources Policy to realise the crucial role of water for life, national security and the economy. Because of the importance of water as a resource and for livelihood supporting all sectors of the economy, the ASM Water Committee while taking into consideration feedback from the Performance Management Delivery Unit

(PEMANDU) and other relevant stakeholders from the Ministries felt strongly that there is a compelling need to explore the concept and rationale of incepting water as a National Key Priority Area (NKPA) even though it is too late (short cut-off by 2020) to consider it for a National Key Economic Area (NKEA), as a way forward for a water secure economy in the country.

The main objective in this Advisory Paper is to develop a rationale for the water economy (resource and livelihood functions of water) as a NKPA associated with the critical complementary objectives for:

(a) **Water security in the country:** Water is life and therefore it is necessary to ensure that there is sufficient water for everyone, the economy and the environment. Water has to be regarded as an integral resource along the lines as for forests, fisheries and minerals with great potentials to contribute to man, the economy and societal development. Undeniably, the vagaries of climate in the form of severe droughts and floods have caused tremendous miseries to many people in the country for which water and water security have to be re-examined more strategically and convincingly for the common good within the boundaries of Federal and State legislations, and the related institutional structures in the country.

(b) **Water economic opportunities:** There is a need to unlock the vast potential investment opportunities through more efficient use of water and promoting scientific, technological and environmental solutions for water management amongst the multi and interdisciplinary water sector uses in the country, as propounded through the NKPA, with least disruptions to the environment.

So far, water per se is not valued as an important natural resource or its economic value recognised according to the ministerial stakeholders interviewed. There is a perception that water is readily available because the country has abundant rainfall, and therefore the rivers would presumably be able to provide all the water needed for one's livelihood and for resource. Strategic planning is now needed more than ever, not only to dispel such implausible profound thinking, but more importantly, to being prepared and resilient to all hazardous events due to climate change. There is a need for water resources to be managed professionally and holistically for the common good.

This Advisory Report advocates for a new paradigm approach to promote water as a NKPA, to give credence to the role of water and to enable strong scientific and technological contributions from the scientific and industrial community and collectively that they become part of the overall Economic Transformation Programmes (ETPs) to enlarge the water economy for the benefit of the country. For a start, the Advisory Report has provided a list of 15 large water programmes and 72 Entry Projects (EPs) to underline the importance of a water NKPA.

TRANSFORMATION ROADMAP

The objective of the roadmap is geared to emphasise the need for a Water NKPA as a strategic way forward in the new paradigm approach. It recommends a wide range of EPs; committed through appropriate policies and investments for a more water-energy-food secure nation. The 72 EPs are by no means exhaustive, but they represent a slew of diversified products for investments and programmes for the scientific and business community to consider (see **Table 1**).

The future of water, in terms of quantity and quality is highly uncertain, and some of this uncertainty is due to the vagaries of climatic conditions. However, the most critical factors are the key drivers of the water economy such as population growth, uncontrollable urbanisation and industrial expansion, low investments in water resources projects, indistinct allocation of water for various uses, reforms impasse in water management, as well as nominal scientific and technological innovations, all of which impede an efficient water future.

Water can and should be developed to get more from each drop. Water underpins food and energy security, and environmental sustainability. It is integrally linked to the health and survival of ecosystems, which helps to regulate the quantity and quality of water. A sustainable water scenario will dramatically increase the amount of water that can be allocated for environmental uses, connect all households to quality piped water, achieve lower per capita domestic water consumption, and sustain food and energy production, thereby achieving greater social equity and environmental protection.

The roadmap is divided into 15 water sector programmes, each with their EP Projects. Column 4 of **Table 1** indicates the timeframe to show that some EPs can be taken up immediately (one to three years) if the water agenda of having a NKPA is adopted, while others may take longer; midterm (five to nine years) and long-term (10 years) by the public and private sectors.

THE WAY FORWARD

There is no alternative to water resources unlike energy, which has alternative sources of energy. Presently, the country relies almost entirely on surface water (97%), and this situation is obviously untenable in the long run for water security reasons. At least five states are already facing water deficits that will require development of groundwater, but this source of water has yet to be developed although we have approximately 5,000 Billion Cubic Metre (BCM) of groundwater compared to 973 BCM of annual rainfall in the country.

The following are some recommendations to move forward:

- **Place water as a national water agenda:** A NKPA will definitively place water on the national water agenda, imperative for economic growth and development in the country. We have already experienced both flood and drought conditions that had affected food prices, caused energy disruptions, trade constraints, undermine the work of authorities and even create a lot of temporary water refugees at the schools and community halls – straining the resources of hospitals to cope with waterborne diseases. From a local flooding problem, it has escalated into a national issue and has become a major challenge in the country as shown in the December 2014 floods. Water shortage also causes a lot of hardships to a great deal of people, and has negative impacts on the tourism industry; tainting the good image of the country, as experienced in the April 2014 drought. Thus, from the perspective of a sustainable water future, we need to have a national water agenda to determine all aspects of water management for the country.

- **Promote Scientific and Research Agenda on Water:** In ASM's Mega Science 1.0 Study, 10 recommendations were put forward for wealth creation, which can easily be taken further through the 72 EPs proposed in the table below. The Mega Science 2.0 Study on the Environment Sector also advocated a new thinking on water management. A separate and detailed Advisory Report entitled "Setting a National Agenda for Integrated Water Research" has also been produced by ASM to emphasise the development of a water Research & Development (R&D) framework. However, what is more important is to ensure that our water security and water sufficiency is intact for all uses. In line with the above strategic thinking, there is also a need to achieve improvements in the ecological health of rivers, lakes, floodplains, wetlands and estuaries so that the many water sources and services they provide are maintained for the present and future use. It is increasingly difficult to argue for "a business as usual" scenario when the stakes are so high, and yet the responses to the water management issues around resource scarcity and the environment are so low, and hardly equal to the size of the problem.

- **Develop Water Benefits:** The industrial sectors will have to move beyond public relation benefits to give water sustainability a seat at the table. They are realising that the interrelated problems of food, energy and water threaten their own industrial sustainability and production, and there is a business opportunity in increasing efficiency and reducing wastes. The National Water Resources Policy 2012 is a tipping point in amplifying the need for actions to a whole new generation of water resources development programmes for securing water resources or short, medium and long-term horizons. There are policy directions for four core areas, namely, water resource security; water resource sustainability; partnerships; and capacity building and awareness; with a total of nine thrust areas and 69 strategic action plans, to move the water agenda forward for a secured future.

- **Water-Food-Energy Nexus:** Towards the end, we have to connect with the Water-Food-Energy nexus. At present, the food production does not commensurate with population growth (we have to import more than we produce) and the cost of food production is getting more expensive. Water, when not supplied at the right place and time needed for agricultural and energy production will only increase the cost of production and hardships faced by the people. In addition, the cost of energy production, which drives the economy, is also escalating at the expense of the consumers. This means that we have to strike a balance between the three legs of the nexus tripod. Water will be needed as a NKPA for the future survival of the country.

Table 1. Summary of Entry Projects (EPs) for a Water NKPA

Item	Water Sectors	Entry Projects	Uptake
Water As a Resource			
1	Flood/ Drought Mitigations	• Develop and improve flood forecasting centre and technology; • Structural and non-structural flood mitigation works; • Develop flood sensitive designs/ solutions for commercialisation; • Improve flood relief, response and recovery mechanism/ institutions; • Develop drought infrastructure and alternative water sources; and • Develop catastrophe insurance industry.	• Immediate • Immediate • Immediate to midterm • Immediate • Mid- to long-term • Immediate
2	Integrated Water Resources Management (IWRM)	• Set up IWRM Training Centers; • Setup RBOs for all major river basins; • Watershed management/ restoration programmes; • Develop Integrated Lake Basin Management (ILBM) and Integrated River Basin Management (IRBM); and • Develop transboundary water resources management.	• Immediate • Immediate • Immediate to midterm • Immediate • Midterm
3	Water Research and Innovation Cluster	• Set up a dedicated Water Research Centre; • Establish a Water Data Centre; • Developed Water Innovation and Industry Clusters; and • Develop Centres of Water Excellence in Local Academia.	• Immediate • Immediate • Immediate to Midterm • Immediate
4	Ecosystem Services	• PES framework and mechanism for Malaysia; • Watershed rehabilitation and management of river basins and resources; • Lake brief and management plans for Malaysian lakes; • Wetland restoration and management; and • Mangrove replanting and coastal protection.	• Immediate • Immediate • Immediate • Midterm • Midterm

Item	Water Sectors	Entry Projects	Uptake
5	Climatic Change Adaptation	• Establish a Regional Water Hub for Climatic Change Adaptation; • Weather and climatic change forecasting and modelling; • Climatic change adaptation; and • Carbon sequestration/ financing.	• Immediate • Immediate • Midterm • Midterm
6	Water Pollution Monitoring and Rehabilitation	• River Basin Pollution Management Programme; • Superfund for clean-up of polluted rivers in Malaysia; • Modernising water quality monitoring network; • Develop water quality modelling tools and infrastructure; • Community river management programmes; and • Pollution control at the source.	• Immediate • Immediate • Immediate • Midterm • Midterm
7	Integrated Coastal Zone Management (ICZM)	• ICZM/ Integrated Shoreline Management Plan (ISMP) Network for all Malaysian states; • Coastal Erosion Monitoring and Rehabilitation Programme; • Estuarine and Marine Fishery Management; • Offshore Sand Mining, Reclamation and Dredging Industry; • Coral Triangle Initiative (STI); and • Transboundary Pollution Monitoring.	• Mid- to long-term • Midterm • Immediate • Immediate • Mid-to long-term • Midterm
8	Meetings, Incentives, Conference and Exhibition (MICE)	• Develop Malaysia as a Water Hub; • Develop Malaysia as MICE for water sector/ industry; and • Host global/ regional/ national water events.	• Immediate • Immediate • Midterm
9	Water-based Recreation and Tourism	• Water tourism products; • Conservation of high-value tourism areas; and • Hosting of water-related events, competitions and festivals.	• Midterm • Immediate • Immediate to Midterm

Item	Water Sectors	Entry Projects	Uptake
10	Waterfront and Water-sensitive City	• Develop integrated urban water resource management; • Improve stormwater management; • Rainwater harvesting; • Water efficient design/ buildings; and • River of Life.	• Immediate • Immediate • Immediate to midterm • Midterm • Immediate to midterm
Water as a Utility			
1	Water Supply Sector	• Privatisation/ corporatisation of water supply sector; • Smart water network monitoring systems for non-revenue water reduction; • Improve urban and rural water supply infrastructure; • Develop water demand management initiatives; • Inter-basin water transfer schemes; and • Commercialisation of technology and expertise.	• Mid-to long-term • Immediate to midterm • Immediate • Immediate to midterm • Mid- to long-term • Mid to long-term
2	Water, Wastewater and Energy Sector	• Expand sewerage infrastructure and regionalisation of sewerage networks; • Waste to wealth – bio-effluent, bio-solids and bio-gas industry; • Potable and non-potable wastewater recycling; • Tertiary treatment for sewage to reduce eutrophication in public waters; • Develop industrial wastewater treatment systems; • Zero-discharge and zero-energy for wastewater facilities; • Hydropower development; and • Improving efficiency of water use in thermal power plants.	• Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term

Item	Water Sectors	Entry Projects	Uptake
3	Groundwater Development	• Groundwater mapping and abstraction; • Groundwater metering and licensing; • Groundwater recharge technology; and • Groundwater infrastructure and service sector development.	• Immediate • Mid- to long-term • Long-term • Immediate to midterm
4	Agricultural Water Management	• Water metering for irrigation areas; • Improve productivity of agriculture water; • Reuse of wastewater for irrigation; • Recycling systems for aquaculture industry; • Livestock waste treatment systems; and • Urban farming.	• Immediate to midterm • Immediate • Immediate • Immediate • Midterm • Midterm
5	Commercial water to Shipping	• Water supply for shipping; • Navigational channel and port dredging; • Ballast water monitoring, management and treatment systems; and • Urban water transport.	• Immediate • Immediate • Immediate • Immediate

LIST OF ANNEXES

Annex 1	– Malaysia Water Vision
Annex 2	– MegaScience Wealth Creation Vision
Annex 3	– List of NKEAs
Annex 4a	– Summary of findings from workshop
Annex 4b	– Summary of discussions from Stakeholder Engagements

LIST OF TABLES

Table 1:	Summary of Entry Projects (EPs) for a Water NKPA
Table 2:	Malaysian Environmental Market (2009)
Table 3:	Number of Programmes and Entry Projects
Table 4:	Estimated Costs and Benefits of Restoration Projects for Different Biomes
Table 5:	EPs for a Water NKPA

LIST OF FIGURES

Figure 1:	Global Water Industry Segments
Figure 2:	Malaysian Environmental Industry Segments (2009)
Figure 3:	Components of Economic Values of Water Resource
Figure 4:	Ecosystem Services
Figure 5:	Water-sensitive Cities Framework
Figure 6:	Global Growth Rates of Selected Water Sectors
Figure 7:	Population Equivalent (PE) Served by Sewerage Systems

LIST OF ABBREVIATIONS

ASM	– Academy of Sciences Malaysia
BCM	– Billion Cubic Metres
BO	– Business Opportunities
CTI	– Coral Triangle Initiative
DID	– Department of Irrigation and Drainage
EEZ	– Exclusive Economic Zone
EGS	– Environmental Goods and Services
E&E	– Electronics and Electrical
EP	– Entry Project
EPP	– Entry Point Project
ETP	– Economic Transformation Programme
GCM	– Global Circulation Models
GDP	– Gross Domestic Product
GIS	– Geographic Information System
GNI	– Gross National Income
GTP	– Government Transformation Programme
HTC	– Humid Tropic Centre
ILBM	– Integrated Lake Basin Management
ICZM	– Integrated Coastal Zone Management
ISMP	– Integrated Shoreline Management Plan
IRBM	– Integrated River Basin Management
IUWM	– Integrated Urban Water Management
IWK	– Indah Water Konsortium Sdn Bhd
IWRM	– Integrated Water Resources Management
KeTTHA	– Ministry of Energy, Green Technology and Water (Kementerian Tenaga, Teknologi Hijau Dan Air)
KPKT	– Ministry of Urban Well-being, Housing and Local Government (Kementerian Kesejahteraan Bandar, Perumahan dan Kerajaan Tempatan)
LUAS	– Lembaga Urus Air Selangor
MADA	– Muda Agricultural Development Authority
MJB	– Majlis Bandaraya Johor Bahru
MICE	– Meetings, Incentives, Conference and Exhibition

MKRA	—	Ministerial Key Result Area	WSIA	—	Water Services and Industry Act
MPIC	—	Ministry of Plantation Industries and Commodities	WWF	—	World Wide Fund for Nature Malaysia
MSMA	—	Manual Saliran Mesra Alam			
NEAC	—	National Economic Action Council			
NAHRIM	—	National Hydraulic Research Institute of Malaysia			
NERI	—	National Environmental Research Institute			
NEWRI	—	Nanyang Environment and Water Research Institute			
NKEA	—	National Key Economic Area			
NKPA	—	National Key Priority Area			
NKRA	—	National Key Result Area			
NRE	—	Ministry of Natural Resources and Environment			
NRF	—	National Research Foundation			
NRW	—	Non-Revenue Water			
NTU	—	Nanyang Technology University			
NUS	—	National University of Singapore			
NWRC	—	National Water Resources Council			
NWRP	—	National Water Resources Policy			
O&G	—	Oil and Gas			
PBAPP	—	Perbadanan Bekalan Air Pulau Pinang Sdn Bhd			
PE	—	Population Equivalent			
PEMANDU	—	Performance Management Delivery Unit			
PES	—	Payment for Ecosystem Services			
R&D	—	Research and Development			
RBO	—	River Basin Organisations			
ROL	—	River of Life			
SAJ	—	Syarikat Air Johor			
SCADA	—	Supervisory Control and Data Acquisition			
SCORE	—	Sarawak Corridor of Renewable Energy			
SMART	—	Stormwater Management and Road Tunnel			
SME	—	Small and Medium Enterprise			
SRI	—	Strategic Reform Initiative			
STI	—	Science, Technology and Innovation			
SWRC	—	State Water Resources Council			
SYABAS	—	Syarikat Bekalan Air Selangor			
TMDL	—	Total Maximum Daily Load			
WEHAB	—	Water, Energy, Health, Agriculture and Biodiversity			

A NATIONAL KEY PRIORITY AREA (NKPA) ON WATER

PREAMBLE

Malaysia has been committed towards the implementation of Integrated Water Resources Management (IWRM) for the sustainable management of the country's water resources since the late 1990s. The National Water Resources Policy formally launched in March 2012 further reaffirms the adoption of IWRM, which calls for the balanced development and management of "water as a resource" and "water for livelihood". Implementation of the IWRM agenda involves the integration of both natural and human systems set within an overall framework that provides the enabling environment with effective institutional arrangements and supported by necessary management instruments. Implementation of IWRM across all sub-sectors and levels of hierarchy are guided by the internationally endorsed 1992 International Conference on Water and the Environment (ICWE) Dublin Principles*.

Academy of Sciences Malaysia (ASM), an independent think-tank providing strategic advice to Government on STI matters, has since 2008, been undertaking studies pertaining to the water sector considered strategic for the country's economic development. The studies have been overseen by a dedicated ASM Water Committee. Adopting IWRM as the central thrust and

noting that IWRM per se is a rather abstract concept, the Committee has for practical application in the Malaysian context, broken down IWRM into discrete subsets or sub-themes. Each of these subsets or sub-themes is then subjected to in-depth studies culminating in the preparation of a Strategy Plan or Advisory Report for consideration and adoption by the relevant authority or agency responsible for their implementation. The studies also undergo a process of strategic consultations with relevant institutional, community and private sector stakeholders.

*The Dublin Principles on Water (ICWE 1992)

Principle No. 1 – Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle No. 2 – Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

Principle No. 3 – Women play a central part in the provision, management and safeguarding of water.

Principle No. 4 – Water has an economic value in all its competing uses and should be recognised as an economic good.

1.0 INTRODUCTION

This report was originally prepared as a Concept Paper for a case to incept water as a **National Key Economic Area (NKEA)** amongst the existing 12 NKEAs in the country. It was initiated by the Academy of Sciences in Malaysia (ASM) as early as March 2014, to provide the key rationale for this initiative as part of the Water, Energy, Health, Agriculture and Biodiversity (WEHAB) Programme. A series of meetings with relevant stakeholders have been held, culminating in two stakeholders workshops held on 3 April 2014 and 26 June 2014.

In the course of discussions with the relevant stakeholders in the Ministries, Performance Management Delivery Unit (PEMANDU) and amongst the ASM Committees on the subject, it was found that it might by now be too late to put water as an NKEA, the reason being the short cut-off entry points for all NKEAs by 2020 (less than 6 more years left). Nevertheless, according to PEMANDU, water is and should already be within most of the other 12 NKEAs although not explicitly stated, and therefore not necessary to have a separate water NKEA.

Because of the importance of water to livelihood and to all sectors of the economy, the 20th ASM Water Committee Meeting on 13th October 2014 felt that there is still a need to explore the concept and rationale of incepting of water, not as a NKEA, but as a **National Key Priority Area (NKPA)** because of its importance, as a way forward in the country. Underpinning this NKPA initiative is the vision to realise the crucial role of water for life, economy and our national security under the context of Water-Food-Energy nexus. Thus this Advisory Report will do the same, to examine the context and types of potential areas that could form the NKPA if it were to be **incepted** in the future.

Water is a renewable and finite resource. All our social systems and economic activities have placed a heavy demand on water. There are already indications that the renewable capacity of surface freshwater lags far behind its current rate of utilisation and the saying goes that tomorrow's water is being used to meet today's needs. Hence, in 1992 at the International Conference on Water and the Environment in Dublin, and later in the same year, at the Earth Summit in Rio de Janeiro, all Heads of States affirmed the economic value of water in all its competing uses and water was

recognised for its economic good. Since then, there was a strong water agenda covering all sectors of the social and political economy worldwide.

The concept of Integrated Water Resources Management (IWRM) as stated in the Preamble was established as an integral guiding principle for water conservation and development, by the Ministerial Declaration at the Hague in March 2000 as part of the **economic good of water**. The IWRM approach has now been accepted internationally and nationally (including Malaysia) as the way forward for efficient, equitable and sustainable development and management of the world's finite resources and for coping with conflicting water demands (United Nations International Decade for Action "Water for Life" 2005 – 2015).

Based on the above global scenario, Malaysia has reviewed the water agenda, taking the Waters Act 1920 as a base, to reflect on commitments to meet the nation's future water needs sustainably. The Waters Act 1920 is an archaic legislation that would need complete overhauling, indeed especially if Malaysia were to adopt the IWRM concept as a key approach for water resource management and to initiate and implement water reforms in water governance to professionally and effectively manage water.

The formation of the National Water Resources Council (NWRC) as an apex advisory and coordinating body for water resources in the country in 1998 is a milestone in water governance in the country. However, its full mandate to function effectively was and still is found wanting. By itself, it could not underline the full importance of the water sector, especially in sustainable water resource management. The major challenge faced by NWRC is the constitutional bond of Federal versus State jurisdiction. This gives rise to the fact that water is under the purview of the respective state governments, which control water resources but water utilities are under the concurrent list in the Federal Constitution, arising from the Water Services and Industry Act 2006 (WSIA). The WSIA 2006 is often impugned on for splitting the water sector into two; water resources and water for utilities, which subsequently placed water supply and services under the shared auspices of both the Federal and State governments. This is the present position of water management in the country, which poses a huge challenge to IWRM.

The "Review of the National Water Resources Study 2000 – 2050", recommended that each state establish a State Water Resources Council (SWRC) that is aligned to the NWRS to manage its water resources, which is under the state list. To date, some states have done so, such as Lembaga Urus Air Selangor (LUAS), Lembaga Urus Air Kedah (LUAN), Sarawak Water Resources Council and Sabah Water Resources Council, while Pahang, Perak, Negeri Sembilan and Johor have their own forms and functions in water management under various formats of privatisation and corporatisation (DID, 2012).

So far, in the water resources sector per se, water is still not valued as an important natural economic resource even with the gazettal of the National Water Resources Policy 2012 (NWRP). Water is not considered as a commodity that cuts across all sectors of the economy, which it should. The perception regarding water is that, it is readily available because the country has abundant rainfall and therefore integrated river basin management (IRBM) would presumably be able to take care of all the water requirements for utilities to tap on, and for everyone to use. This thinking has to be debunked because it is now a well-known fact that we are subjected to the vagaries of climatic change, and the long dry spell from January to mid-March 2014 is a testimony that everyone is affected by the climatic systems; and water resources will have to be managed professionally and holistically now for the common good.

An important change approach is to promote water as a NKPA, to give credence to the role of water and to enable strong scientific and technological contributions from the scientific and industrial community to be part of the overall Economic Transformation Programmes (ETPs), to widen the water economy for the benefit of the country.

2.0 OBJECTIVES

The main objective of this report is to develop a rationale for the water sector (resource and utility functions of water) as a NKPA. Associated with this main objective are the critical complementary objectives for:

- a) **Water security in the country:** where water is life and therefore it is necessary to ensure that there is sufficient water for everyone, the economy and the environment. Water must be regarded as an integral resource such as forests, fisheries and minerals

with great potential to contribute to the economy and societal development.

- b) **Water economic opportunities:** unlocking the vast investment potential opportunities of implementing the water NKPA for the country through more efficient use of water and promoting scientific, technological and environmental solutions for water management amongst the multi- and inter-disciplinary sectors in the country.

3.0 THE WATER AGENDA

The Water Agenda embodied in the Malaysian Water Vision and Mission spelt out the need for commitment to develop and manage water in a sustainable and equitable manner. To carry this water agenda forward, the water sector has to be one of the NKEAs or as a separate NKPA to play its full pivotal role as a socio-economic driver for the country; one which the government and the private sector would find it attractive to invest in and to develop.

3.1 The Malaysian Water Vision

The Malaysian Water Vision was a coalescence of many water policy statements formalised in 2000 as follows:

"In support of Wawasan 2020 (towards achieving developed nation status), 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 (details are in **Annex 1**) are as follows:

- (a) **Water for people** – all communities will have access to safe, adequate and affordable water supply, hygiene and sanitation;
- (b) **Water for food, agriculture and rural development** – provisions of sufficient water to ensure national food security and promote rural development;
- (c) **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;

- (d) **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
- (e) **Water for Energy** – this was 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.

3.2 The Malaysian Water Mission

Following from the Malaysian Water Vision, a National Framework for Action for Water Reforms was structured to achieve the key objectives of the Vision, entailing:

- (a) Managing water and water resources efficiently and effectively (addressing both quantity and quality aspects) as water demands increase in tandem with population growth and industrialisation;
- (b) Moving forward towards IRBM and ILBM taking full cognizance of river and lake basins as geographical units with well-defined boundaries containing the sum of all hydrological processes operating within them, and transcending political and administrative constraints, making them ideal water management units to address water problems;
- (c) Translating awareness to political will and capacities to create an enabling environment for the much needed institutional reforms to deal with deterioration of water quality, decrease in water availability and conflicts among users (irrigation, hydropower, industry and domestic users). There is also a need to instil awareness of the economic, social and environmental values of water among politicians, decision makers and all stakeholders; and
- (d) Moving towards adequate (safe) and affordable water services (befitting a developed nation status by 2020) through the provisions of adequate infrastructure for water delivery to all sectors of the economy.

Developing water as a NKPA is thus a continuum step towards realising the Water Vision as an integral component of the National Transformation Programmes moving in tandem with the other 12 NKEAs and Water Resources Policy to drive the country towards a high-income status, be competitive globally in the production of goods and services and to ensure water security in the country.

It is also part of the ASM Mega Science 1.0 Study which recommended water for wealth creation for the economy of the country (details of 10 proposals in Mega Science 1.0 in **Annex 2**).

4.0 KEY DRIVERS FOR A WATER NKPA INITIATIVE

The water sector is a fast growing socio-economic sector as population increases in the face of water becoming more variable and scarce. So far, Malaysia, like many countries, still focuses on supply-oriented approaches, drawing from a water system that is already stressed to meet water demands.

Increasingly, this approach is growing untenable, placing massive pressures on water resources that are already facing water quality impairments, affecting both human and ecosystem health. If nothing is done at present, the overall detrimental impacts will be enormous. It will constrain socio-economic development, lower the standard of living of everyone; and exponentially increase the cost of water source protection, water treatment and distribution, and rehabilitation of the environment.

The above scenario will need closer scrutiny on how best to reduce the pressures on water resources from the expected key drivers of the water NKPA Initiative. These are as follows:

- (a) **Population growth and urbanisation:** The dynamics of population growth will mean an ever increasing water demand. Investments in water resources and water infrastructure will have to increase in tandem with higher water consumption demand patterns; and investments will definitively play a major role in the water future.
- (b) **Industrial development:** Rapid industrial and manufacturing development will require an increasing supply of water, while development of thermal and hydropower infrastructure will require enormous amounts of water to generate electricity.

All these future development will have to be factored in the short to long-term water agenda.

(c) **Changing food demand and consumption patterns:** Feeding a growing population will raise the tension of stress on agricultural production, a sector which is the main consumer of water. Changes from traditional grain diet to higher protein/meat due to growing affluence will also add to the water demand in future.

(d) **Climatic change impacts:** Uncertainty in climatic change will require adaptation strategies to improve resilience to overcome issues of water availability and reliability, including issues of increasing risk of sea level rise and natural disasters (intense storms, floods and drought).

All the above will require effective water management with appropriate approaches on conservation, efficiency, re-use and replenishment of natural water sources and systems, where investments in water innovations and technology in water development, efficiency and sustainability, will play a large part. Singapore is an example of a country that has become a leader in water reclamation and recycling; Israel leads the world in irrigation efficiency; and Canada is internationally recognised for its water treatment technology.

The term coined for this water future is the 'Blue Economy' (Henderson & Parker 2012) but related to this, is the current paradigm shift in many countries to move away from dependency on 'blue water' which includes surface and groundwater, towards utilisation of 'grey water'. Grey water is now treated in many countries with innovative technology rendering it non-polluting to the water sources, rivers and seas. On the industrial front, the key focus is on water footprints of all industrial and manufactured products; a conservation index to account for water savings. Related to this is the water-energy-food nexus, which calls for a multi-faceted approach to improve efficient management of the three critical sectors to maximise the benefits for all end users and for national security reasons.

4.1 Global Investment Water Sector Scenario

Globally, the water industry generates a lot of investments in the business of managing water resources, water supply and wastewater treatment for various uses. An indication of the vast potential of water

as a NKPA in the economic development of the country include investments in:

- (a) **Utilities:** The whole sector of municipal water and wastewater services
- (b) **Infrastructure:** Equipment, technology and services to water utilities especially in the development of water treatment and sewerage infrastructure
- (c) **Services:** Consultancy, engineering, construction works
- (d) **Regulations:** Monitoring and regulation of environmental standards related to water quality and safety
- (e) **Technology Development:** Development of technology for treatment of water and wastewater, etc.
- (f) **Research and Development (R&D):** Constant R&D on water in research institutions and universities

The global water industry market is estimated to be within the range of USD\$360 billion with an annual growth rate of 4 – 5% (refer to **Figure 1**). The private sector market alone is worth USD\$229 billion, making it an attractive sector for investment. An example of the breakdown of the sector shows the scale of investments generated worldwide:

- (a) The majority of the market share, totalling USD\$185 billion, is for municipal services of which the private sector accounts for 20 – 22% (USD\$40 billion).
- (b) 26% – 27% (USD\$100 billion) are under consulting, engineering, construction operations and other services.
- (c) 21% – 22% (USD\$80 billion) are from sale of equipment and technology.
- (d) 2% – 3% (USD\$9 billion) are for residential treatment equipment.

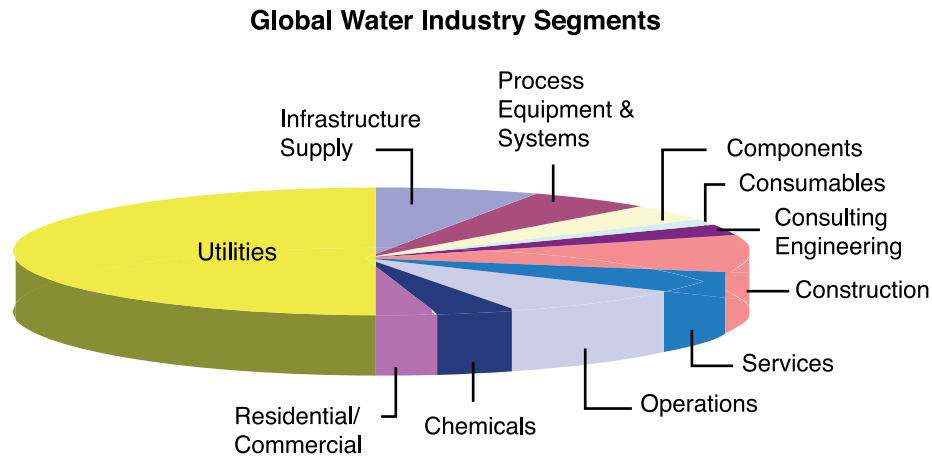


Figure 1. Global Water Industry Segments

Source: <http://www.snetglobalwaterindexes.com/market.html> n.d.

4.2 The Malaysian Water Sector Scenario

In terms of water business investments in Malaysia, it is far from being nondescript. The Environmental Goods and Services (EGS) sector (water, air and waste management, renewable energy, monitoring, analysis and assessment) for example, accounts for a major sector in the country’s economy (refer to **Figure 2**).

An analysis of 11 service and equipment segments under the EGS shows an estimated total revenue of RM 7,060 million in 2009 (1.38% of Malaysia’s gross domestic product), employing directly an estimated 29,700 workers in 2,700 private companies alone. This does not include those who are employed in the public sector that regulates and monitor the industry, where water plays an important role. In comparison, neighbouring countries such as Thailand and Indonesia, water (including electricity and gas) forms about 2.8% and 0.75% of their GDP respectively, compared to 3% in Canada and 1.38% in Malaysia.

The largest contributor to revenue and employment falls under environmental infrastructure service companies related to water utilities, wastewater treatment and waste management (76% of total EGS) (refer to **Table 2**). Thus, even within the country, water has already provided vast opportunities for investments in the economy.

Table 2 and **Figure 2** have not registered in the developmental potential of water resources yet, which is another vast area of opportunities in the water industry. There are over 90 large lakes and 189 major river basins in the country that are now requiring management, rehabilitation and restoration with potentials for passive and active development. All these are untapped investment opportunities awaiting public and private participation where the economic and financial rewards will be substantial, including the large multiplier effects and number of jobs that will be created. Thus, the rationale to have a specific water NKPA cannot be underestimated.

Table 2. Malaysian Environmental Market (2009)

Sector	Market Size (RM million)	No. of Companies	No. of Employees
EQUIPMENT			
Water equipment and chemicals	950	200	1,820
Air pollution control	180	80	270
Instruments and monitoring systems	170	60	320
Waste management equipment	300	140	580
SERVICES			
Solid waste management	1,800	1,100	14,400
Hazardous waste management (scheduled waste)	150	100	800
Consulting and engineering	340	290	1,550
Remediation/industrial services	70	80	280
Analytical services	150	60	750
Wastewater treatment (municipal and individual)	1,130	400	4,120
Water utilities	2,560	200	4,820
Core environmental goods and services	7,800	2,710	29,710

Source: Asia-Pacific Economic Cooperation Secretariat 2010

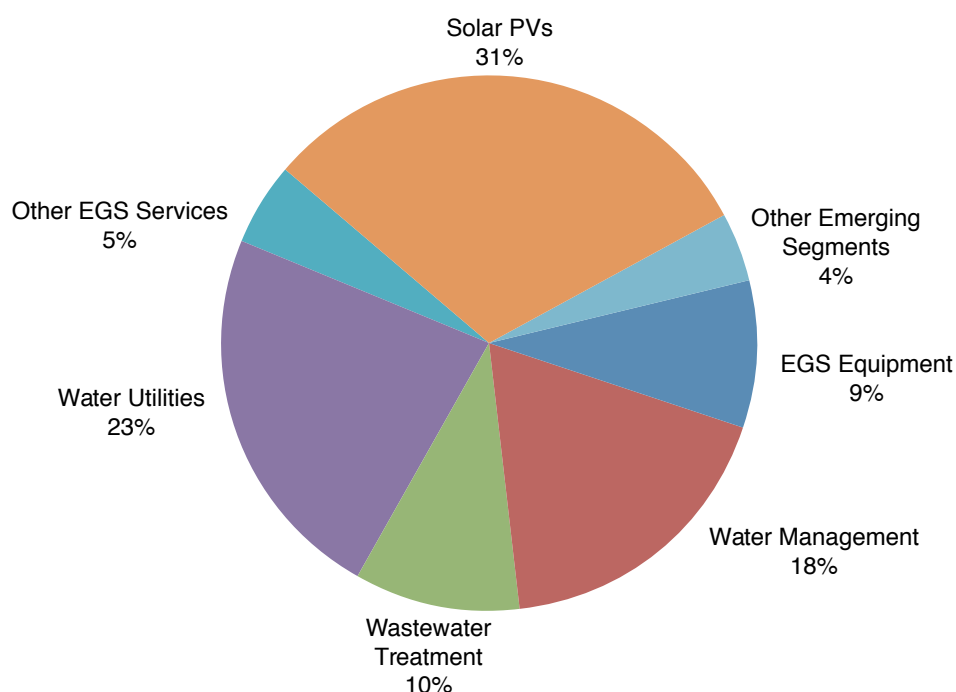


Figure 2. Malaysian Environmental Industry Segments (2009)

Source: Asia-Pacific Economic Cooperation Secretariat 2010

5.0 THE GOVERNMENT TRANSFORMATION PROGRAMME (GTP)

Since it is already too late to incept water as a NKEA, we have to look at water to becoming a potential NKPA, and for this we will have to reflect again on the **intent** of the GTP and the ETP.

The GTP, unveiled on 28 January 2010 by Prime Minister Dato' Sri Mohd Najib Tun Abdul Razak, is a broad-based programme of change to fundamentally transform the Government into an efficient and people-centred institution. The two main objectives of the GTP are:

- (a) **Priorities that matter most to the people** – this is where water is a good candidate, as it matters to everyone.
- (a) **Delivering fundamental changes on a nationwide basis** – time is ripe for a fundamental change in attitudes towards water conservation and sustainability through the IWRM approaches.

The GTP's structure is intuitive. It identifies areas that need the most attention, and to focus attention on the said areas. Of the seven pressure points, designated as National Key Results Areas (NKRAs) to improve the socio-economic growth of the country, water touches on at least five of the seven pressure points (in bold) by intent:

- Reducing Crime
- Fighting Corruption
- **Assuring Quality Education.**
- **Raising Living Standards of Low Income Households**
- **Improving Rural Development**
- **Improving Urban Public Transport**
- **Addressing Cost of Living**

The GTP also contains a Ministerial Key Result Area (MKRA) component, which addresses developmental goals not covered by the NKRAs, and which water can be considered too.

6.0 THE ECONOMIC TRANSFORMATION PROGRAMME (ETP)

The ETP was launched on 25 September 2010 as part of Malaysia's National Transformation Programme. Its goal is to elevate the country to a developed-nation status **by 2020**, targeting a gross national income (GNI) **per capita of USD15,000**. To achieve this, USD444 billion in investments is targeted, which will **create 3.3 million new jobs**.

The ETP's targets for 2020 will be achieved through the implementation of the 12 NKEAs (refer to **Annex 3**), representing economic sectors which account for significant contributions to GNI and job creation. The ETP is also centred on raising Malaysia's competitiveness through the implementation of six Strategic Reform Initiatives (SRIs), comprising of policies which aim to strengthen the country's **commercial environment** to ensure Malaysian companies are globally competitive.

The ETPs are driven mainly by the NKEAs and SRIs. The 12 NKEAs are as follows:

1. Oil, Gas and Energy	7. Wholesale and Retail
2. Palm Oil and Rubber	8. Education
3. Financial Services	9. Healthcare
4. Tourism	10. Communications Content and Infrastructure
5. Business Services	11. Agriculture
6. Electronics and Electrical	12. Greater Kuala Lumpur/ Klang Valley

As can be seen from the 12 NKEAs, water touches on all of them to varying degree and scale. Each NKEA has Entry Point Projects (EPPs), which explore new growth areas, and business opportunities (BOs), to enable the sector to move further up the value chain. To date, a total of 152 EPPs have been identified of which 149 have been announced from the 12 NKEAs.

As of 31 December 2012, the total investments for the 149 projects announced were RM211.3 billion although the GNI in year 2020 is targeted to be RM135.6 billion and jobs created are 408,443 (Annual Report on ETP, 2012).

Being one of the main contributor to economic development, water is assumed to have been omitted from NKEAs by default rather than by intent. The original process of developing the 12 NKEA sectors was based on a definition of 32 broad sectors by a classification of 71 National Account sectors, where **water was categorised under utilities**. Based on the GNI projection up to 2020, assessed on the basis of historical sector growth rates, global projected sector growth rates, and qualitative assessment of Malaysia's competitive advantage relative to sector best practice, **utilities was ranked 16th among the 32 sectors**, in terms of incremental GNI impact. Thus, water was omitted from the 12 key sectors or NKEAs and is only recognised as a key support utility.

However, it must be noted that putting **water under utilities**, limits the full potential and importance of the water sector; which has far wider ramifications in content and context, as it cuts across multiple sectors of the economy (refer to **Section 7** for further details). Even among the 12 NKEAs, the presence of water is widely embedded in all sectors such as the NKEAs for Greater Kuala Lumpur/ Klang Valley (Wastewater treatment plants, gross pollutant traps, sewage network improvements, River of Life), Tourism (ecotourism, resort development, Biodiversity Hub), Agriculture (seaweed farming, integrated aquaculture zones, Business sector (green technology development) and Oil, Gas and Energy (hydropower, renewable energy).

By just factoring in the water sector contributions alone in these existing 12 NKEAs, the true economic and financial value of water in these NKEAs is already significant. Secondly, in terms of water as a stand-alone NKEA, there will be substantial job creation and the GNI will also be high when the focus is on: (a) water as a resource and (b) water as a utility, whereby there are already substantial ongoing investments in the water utility sector. Therefore, rather than focusing on water solely under **utility** (which includes other non-water utilities), a reassessment of water **both as a resource and as a utility**, is necessary and indispensable because of its significance to the nation.

If water cannot be considered for a NKEA, then it should be considered as a NKPA either in the GTP or as a special component in the ETP, or in a separate state economy grouping all together, for all the reasons mentioned above and in **Section 7**.

7.0 ECONOMIC VALUATION OF WATER

Water serves two broad roles in the economy. First, 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 (refer to **Figure 3**).

So far, the economic value of water and its importance per se are not reflected accurately in the GDP, which are the reasons for it to be put under the category of utilities in the assessments for NKEAs. For example, in the Malaysian input-output table, water is not explicitly categorised in the economic sector of the economy. Its importance is only implicit under the waterworks sector, which encompasses the monetary value of all types of work activities involving the use and supply of water. Since all sectors in the economy use waterworks as an intermediate input to produce their respective outputs, this sector in turn, will also utilise inputs from other sectors.

This feature is clearly evident in the 2005 input-output table (latest), where waterworks constituted only 0.28% of the total intermediate inputs used by the economy, while its value-add was about 1% of GDP. The value of waterworks consumed by the final consumers was about the same as that of intermediate input. Related to this sector is water transportation (shipping etc.), which accounted some 1.6% of total intermediate inputs and 1% of total value added in 2005. This figure simply means that the financial cost of water provision as an input in the economic process is hidden by other intermediate values. Hence, reliance on such figures will only portray that the contribution of water to GDP is minute, relative to the other sectors.

It is clear that without water, the economy will cease to operate. Even so, not the entire value (cost) of water as an input is captured by GDP or GNI. Consider the huge amount of water, which is being used to produce paddy in our rice bowl areas. If water is supplied at a very low rate (or subsidised), then the cost of water as an

intermediate input (as reflected in our GDP accounts) in the paddy sector will be grossly underestimated and will be perceived to be unimportant, and hence, the perceived low value and unimportance of water.

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. It is similar to the case of agriculture where the external benefits from agriculture such as rural landscape and its role in protecting the vitality of rural resources, culture and heritage are not captured by GDP/GNI. Similarly, the benefits from the ecological functions of forest resource such as storm protection, coastal stabilisation and water catchments are not directly captured by GDP. Whatever

expenses incurred in the economy to protect the water resources such as pollution clean-up expenditures by the government due to oil spill or public defensive costs to maintain the resilience of our forest so that it will continue to provide the various ecological functions, including water catchment, goes to GDP through value added activities within the waterworks sector.

In short, the GDP/GNI will not be an appropriate indicator to reflect the real importance and value of water as an input as an environmental resource. Its importance in monetary terms may be reflected through other measures such as ecosystem valuation, productivity change or a production function approach.

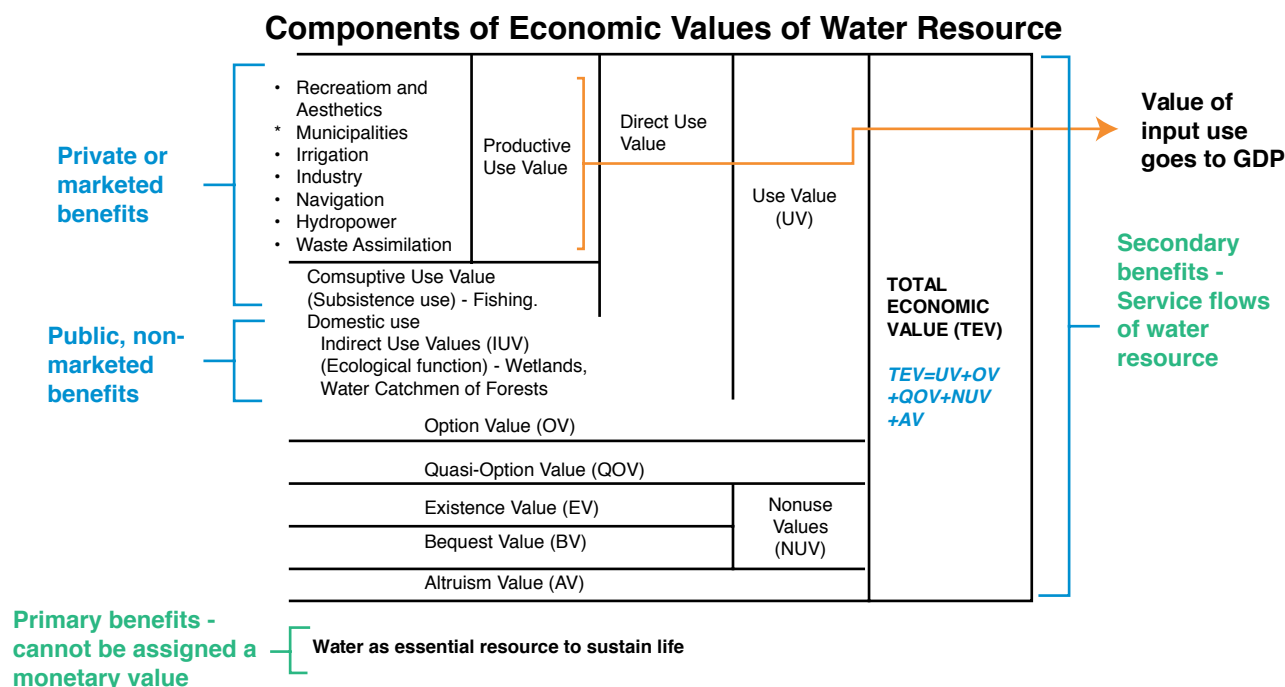


Figure 3. Components of Economic Values of Water Resource

Source: Jamal Othman 2014

8.0 A WATER NKPA

The water industry in Malaysia is big, but is fragmented, and therefore hidden due to traditional categorisation, such as manufacturing, construction, services, etc., whereas in other countries like the United States, the water industry is recognised as a distinct industry by itself, providing significant contributions to the nation's revenue and charts growth rates of 6 – 7% per annum. Other developed countries are already investing intensively in developing new and more efficient technologies and exporting these technologies and services such as Singapore.

In Malaysia, the water services industry alone can be a thriving business sector especially if it includes other water sub-sectors such as water resources, irrigation and drainage, sewerage, flood management, environmental management, groundwater, marine sector, etc. Likewise the push for greater adoption of Green Technology and on climate change adaptations increases the potential areas for investments, particularly to the Blue Ocean industry and services. The contributions of water to the non-marketed benefits are so significant that there should be mechanisms to incorporate the true value of water in the socio-economic chain, e.g. industrial water footprints and Payment for Ecosystem Services (PES).

Water can easily be embedded into the GTP and ETP as a NKPA, as it is undoubtedly an important resource in the country, similar to forests and minerals. It contributes substantially to the national GDP directly and indirectly (as seen in **Section 7**) via its stored resource areas, or through ecosystem services and through its use by the utilities under the water industry sector. It has a strong economic value chain of its own when it is used for water supply, sale of water to neighbouring country, tourism, agriculture, transportation, etc. Thus, water cannot be undervalued and should be an important component of the ETP similar to the other NKEAs such as for oil and gas, agriculture, tourism etc. In fact, a study of the main attributes of the existing 12 NKEAs indicates aspects that a water NKPA can also provide:

- (a) Inclusivity of employment for a broad spectrum of the population (e.g. wholesale and retail, business services, tourism, etc.);
- (b) Life, living and business comfort and sustainability development (e.g. Greater KL/ Klang Valley, etc.); and

- (c) GNI driver (e.g. in all 12 NKEAs).

Three policy principles in the NWRP 2011 will form the core rationale for a water NKPA:

- (a) **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 the environment. It has an intrinsic as well as a financial cost value that could be much higher than those of other economic sectors.
- (b) **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.
- (c) **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.

The core rationale will be discussed in more detail in **Section 9**, where potential EPs for NKPA have been identified under each water sector to meet the country's targets by 2020 and beyond (not in any order of priority). These EPs are divided into two components (a) EPs for water as a resource; and (b) EPs for water as a utility (refer to **Sections 9** and **10**, respectively).

In preparing and identifying the original EPPs for the Concept Paper for a water NKEA, two Stakeholder strategic consultative workshops were held (3 April 2014 and 26 June 2014) to get feedback from various government agencies as well as separate engagements with key ministries comprising the Ministry of Energy, Green Technology and Water (KeTTHA), Ministry of Natural Resources and Environment (NRE), Ministry of Urban Wellbeing, Housing and Local Government (KPKT), Ministry of Tourism and the Ministry of Plantation Industries and Commodities (MPIC) (details refer to **Annex 4a**).

The findings from the Workshops and engagements with the various Ministerial stakeholders affirmed that the timeframe is too short for a water NKEA, and therefore, this separate report was written as an Advisory Report to incept water as a NKPA (see details from stakeholders in **Annex 4b**).

9.0 ENTRY PROJECTS (EPS) FOR WATER RESOURCES

Altogether there could be as many as 15 large programmes and 72 EPs with water both as a resource and for utilities shown in the Table below with a brief description of each EPs.

Some of these were developed during the concept paper for the NKEA and from the recommendations of Mega Science 1.0 and 2.0 Projects to create new wealth opportunities using water such as ecotourism, market and export high quality water; clean water for aquaculture industry, Malaysian brand for domestic water purification unit; downstream water tapping; rainwater harvesting and zero pollutant discharge technologies. Many EPs point to new opportunities for investments, with R&D pushing the Science, Technology and Innovation (STI) frontiers to new levels in the water sectors. These are discussed in **Sections 9 and 10**.

Table 3. Number of Programmes and Entry Projects

Water Resources			Water Utilities	
Programmes		Potential EPs	Programmes	Potential EPs
1.	Flood/ Drought Mitigation	6	1. Water Supply Sector	6
2.	Integrated Water Resource Management	5	2. Water, Wastewater and Energy Sector	7
3.	Water Research and Innovation Clusters	4	3. Groundwater Development	4
4.	Ecosystem Services	5	4. Agricultural Water Management	5
5.	Climate Change Adaptation	4	5. Commercial Water to Shipping	4
6.	Water Pollution Monitoring and Rehabilitation	5	TOTAL	26
7.	Integrated Coastal Zone Management	6		
8.	Meetings, Conferences and Exhibitions	3		
9.	Water-based Recreation and Tourism	3		
10.	Waterfront and Water-sensitive Cities	5		
TOTAL		46		

9.1 Flood/ Drought Mitigations

Presently, there is heavy investment in structural measures for flood mitigation works including flood protection bunds, deepening river channels, bypass of flood pathways, flood retention ponds and flood retention dams. From 1971 to 2000, and from 2001 to 2005, RM 1.642 billion and RM1.790 billion respectively, were spent on structural flood mitigation measures. For the Ninth Malaysia Plan (2006 – 2010), allocation for structural flood control works escalated to RM3.834 billion and for the Tenth Malaysia Plan, estimates for flood mitigation works was RM17 billion. The Stormwater Management and Road Tunnel (SMART) for example, which was built to divert flood waters to control flooding in Kuala Lumpur, cost a total of RM1, 887 million (DID 2007).

The flipside to flooding is drought, which is worsened by ever increasing water demand from all sectors. The 1997/1998 (El Nino) drought crisis in the Klang Valley and the recent February/March 2014 drought have led to water rationing. Prolonged drought results in extensive environmental, economic and social impacts. This is because Malaysia depends exclusively on surface water sources such as rivers for its water supply while groundwater only accounts for 3% of total supply.

In terms of investments in flood/drought mitigation, structural works alone accounts for large amounts of government spending. While both structural and non-structural measures have been developed, floods and droughts still remain major risk factors in the country. Investments in effective flood/drought forecasting technologies would help in creating an early warning system and facilitate a proper response time to manage such crises.

As floods prevail, the private sector may have a large market to invest in. Improvements in disaster response, especially for flood/drought, is another avenue. Lastly, the insurance sector can potentially look into disaster insurance coverage as a growth sector.

Potential EPs:

- Develop and improve flood forecast centre and technology;
- Structural and non-structural flood mitigation works;
- Develop flood sensitive designs/ solutions for commercialisation;
- Improve flood relief, response and recovery mechanism/ institutions;
- Develop drought infrastructure and alternative water sources; and
- Develop catastrophe insurance industry.

9.2 Integrated Water Resources Management (IWRM)

The adoption of IWRM approach for sustainable management of water resources in Malaysia is well defined in the NWRP and the Malaysian Water Vision. IWRM implementation progress in Malaysia can be seen in the following areas:

- (a) Water laws have been streamlined especially on water resources and water services management. The Water Services Industry Act (2006) and National Water Services Commission Act (2006) have been gazetted while states such as Selangor, Kedah, Sabah and Sarawak have created their own state legislations for the said purpose.
- (b) River basins as a planning unit have been adopted to complement traditional spatial planning.

To actualise IWRM, sectoral programmes are developed for:

- (a) **IWRM Capacity-building:** Training centres to impart IWRM to water managers is required to improve on knowledge and skills.
- (b) **River Basin Organisations (RBOs):** Dedicated RBOs need to be set up to administer the various river basins throughout the country. This is to enable systematic management of river basins in line with IRBM practices. Such models should be based on

existing organisations, for instance, those already set up by LUAS for Sungai Selangor and Sungai Langat basins.

- (c) **Integrated Lake Basin Management (ILBM):** Lakes have not been well studied until recently through the National Lake Study by National Hydraulic Research Institute of Malaysia (NAHRIM), in association with the ASM, which has identified 90 major lakes within the country. This has led to the setting up of a National Lake Information Database for Malaysia and moving towards a strategic framework for the development and management of the Malaysian lakes.
- (d) **River Basin Restoration:** There are 189 big river basins, and some of which are in various degree of degradation, thus requiring integrated river basin or watershed management plans to be developed to restore them.
- (e) **Transboundary Waters:** Transboundary waters for Malaysia is not a significant issue as the country does not share any large water systems with neighbouring countries, with the exception of the Sungai Golok (Thailand and Malaysia), Straits of Johor (Singapore and Malaysia), Straits of Malacca (Indonesia and Malaysia) and groundwater aquifers within Borneo (Indonesia and Malaysia). However, these transboundary waters will still need innovative ideas to administer them especially when water is scarce.

Potential EPs:

- Set up IWRM Training Centre;
- Setup RBOs for all major river basins;
- Watershed management/restoration programmes;
- Develop ILBM; and
- Develop transboundary water resources management.

9.3 Water Research and Innovation Cluster

Malaysia has abundant water resources which can enable the country to position itself in the forefront of water and environmental technology and products. NAHRIM, for example, has been at the forefront of R&D in the field of hydraulics with research covering coastal and geohydrology. It is also involved in studying climatic and sea level changes through modelling, rainwater harvesting technology, tsunami modelling and forecast, lake assessment. Besides that, it has also been host to various forums, conferences and technical exchanges. Other research centres such as the Humid Tropic Centre (HTC) under DID and centres of excellence with Malaysian Universities, researching on water-related fields has also been established.

The Malaysian water industry will see further growth if it actively attracts collaboration from international, regional and local water companies to set up private sector investments and research centres within the country. In the spirit of how Penang and Kedah has been at the forefront in the E&E industry, Selangor for industrial development, and Terengganu as the O&G cluster, there should be greater investment to turn Malaysia into an attractive destination hub for water innovation and technology. In turn, these innovation clusters should have access and linkages with water laboratories, research centres and to the Academy, globally.

Singapore, for instance, has invested SGD470 million through the NRF into R&D, in the water sector and aspires to be a 'Global Hydrohub'. Funds are allocated to attract industries, venture capital and investors focusing on cutting-edge technology and research in water technology. The water sector is estimated to contribute a total of SGD1.7 billion by 2015 to Singapore's GDP while creating 11,000 new professional and skill-based jobs. Companies that were attracted include General Electric, Black & Veatch, Marmon Water and Pall Corporation from the United States; Nitto, Denko and Toray Industries from Japan; Siemens from Germany and Veolia and Suez from France. It has also managed to bolster local companies to become regional leaders such as Hyflux (global water and environmental solutions provider), SembCorp Industries (water utility company and waste management company) and Keppel Integrated Engineering (environmental engineering and technology). Academic collaborations with the industry are also well-developed with the formation of the Nanyang Environment and Water

Research Institute (NEWRI) at the Nanyang Technology University (NTU) and the National University of Singapore (NUS)'s National Environmental Research Institute (NERI). Both institutes are actively involved in urban environmental and water R&D in the field of membrane technology, environmental biotechnology, eco-efficient water treatment and smart sensing and engineering technology and to effect commercialisation of technology.

Malaysia should review its own home-grown water industry to determine potential sectors that need to be developed as well as key research areas to pursue. Rather than just be a consumer of "plug and play" technology from other countries, it is high time to develop our own local products and services, which can be exported to other countries instead.

Potential EPs:

- Set up a dedicated Water Research Centre;
- Establish a Water Data Centre;
- Developed Water Innovation and Industry Clusters;
- Develop Centres of Water Excellence in Local Academia;

9.4 Ecosystem Services

The ecosystem services framework (refer to **Figure 4**) as described in the Millennium Ecosystem Assessment (2005) indicates that assets and services provided by the natural environment can be divided into provisioning, regulating, cultural and supporting services. So far, only services related to provisioning services (water supply and extractive use) typically have market prices while many other ecosystem services provide non-market benefits.

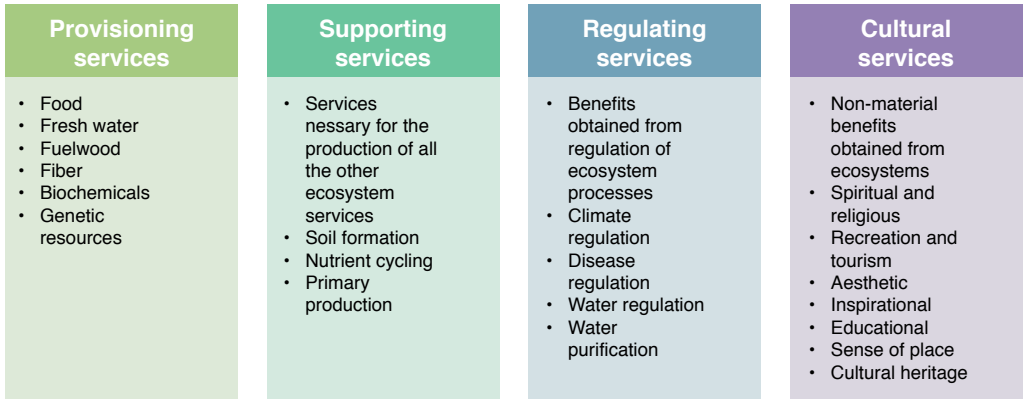


Figure 4. Ecosystem Services

The total value of the world's freshwater ecosystem services (including fish production, groundwater recharge and climate regulation) has been estimated to be worth USD\$5 trillion annually. In Asia alone, the economic value of services provided by river and lake ecosystems is about USD\$1.75 trillion per year.

One way to monetise the ecosystem is to define them as natural infrastructure (green infrastructure) which is defined as the strategic use of networks of natural lands, working landscapes and open spaces to conserve ecosystem values, functions and provisions

of associated benefits to the human population. These natural green infrastructures comprise forests, wetlands, riparian buffers and other natural elements of the landscapes. Through preservation and conservation, it can help generate income or to mitigate against costly infrastructure and rehabilitation needs (World Resources Institute 2013).

Natural green infrastructure investment can also include human built infrastructure that mimics replacements of the natural function of these ecosystems, such as rain gardens, green building

technology, green roof, water sensitive infrastructure and constructed wetlands.

The incidence of water pollution and rapid development in river basins may result in economic losses and reduction in the quality of life in the country. As such, the high ecosystem services value means that investing in maintaining the existing natural infrastructure would contribute significantly to the economy of the country, and it would be less than

the cost needed to remediate degraded waterways while reducing the need for extensive water treatment processes (refer to **Table 4**). Failure to recognise the actual economic value of ecosystem services often leads to widespread degradation and loss of ecosystem services.

Table 4. Estimated Costs and Benefits of Restoration Projects for Different Biomes

Biome/ecosystem	Typical cost of restoration (high-cost scenario)	Estimated annual benefits from restoration (avg. cost scenario)	Net present value of benefits over 40 years	Internal rate of return	Benefit/cost ratio
		US\$/ha	US\$/ha	%	Ratio
Coastal	232,700	73,900	935,400	11%	4.4
Mangroves	2,880	4,290	86,900	40%	26.4
Inland wetlands	33,000	14,200	171,300	12%	5.4
Lake/river	4,000	3,800	69,700	27%	15.5

Note: Adapted from TEEB (2009a)

Source: UNEP 2011

The mechanism for PES is not well-developed in Malaysia, and therefore a framework for PES must be developed. Primarily, the mechanism would involve incentive-based financing whereby custodians for natural infrastructure are compensated to conserve, sustainably manage and/or restore ecosystems to maintain their ecosystem services. Usually, this would entail downstream beneficiaries paying for upstream landowners.

A river basin ecosystem valuation was carried out by the WWF on the contribution of Ulu Muda Forest Reserve to water supply to the states of Kedah and Pulau Pinang. In 2005, the Muda catchment contributed RM157 million to Kedah and RM139 million to Penang, in terms of annual potable water supply. However the

annual profits to water supply companies does not take into account the ecosystems value, which extends beyond RM296 million. In terms of other uses of water such as irrigation input for farming, the calculated income benefit of the MADA irrigation scheme was estimated to be worth RM776 million in 2006 (WWF 2009). Overall, the total benefits that can be derived from water and ecosystem services are tremendous.

Infrastructure plays a critical role in water storage and treatment, but natural infrastructure investments can also reduce or avoid costs and enhance water services and security, complementing the necessary built infrastructure as part of an integrated system to deliver cost-effective and safe drinking water to the public (WRI 2013).

Potential EPs:

- PES framework and mechanism for Malaysia;
- Watershed rehabilitation and management;
- Lake brief and management plans for Malaysian lakes;
- Wetland restoration and management; and
- Mangrove replanting and coastal protection.

Potential EPs:

- Establish a Regional Water Hub for Climatic Change Adaptation;
- Weather and climatic change forecasting and modelling;
- Climatic change adaptation mechanisms for business; and
- Carbon sequestration/ financing.

9.5 Climatic Change Adaptation

Climatic change scenarios based on 15 GCMs have indicated changes towards precipitation, evaporation, soil moisture and run-off rates. Weather changes will lead to greater water variability; scarcity in some areas and higher precipitation rates in others. Impacts will be felt by major water resource systems and sectors including urban infrastructure (water supply and sanitation, urban drainage), water-related natural disasters (flood, droughts, landslides), rural development (agriculture, food security, livelihood), energy, transportation, health and the environment.

Due to the uncertainties brought about by climatic changes, which will increase the country's vulnerability and risk to water security, understanding the impacts of climatic change is essential to ensure adaptation measures can be implemented to buffer the mid and long-term impacts. Climatic change forecasting and modelling will be an important sector to consider in the immediate future to prepare for climatic change adaptations. A more accurate climatic change model for the country would allow assessment of the current water resources status, calculation of risks to ensure policy and decision-makers can carry out short and long-term planning.

It is inevitable that climate change adaptations to reduce the nation's vulnerability towards potential impacts would involve greater investments in the economy. This, in turn, would give rise to a whole new investment sector, which the government and private sector can be involved, essentially turning climatic change into an economic opportunity for innovative design and services.

9.6 Water Pollution Monitoring and Rehabilitation

Water pollution generated from urban, industrial, energy generation and agriculture results in severe water degradation. One major area of impact is polluted waterways, which supply nearly all of Malaysia's raw water for water supply, resulting in increased treatment costs and also water supply disruptions at times. The cost of rehabilitating polluted water is significant while ecosystem degradation also results in a loss of ecosystem services.

Existing pollution control laws in Malaysia mandate treatment of wastewater from industries, sewage treatment plants and landfills to ensure pollution is managed. This requirement is a driver for investments in effluent and wastewater treatment systems to effectively to meet the necessary standards. This market would further expand as tighter environmental regulations are introduced especially in the oil palm and rubber production sector to improve discharge of their waste products, and also for SMEs to improve wastewater discharge quality (currently, under the Environmental Quality Act 1974, the wastewater treatment requirement is only mandated to premises generating over 60 cubic meter of wastewater a day).

Another area that has not been fully explored is addressing non-point source pollution. Mandating TMDL control could spur the need for investments in point/non-point source pollution control, stormwater control, oil and grease recycling and other green infrastructure.

Nutrient pollution is a growing issue that would likely see more stringent limits in the future. There will be an emergent market to develop and introduce

advanced technologies for nutrient removal and recovery. At present, the majority of wastewater treatment plants apply secondary treatment (activated sludge, sedimentation tanks). Tertiary treatment such as nitrification and denitrification systems for nutrient removal to meet standards of 4 mg/L (Bosma 2013) is not fully developed.

The pollution monitoring network in Malaysia also needs to be upgraded to a more integrated and automated network rather than depending on manual sampling and analysis. The technology for automated monitoring of pollutants is readily available for adoption. Having such systems in the country would improve monitoring efforts significantly through improved data collection, faster data acquisition and analysis and allow for greater response time, faster sharing of information and facilitate improved decision-making by the relevant agencies.

Potential EPs:

- River Basin Pollution Management Programme;
- Superfund for clean-up of polluted rivers in Malaysia;
- Modernising water quality monitoring network;
- Develop water quality modelling tools and infrastructure; and
- Community river management programmes.

9.7 Integrated Coastal Zone Management (ICZM)

Malaysia has a coastline of 9,323 km, home to a significant number of people. The coastal areas have vast untapped natural and mineral resources, as well as high value ecosystems. Utilisation of estuarine and marine resources can provide jobs and alleviate poverty for coastal communities but it may also speed up depletion of these very delicate ecosystems through increasing pollution, habitat loss and degradation of the environment.

Investments in coastal and marine systems for most parts are exploitive/extractive activities including coastal development and reclamation, fisheries, marine trade and shipping, energy generation (seawater cooling), etc. Impacts on its hinterland also ultimately find their way to the ocean through conveyance via waterways

resulting in pollution accumulation, salinity intrusion and degradation of the ecosystem.

Developing sustainable utilisation of coastal and marine resources has been a cornerstone for nations bordering the South China Sea, whereby ICZM and ISMP were developed as an effective management framework. The development of ICZM and ISMP within Malaysia has yet to be fully developed with only several states having their own ICZM/ISMP plans including Sabah, Sarawak, Pahang, Johor and Penang.

Malaysia's coastline faces a host of issues including severe erosion, water pollution, loss of coastal forests and mangroves, saline intrusion into groundwater, overfishing, natural disasters (tsunami and flooding), river mouth siltation, coral bleaching, off-shore sand mining, mineral exploitation and unsustainable reclamation. Thus, there is an urgent need to address the problems by protection works, the setting up of coastal monitoring stations for better monitoring of coastal retreat/ accretion and allow for improved mitigation for critical coastal stretches. The last major undertaking was carried out by DID under the National Coastal Erosion Study 1985 and has yet to be updated (at present proposal is out for an update of the 1985 study).

While coastal erosion is a significant threat, it also provides opportunities for investment, particularly from the private sector. The key areas of participation would be in providing coastal structural solutions such as breakwaters, groynes, coastal armour and retention walls. Beach reclamation and reforestation of coastal areas are some of the non-structural measures to offset coastal erosion. In tandem, reclamation works are another significant sector especially in states like Penang, Malacca and Johor while dredging activities to ensure sustainability of ports, marinas and shipping channel are other avenues for private investors.

Coastal water pollution is another area requiring investments. While monitoring for rivers have been carried out, the coastal and marine water monitoring system can still be further developed, especially in terms of early warning systems, for instance oil spills. Frequent episodes of red tide and algal bloom due to nutrient inputs and *E.coli* contamination from human wastes also affect the fishery and tourism sectors. Transboundary monitoring networks with our neighbouring countries also can be improved, especially in the monitoring of pollution.

For ecological management, more sustainable fishery management is required, such as low-impact aquaculture, coastal and deep sea fishery stock management. The fishery industry is a multi-billion dollar industry that contributes significantly towards the national economy, and in case of a stock collapse, can prove severe for the fishery community dependent on the sector. Development of cage and tank culture for freshwater and marine fishery is also highly dependent on unpolluted water.

One major marine programme is CTI of which Sabah forms part of the multi-nation effort to preserve the important seascapes and its resources. The Sabah coastline is also home to many important high-value ecosystems such as coral reefs, marine parks, islands and seagrass and seaweeds beds, which generate income through ecotourism. The various national and regional programmes proposed under the CTI offer opportunities such as conducting of oceanographic surveys, fish management, research opportunities, aquaculture/ mariculture development, ecotourism and support many downstream industries.

Potential EPs:

- ICZM/ ISMP Network for all Malaysian States;
- Coastal Erosion Monitoring and Rehabilitation Programme;
- Estuarine and Marine Fishery Management;
- Offshore Sand Mining, Reclamation and Dredging Industry;
- CTI; and
- Transboundary Pollution Monitoring.

9.8 Meetings, Incentives, Conference and Exhibition (MICE)

The water industry has various conferences, events and platforms for governments, business communities and the public to participate in. Some of the major events include:

Event	Organisers
World Water Week	Stockholm International Water Institute
World Water-Tech Investment Summit	UK Trade and Investment
Water 2 Money – Global Water Investment Summit	EuroMoney Water Events
IWA World Water Congress and Exhibition	The International Water Association
International Young Water Professional Conference	The International Water Association
AQUATECH	Amsterdam Rai
Ozwater	Australia Water Association
International Congress on Water, Waste and Energy Management	C3/IPP (Portugal), Extremadura University (Spain) and Salamanca University (Spain)
Singapore International Water Week	Singapore International Water Week Pte Ltd
Asia Water Conference	United Business Media (M) Sdn Bhd
International Conference on Urban Drainage	Ministry of Natural Resources and Environment, DID, IWA, CEDEX
Malaysia Water Resources Forum	Malaysian Water Partnership
Water Malaysia	Malaysia Water Association

Source: <http://water-conferences.com/>

Business tourism generally focuses on high-yield travellers. The number of tourism arrival in 2012 was 25.03 million, with business related tourists amounting to 5% of the number, or 1.2 million. The expenditure from international business travellers accounted for RM11.0 billion (2012) while the economic impact value was estimated at RM18.2 billion (MyCEB 2014).

Promoting Malaysia as a water MICE centre will contribute to foreign exchange earnings, offer opportunities for trade and export promotion, increase Malaysia's international profile and exposure, promote business networking and collaborations, attract industry players and investors to the country, allow knowledge sharing, etc.

Malaysia already plays host to several internationally recognised forums such as the Malaysia Water Resources Forum and Asia Water Week. It will also host the International Conference on Urban Drainage in 2014. The goal of this sector is to bring higher profile events to the country, which would be attractive to the largest water industry players.

Potential EPs:

- Develop Malaysia as Water Hub;
- Develop Malaysia as MICE for water sector/ industry; and
- Host global/ regional/ national water events.

9.9 Water-based Recreation and Tourism

Water-based tourism in Malaysia covers a host of high-value tourism products that generate income to the country as well as provide jobs. These include:

- (a) **Water Theme Parks:** Legoland Water Park, Sunway Lagoon, A Famosa Water Theme Park, Bukit Gambang Water Park, Desa Water Park, Bukit Merah Laketown Water Park, Lost World of Tambun, Gold Coast Morib Water Theme Park, Water World I-City
- (b) **Cruise:** Star Cruises, Princess Cruises, P&O Cruises
- (c) **Island Resorts:** Redang Island, Tioman Island, Langkawi Island, Pangkor Island, Perhentian Island, Kapas Island Sipadan Island, Mabul Island, Turtle Island, Mataking Island, Labuan Island
- (d) **Beaches:** Batu Feringghi, Sepang Gold Coast, Morib Beach, Port Dickson, Cherating, Desaru

- (e) **Festivals/ Competitions:** Malaysia Water Festival, Labuan International Sea Challenge, Regatta Lepa, Royal Langkawi International Regatta, Penang Dragon Boat Race, International Pahang Rafting Expedition, Melaka River Fiesta, 1 Malaysia International Tourism Night Floral Parade, Sarawak Regatta

- (f) **White Water Rafting:** Padas and Kiulu (Sabah), Kuala Kubu Baru (Selangor), Ulu Slim, Gopeng and Grik (Perak)

Water ecotourism is an essential income earner for the country and to attract greater interest from tourists, new tourism products should be built while areas of natural beauty should be preserved to ensure their sustainability. Generally, ecotourism forms part of PES as tourism earnings compensates for the opportunity costs of conserving such areas as compared to land development.

Potential EPs:

- Water tourism products;
- Conservation of high-value tourism areas; and
- Hosting of water-related events, competitions and festivals.

9.10 Waterfront and Water-Sensitive City

Rapid urbanisation (currently at 71%) has led to the growth of urban centres, particularly those of the major conurbations of Penang, Kuala Lumpur and Johor Bahru. These areas are major centres of population, industry, institutions, commerce and services. The concentration of population within these urban centres results in stress to water supply, stormwater management, pollution, infrastructure provision and risks of urban related disasters.

The growth of cities undergoes several transition phases (refer to **Figure 5**), which includes meeting basic water and sanitation needs to managing resultant runoff and finally evolving to include sustainability and water sensitive designs. Malaysia has succeeded in

providing water supply and sewerage infrastructure but has yet to undergo a transition to a more sustainable city development model.

Eco-design and the development of water sensitive cities not only focus on making infrastructure more water and energy efficient but also in the development of new technologies and innovation that are able to generate jobs and growth. In Europe, the Eco-design Directive Working Plan lists 12 major sectors for development, of which one major sector focuses on water efficient

devices and products (e.g. taps, showers, consumer products).

Turning cities that are currently intensive users of water and sources of pollution into a sustainable one, would entail a rethinking of cities acting as water catchments instead, to effectively closing the loop in the urban hydrological cycle. This can be done through minimising the use of water (through water demand management) while improving on reuse of wastewater for non-potable use (toilet flushing, irrigation) and capturing stormwater run-off. One such existing example is Singapore.

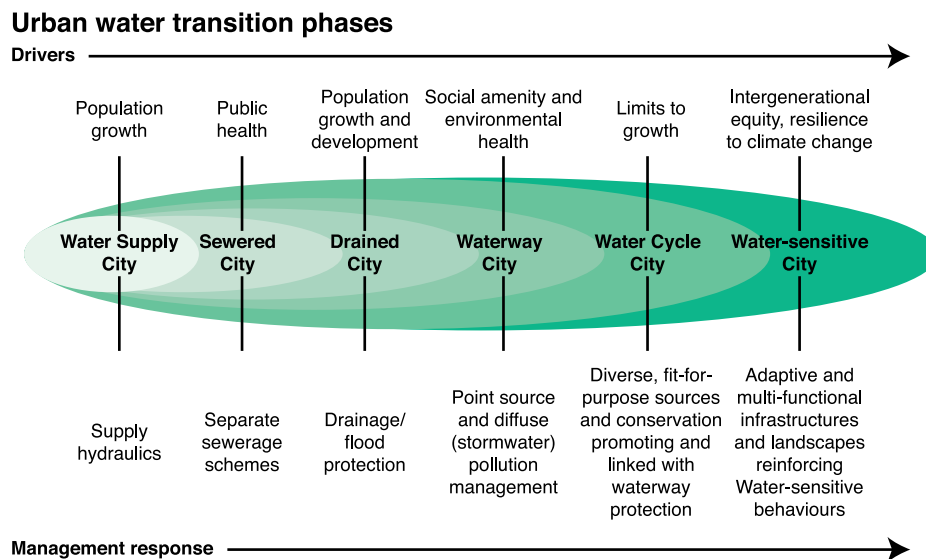


Figure 5. Water-sensitive Cities Framework

Source: Wong & Brown 2009

In terms of IUWM, several key areas of investments include:

- Stormwater management** in Malaysia has progressed from mainly infrastructure intensive conveyance of stormwater from cities to more sustainable and environmentally-friendly management of run-off as espoused through *Manual Saliran Mesra Alam (MSMA)*, published by the DID. Stormwater capture and reuse is another avenue to increase available water resources, coupled with water pollution controls and catchment management, similar schemes to those implemented in Singapore, such as the clean up of Marina Barrage and Kallang River which could increase water resource reserves
- Implementation of rainwater harvesting systems for residential, commercial and institutional land use to maximise water capture while reducing stormwater run-off. This should be coupled with water demand management through reuse of grey water and adoption of **water efficient utilities** (washing machine, shower heads, sprinkler systems and toilets). Six states (Perak, Selangor, Johor, Malacca, Kelantan and Perlis) in Malaysia have provisions under the Uniform Building By-laws 1984 to make rainwater harvesting systems mandatory in premises with 100m² of rooftop.

(c) The **River of Life (ROL)** is tied closely with the water sector as it encompasses river rehabilitation, beautification and riverbank development. The ROL and other similar river rehabilitation works can be a significant sector for Malaysia especially in the context of urban rivers. Similar programmes include the Malacca River Rehabilitation, which is now a major boon for tourism of the state. The Republic of Korea has invested in a USD17.3 billion project for the Four Major River Restoration Project, which is expected to create 340,000 jobs and generate USD31.1 billion in the economy.

(d) **Water sensitive design and eco-labelling** relates to improving the eco-efficiency of cities by optimising the benefits of water resources in the most beneficial way. Investing in water sensitive design and eco-efficient infrastructure makes sense as it could ultimately reduce the overall cost of water pollution and investments in conveyance, treatment and flood-mitigation systems.

Potential EPs:

- Develop integrated urban water resource management;
- Improve stormwater management;
- Rainwater harvesting;
- Water efficient design/ buildings; and
- River of Life.

10.0 EPs FOR WATER UTILITIES

10.1 Water Supply Sector

Water supply infrastructure is one of the most basic investments in the water sector. Rapid urbanisation requires ever greater investments to improve water storage, treatment, supply network, conservation and re-use. Worldwide, water supply and demand applications are estimated to be a USD450 – 500 billion (refer to **Figure 6**).

The water sector value chain can be divided into three main categories: infrastructure, treatment and utilities:

Water infrastructure

- (a) Pumps, pipes and valves (global growth of 2% to 4% and as high as 10% to 15% in emerging markets)
- (b) Water reuse, conservation and recycling equipment (global growth of 6% to 12% and as high as 16% in emerging markets)
- (c) Demand reduction products and metering infrastructure
- (d) Infrastructure projects (global growth of 6% but as high as 12% to 24% in emerging markets)

Water treatment

- (a) Chemical treatment for municipal/utility water sources as well as industrial water and wastewater
- (a) Filtration, membrane technology and desalination (growth rates of 15% to 20%)
- (a) Physical water treatment utilising technology such as ultraviolet and ozone disinfection. Ballast water treatment is an emerging market (global growth rates of 2% to 4% but can be as high as 20% in emerging markets)
- (a) Pollution monitoring and testing equipment (global growth rates of 5% to 7% but as high as 15% to 20% in emerging markets)

Water Utilities

- (a) Private investment in the water sector, such as water asset management, treatment and supply
- (b) Provision of expertise in water related sectors, such as engineering, operations, system provision, monitoring and consultancy

	Pump, pipes, valves	Water treatment equipment	Desalination, membranes	Water testing equipment	Irrigation	Water, wastewater project market
Global	2-4%	2-4%	15-20%	5-7%	6-12%	6-2%
China	10-15%	13.5%	26.0%	11%	14-16%	24.0%
India	>15%	15-20%	15-20%	15-20%	16.0%	12-15%

Figure 6. Global Growth Rates of Selected Water Sectors

Source: Impax Asset Management Limited 2013

Water infrastructure investments in Malaysia are significant, which encompasses dam construction, water treatment plants, water delivery networks and wastewater treatment plants. Large-scale projects such as the Pahang-Selangor water transfer project accounted for RM3.9 billion alone and generated many jobs related to its construction and down line supply chain such as material supply, equipment sales and machinery. Foreseeing greater water demands and deficits in Malaysia and in the absence in investments in alternative water supply schemes, inter-basin water transfer will be essential.

Large-scale and high-capital infrastructure works with good returns on investments will likely see active private sector interest to invest in the sector. Already water infrastructure development and supply in the country has been privatised or corporatised with the emergence of companies such as SAJ, SYABAS, Puncak Niaga Holdings, Ranhill Utilities and Konsortium ABASS.

Most of the companies are only involved in water treatment, which has high profit margins as they are not burdened in building infrastructure works or maintaining water mains/pipelines. A success story on privatisation is the case of Perbadanan Bekalan Air Pulau Pinang Sdn Bhd (PBAPP) due to the fact that it was involved in the entire spectrum of the water supply sector from catchment to consumers (Chan 2009). Aging water infrastructure, results in high loss of water through NRW.

In Selangor and Kuala Lumpur, for example, 40% of the distribution system comprise of old asbestos cement pipes with some sections as old as 35 years. Damage and inefficient infrastructure accounts for 40% to 60% of NRW in Malaysia alone, highlighting the urgency of replacing old infrastructure as well as new investments in more sustainable water delivery systems. Replacing the aging pipelines is estimated to require at least RM1 billion annually for capex cost alone (Vanitha Nadaraj 2014).

Smart water networks include fully integrated products, solutions and systems to enable water utilities to remotely and continuously monitor and diagnose problems, pre-emptively prioritise and manage maintenance issues, and control and optimise all aspects of drinking water network using data-driven insights (Bosma 2013). The drive for greater water efficiency would require investments in a whole new sector which includes:

- Instrumentation: Measurement and sensing devices (smart water meters, electromagnetic and acoustic sensors)
- Real time communication channels: For data gathering from sensing devices and instructing devices

- (c) Data management software: For processing data and visualisation with GIS, spreadsheets or graphs including work order management and customer information systems
- (d) Real time data analytics and modelling software for real time monitoring and analysing responses
- (e) Automation and control tools for conducting network management task remotely and automatically, such as the SCADA system

The technology is already made available by water sector companies such as Innovyze, Sensus, GE Water and Power IBM, Neptune and CH2MHILL, but it is not fully implemented in Malaysia. The benefits of the smart water network will be in addressing the high NRW in the country as well as to enable water utility companies to improve their services and costs by reducing economic losses and better optimise infrastructure performance and lifespan.

Potential EPs:

- Privatisation/ corporatisation of water supply sector;
- Smart water network monitoring systems for non-revenue water reduction;
- Improve urban and rural water supply infrastructure;
- Develop water demand management initiatives;
- Inter-basin water transfer schemes; and
- Commercialisation of technology and expertise.

10.2 Water, Wastewater and Energy Sector

In Malaysia, the wastewater is managed by the national concession company, IWK. Its services cover throughout Malaysia excluding Majlis Bandaraya Johor Bahru (MBJB), Kelantan, Federal Territory of Labuan, Sabah and Sarawak.

Many areas are also still not connected to centralised sewage treatment systems while rural areas mainly depend on pour flush, pump flush, individual septic tanks and non-mechanised sewage treatment systems (refer to **Figure 7**). Similar to water supply networks, aging sewerage pipelines also require costly replacements.

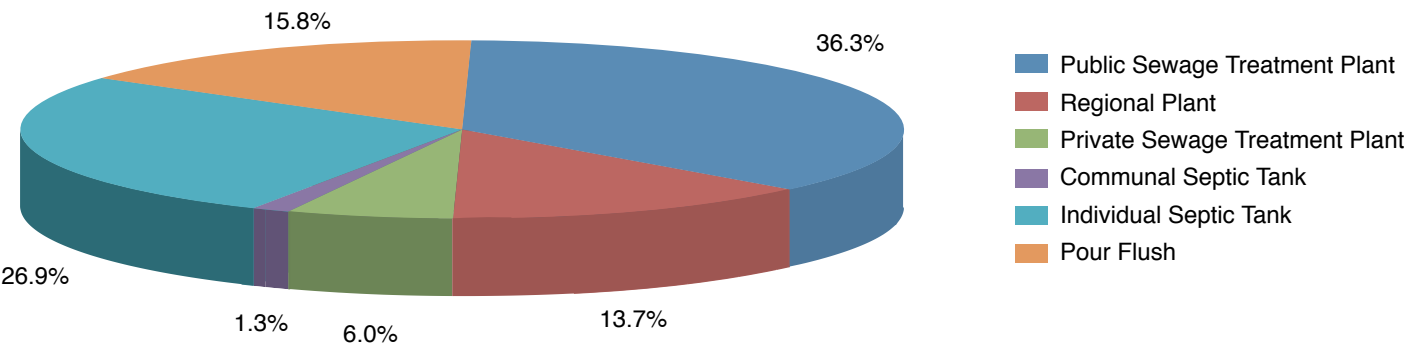


Figure 7. Population Equivalent (PE) Served by Sewerage Systems

Thus, the outlook for the sewerage industry as one of the growth engine looks promising as the need for sewerage network coverage and expansion are set to increase. Major works through sewerage catchment development strategies will see investments in infrastructure and upgrading work for sewage and sludge management facilities throughout the country. Another avenue that has not been developed in Malaysia is the connection of sullage streams into the sewer system and its eventual treatment.

In the past, wastewater from sewage treatment and industrial processes were treated as useless by-products that were flushed out into rivers, resulting in pollution. However, wastewater as a resource, is gaining attention as water scarcity increases and affects the profits. The wastewater treatment delivery equipment, instrumentation, process equipment and treatment market alone is estimated to be USD\$57 billion in 2011 and is expected to exceed USD\$93 billion by 2016, with an annual growth rate of 10.4%.

Resource recovery through wastewater reuse and recycling, biosolids production and energy recovery (biogas) would enable wastewater treatment plants to become resource generators and renewable energy generators. Technology exists to turn wastewater treatment plants that are capable of recovering the energy required to operate and could potentially fulfill 10% of national electricity demand (Water Environment Research Foundation).

Nutrient recovery through wastewater and sewer mining is a growing sector worldwide, driven by the need to reduce nutrient pollution to the environment. Economic drivers worldwide, such as the need to meet stricter environmental standards (nitrogen, phosphorus) and play a part in economising the reuse and recovery of material/wastewater. Capturing nutrients from wastewater would transform what would otherwise be waste products, into environmentally friendly and commercially viable fertilisers. Research and development have improved the types of materials that can be recovered through wastewater mining, including metals, thermoplastics, ammonia, hydrogen, methane, etc. (Bosma 2013).

Malaysia is still very much dependent on surface water treatment as a main source of water supply. In order to diversify the water resource supply, new sources must be tapped. One avenue would be to look at the potential for wastewater recycling as potable water

source (indirect potable use) to supplement rainwater and river capture supply. Malaysia has not invested much in membrane technology nor desalination and these technologies are still costly and require high energy inputs which are prohibitive with the current water pricing in Malaysia. However, with increasing water scarcity and supply, especially to urban areas, there may be markets to tap into such areas. However, if recycled water is not feasible for potable water supply, its utility as industrial water and agriculture water is still very much untapped.

In terms of hydropower development, Malaysia still has numerous potential areas for development of hydropower as a source of renewable energy. Hydropower forms only 15% of the total energy, and are from dams, the latest ones being Nenggiri (450 MW), Lebir (272 MW), Galas (108 MW), Ulu Terengganu (516 MW), Tekai (156 MW), Telom (91 MW) and Maran (109 MW) dams. Sarawak is planning 12 dams to support the Sarawak Corridor of Renewable Energy (SCORE) with a total capacity of 7,000 MW of electricity. For Sabah the only dam proposed has been the Liwagu (164 MW) Dam (Thahirah & Bodger 2009).

Potential EPs:

- Expand sewerage infrastructure and regionalisation of sewerage networks;
- Waste to wealth – bio-effluent, bio-solids and bio-gas industry;
- Potable and non-potable wastewater recycling;
- Develop industrial wastewater treatment systems;
- Zero-discharge and zero-energy for wastewater facilities;
- Hydropower development; and
- Improving efficiency of water use in thermal power plants.

10.3 Groundwater Development

Groundwater remains an untapped resource for Malaysia despite National Economic Action Council (NEAC) identifying the resource for development in 1998. To date, groundwater only accounts for 3% of the total of water utilisation in Malaysia, equivalent to 446 MLD.

Currently, industries use groundwater for their plant operations and cooling systems mainly in Selangor (groundwater abstraction is regulated through LUAS) while the major large-scale development of groundwater resources for potable use is in Kelantan. An initial private venture to develop groundwater at Batang Padang Perak by Sime Darby was planned. Other schemes mainly utilise artisanal wells or tube wells in Perlis, Sabah, Sarawak, Labuan, Pahang and Terengganu.

The development of groundwater in Malaysia would involve a whole new industry, which encompasses the entire supply chain from abstraction, treatment, supply and recovery as well as downstream industries supply construction materials, process systems and workforce requirements. Likewise, new developments in governance, regulatory mechanisms and legislation would have to be put in place.

Another area of groundwater development would be through conjunctive use of the resources, such as through river infiltration and aquifer storage and recovery, whereby rainwater, flood runoff or treated wastewater can be used to replenish the aquifers that have been reduced through abstraction activities. River Bank Filtration and Horizontal Collector Well technologies have been successfully implemented in Jeli, Kelantan and holds promise for similar use in the country. All these provide ample opportunities for public and private investments if the incentives are adequate.

Potential EPs:

- Groundwater mapping and abstraction;
- Groundwater metering and licensing;
- Groundwater recharge technology; and
- Groundwater infrastructure and service sector development.

10.4 Agricultural Water Management

Agriculture is one of the major consumers of water (70%), and with increasing need for food production, more water would be required in future. Traditional irrigation techniques are inefficient, where only 30% to 40% of the irrigation water going towards crop uptake, and the remainder is lost through evaporation

or leakage. Moreover, environmental degradation due to agriculture, especially from nutrient run-off and excessive drainage is becoming a challenge.

Previous water investments in agriculture involve infrastructure development especially in irrigation systems for wet paddy cultivation, allowing for double cropping to increase the yield per acre of field. There are eight major granary schemes in the country contributing 70% of the national rice output, comprising Muda, Penang, Kerian/Sungai Manik, Kerian, Sungai Manik, Seberang Perak, Barat Laut Selangor, Besut/Setiu, Kemasin-Semerak and Kemubu.

The Muda Irrigation scheme for example, has managed to improve irrigation efficiency up to 70% (2010) while the remaining schemes have efficiencies of 40% to 50%. To improve target efficiencies of 75% by 2050, irrigation water demand management will have to be implemented. While this can be done through non-structural measures, additional methods such as increasing water rates or installation of irrigation water meters have not received favourable responses.

However, water metering is vital for water resource management as it provides data on water consumption and enables detection of leakage, illegal connection and conveyance losses (major sources of NRW). Water metering schemes is viable if implemented in estates or large-scale commercial farming areas. In other countries wastewater is used for irrigation. New avenues for investments in the agricultural water sector encompass improving efficiency in irrigation through metering of water, improved conveyance and delivery methods (drip irrigation), changing crop management practices, groundwater recharge and the reuse of wastewater.

For non-paddy crops, major water users include fruits, vegetables and horticulture. Their water requirements would need greater research for better management of water that includes introduction of drought resistant variants, reduction of excess irrigation, soil conditions and ensuring crops are grown in suitable agro-climatic zones.

Livestock wastes are main sources of pollution in the river systems. Most of the waste treatment systems are primitive at best or non-existent altogether. Thus, to ensure that livestock wastes does not contaminate water, especially in the case of pig farming, a more

modern livestock management system must be developed. Some of the waste treatment systems available are structural in nature while other forms of natural treatment such as constructed wetland systems have been proposed. Clearly this is one agronomic sector that has yet to be looked into.

Potential EPs:

- Water metering for irrigation areas;
- Improve productivity of agriculture water;
- Reuse of wastewater for irrigation;
- Livestock waste treatment systems; and
- Urban Farming.

10.5 Commercial Water to Shipping

The shipping industry is a significant sector for Malaysia, which is located among one of the busiest marine lanes in the world, the Straits of Malacca. The major ports within the country are as follows:

Peninsular Malaysia	Sabah and Sarawak
• Port of Penang • Lumut Port • Port Klang • Port Dickson • Sungai Udang Port • Malacca Port • Tanjung Pelepas Port • Johor Port • Pasir Gudang Port • Kuantan Port • Kertih Port • Kemaman Port	• Kuching Port • Rajang Port • Bintulu Port • Miri Port • Labuan Port • Kota Kinabalu Port • Sepanggar Bay Oil Terminal • Kudat Port • Sandakan Port • Lahad Datu Port • Kunak Port • Tawau Port

The shipping industry needs a lot of freshwater supply for consumption and operations. The sale of freshwater to local and international shipping companies generates income to the nation.

Another aspect of water contribution to shipping is marine pollution. The shipping industry generates pollution through various sources. The most significant of which is ballast and bilge water, which have the potential to pollute coastal waters (from pollutants and from introduced species) if discharged without prior treatment. As Malaysia is a signatory to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (via Malaysian Shipping Notice MSN 04/2012), ships constructed after June 2012 with ballast water capacity of 5,000 cubic meters or more, are required to conduct ballast water management when operating within the country's Exclusive Economic Zone (EEZ).

In a sense, ballast water has yet to be viewed as a pollutant in the country, and thus, is largely unregulated and unmanaged. Many Malaysian ports are not equipped with ballast management and treatment facilities, and occurrences of illegal discharges in the marine waters. Infrastructure and technological development can include ballast water exchange systems, on-board treatment systems, port reception and treatment facilities and improvement in ship design.

Threats from uncontrolled ballast water may lead to harmful algal blooms and introduction of alien species which may result in degradation of high-value ecosystems along the coast; affecting the fishery and tourism industry. Dredging activities for development of ports, jetties and marinas is another major economic activity. Existing ports are also expanding to accommodate the new generation of super tankers such as Post-Panamax, which requires greater draft and space to manoeuvre. In other areas, tourism is expected to grow, which means increased demand in marinas, cruise terminals and airport extensions. Other factors such as potential deep sea mining and sand sourcing will drive demand for dredging.

Lastly, many cities are looking into investing into urban water transport. As part of public transport development, cities with rivers are exploring alternatives to landward transport and are considering water transport as a tenable option. Sarawak is the only major inland transport user for both passenger and cargos. Other markets for urban water transport include river cruises, such as those found in Malacca.

Potential EPs:

- Water supply for shipping;
- Navigational channel and port dredging;
- Ballast water monitoring, management and treatment systems; and
- Urban water transport.

11.0 TRANSFORMATION ROADMAP

The transformation roadmap is geared to the precise objective of contributing to a need for a Water NKPA, with recommendations involving a number of wide-ranging EPs, as shown earlier, committed through appropriate policies and investments for a more water-energy-food secure nation. The number of EPs is by no means exhaustive, but they represent the range of products for investments and programmes that the scientific and business community can undertake in the future.

The future of water is highly uncertain and some of this is due to the vagaries of climate. However, the most

critical factors are the key drivers of population growth, uncontrollable urbanisation and industrial expansion, low investments in water resources, indistinct allocation of water to various uses, impasse reforms in water management, and nominal technological changes.

Water can and should be developed to get more from each drop. Water underpins food and energy security, and environmental sustainability. It is integrally linked to the health and survival of ecosystems, which help to regulate the quantity and quality of water. A sustainable water scenario will dramatically increase the amount of water allocated to environmental uses, connect all households to quality-piped water, achieve lower per capita domestic water consumption, as well as sustain food and energy production. Thereby, achieving greater social equity and environmental protection.

A number of EPs have been summarised in **Table 5** for further discussions and refinement. The roadmap is inserted in column 4 of Table 4 to show that some EPs can be taken up immediately (one to three years) if the water NKPA is adopted, while others may take longer; midterm (five years) and long-term (ten year) for uptake by the public and private sectors.

Table 5. EPs for a Water NKPA

Item	Water Sectors	Entry Projects	Uptake
Water As a Resource			
1	Flood/ Drought Mitigations	• Develop and improve flood forecasting centre and technology; • Structural and non-structural flood mitigation works; • Develop flood sensitive designs/ solutions for commercialisation; • Improve flood relief, response and recovery mechanism/ institutions; • Develop drought infrastructure and alternative water sources; and • Develop catastrophe insurance industry.	• Immediate • Immediate • Immediate to midterm • Immediate • Mid- to long-term • Immediate
2	Integrated Water Resources Management (IWRM)	• Set up IWRM Training Centres; • Setup RBOs for all major river basins; • Watershed management/ restoration programmes; • Develop ILBM and IRBM (ILBM); and • Develop transboundary water resources management.	• Immediate • Immediate • Immediate to midterm • Immediate • Midterm
3	Water Research and Innovation Cluster	• Set up a dedicated Water Research Centre; • Establish a Water Data Centre; • Developed Water Innovation and Industry Clusters; and • Develop Centres of Water Excellence in Local Academia.	• Immediate • Immediate • Immediate to Midterm • Immediate

Item	Water Sectors	Entry Projects	Uptake
4	Ecosystem Services	• PES framework and mechanism for Malaysia; • Watershed rehabilitation and management of river basins and resources; • Lake brief and management plans for Malaysian lakes; • Wetland restoration and management; and • Mangrove replanting and coastal protection.	• Immediate • Immediate • Immediate • Midterm • Midterm
5	Climatic Change Adaptation	• Establish a Regional Water Hub for Climatic Change Adaptation; • Weather and climatic change forecasting and modelling; • Climatic change adaptation; and • Carbon sequestration/ financing.	• Immediate • Immediate • Midterm • Midterm
6	Water Pollution Monitoring and Rehabilitation	• River Basin Pollution Management Programme. • Superfund for clean-up of polluted rivers in Malaysia; • Modernising water quality monitoring network; • Develop water quality modelling tools and infrastructure; • Community river management programmes; and • Pollution control at source	• Immediate • Immediate • Immediate • Midterm • Midterm
7	Integrated Coastal Zone Management (ICZM)	• ICZM/ ISMP Network for all Malaysian States; • Coastal Erosion Monitoring and Rehabilitation Programme; • Estuarine and Marine Fishery Management; • Offshore Sand Mining, Reclamation and Dredging Industry; • Coral Triangle Initiative (STI); and • Transboundary Pollution Monitoring.	• Mid- to long-term • Midterm • Immediate • Immediate • Mid-to long-term • Midterm

Item	Water Sectors	Entry Projects	Uptake
8	Meetings, Incentives, Conference and Exhibition (MICE)	• Develop Malaysia as Water Hub; • Develop Malaysia as MICE for water sector/ industry; and • Host global/ regional/ national water events.	• Immediate • Immediate • Midterm
9	Water-based Recreation and Tourism	• Water tourism products; • Conservation of high-value tourism areas; and • Hosting of water-related events, competitions and festivals.	• Midterm • Immediate • Immediate to Midterm
10	Waterfront and Water-sensitive City	• Develop integrated urban water resource management; • Improve stormwater management; • Rainwater harvesting; • Water efficient design/ buildings; and • River of Life.	• Immediate • Immediate • Immediate to midterm • Midterm • Immediate to midterm
Water as a Utility			
1	Water Supply Sector	• Privatisation/ corporatisation of water supply sector; • Smart water network monitoring systems for non-revenue water reduction; • Improve urban and rural water supply infrastructure; • Develop water demand management initiatives; • Inter-basin water transfer schemes; and • Commercialisation of technology and expertise.	• Mid-to long-term • Immediate to midterm • Immediate • Immediate to midterm • Mid- to long-term • Mid to long-term

Item	Water Sectors	Entry Projects	Uptake
2	Water, Wastewater and Energy Sector	• Expand sewerage infrastructure and regionalisation of sewerage networks; • Waste to wealth-bio-effluent, bio-solids and bio-gas industry; • Potable and non-potable wastewater recycling; • Tertiary treatment for sewage to reduce eutrophication in public waters; • Develop industrial wastewater treatment systems; • Zero-discharge and zero-energy for wastewater facilities; • Hydropower development; and • Improving efficiency of water use in thermal power plants.	• Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term • Mid- to long-term
3	Groundwater Development	• Groundwater mapping and abstraction; • Groundwater metering and licensing; • Groundwater recharge technology; and • Groundwater infrastructure and service sector development.	• Immediate • Mid- to long-term • Long-term • Immediate to midterm
4	Agricultural Water Management	• Water metering for irrigation areas; • Improve productivity of agriculture water; • Reuse of wastewater for irrigation; • Recycling systems for aquaculture industry; • Livestock waste treatment systems; and • Urban farming.	• Immediate to midterm • Immediate • Immediate • Immediate • Midterm • Midterm
5	Commercial water to Shipping	• Water supply for shipping; • Navigational channel and port dredging; • Ballast water monitoring, management and treatment systems; as well as • Urban water transport.	• Immediate • Immediate • Immediate • Immediate

12.0 THE WAY FORWARD

As indicated in the Introduction for this Advisory Report, it is hoped that water can be a NKEA amongst the 12 NKEAs for the reasons and justifications given above. However, if water cannot be included as an NKEA because of the short-time factor, as indicated by all the relevant Ministerial stakeholders involved, then an alternative is to have the water sector as a **NKPA**, for the very same reasons stated earlier. The importance of water cannot be taken lightly as it is a part of life – without water, there is no life.

There is also **no alternative to water resources** unlike energy which can have alternative sources of energy. Presently, the country relies almost entirely on surface water (97%). This situation is obviously untenable in the long run for water security reasons. At least five states are already facing water deficits that will require development of groundwater, but this source of water has yet to be developed, although we have approximately 5,000BCM compared to 973 BCM of annual rainfall in the country.

A NKPA will definitively place water on the **national water agenda**, imperative for economic growth and development in the country. We have already experienced both flooding and drought conditions that caused severe ramifications on food prices, energy disruptions, trade constraints, undermining the work of authorities and even creating a lot of temporary water refugees at schools and community halls; straining the resources of hospitals to cope with water-borne diseases. From a local flooding problem, it has escalated into a national issue and has become a major challenge in the country. Water shortage has also caused negative impacts on the tourism industry. As a result, it has tainted the good image of the country. Thus, from the sustainable water future perspective, we need to have a national agenda to determine all aspects of water management for the common good.

The Mega Science 1.0 Study on Water has provided 10 recommendations for wealth creation, which can easily be taken further through the 72 EPs, as proposed earlier. However, what is more important is to ensure our water security and water sufficiency is intact for all uses.

There is also a need to achieve improvements in the ecological health of rivers, lakes, floodplains, wetlands and estuaries so that the many water sources and services they provide are maintained for the present and future use. Climatic conditions have become unpredictable and images of water variability are causing serious hardships to a lot of people in the country. It is increasingly hard to argue for "a business as usual" scenario when the stakes are so high, and yet the responses to the water issues around resource scarcity and the environment are dismal, as compared to the size of the problem.

The industrial sectors have also moved beyond public relations benefits to provide water sustainability prominence. They are realising that the interrelated problems of food, energy and water threaten their own industrial sustainability, and that there is gain to be made in increasing efficiency and reducing wastes in the environment. The **National Water Resources Policy of 2012** is a tipping point in amplifying the need for actions to a whole new generation of water resources development programmes for securing water resources or short, medium and long-term horizons. There are policy directions for four core areas, namely, water resource security; water resource sustainability; partnerships; and capacity building and awareness; with a total of nine thrust areas and 69 strategic action plans, to move the water agenda forward for a water secured future.

Towards this end, we have to tie in more closely at the Water-Food-Energy nexus. Presently, the agricultural sector is producing food at a rate that is not commensurate with population growth (we have to import more than we produce) and the cost of food production is getting more expensive. Water, not being in the right place at the right time needed for agricultural and energy production, will only increase the cost of production and hardships to the people. Moreover, the cost of energy production which drives the economy, is also rising at the expense of the consumers. It means one thing – we need to strike a balance between the three legs of the nexus tripod. Water will be needed as a NKPA if it cannot be an NKEA since agriculture and energy are both NKEAs.

REFERENCES

- Air Kelantan Sdn Bhd n.d., *Economics of Groundwater Engineering: Case Study of Groundwater Abstraction, Treatment and Supply, Based on Life Cycle Cost Analysis*, Air Kelantan Sdn Bhd, Kelantan.
- Asia-Pacific Economic Cooperation Secretariat 2010, *Malaysia Environmental Industry 2010 Case Study*, Asia-Pacific Economic Cooperation Secretariat, Singapore.
- Asian Development Bank 2012, 'Good Practices in Urban Water Management', eds Chiplunkar, A, Seetharam, K & Tan, CK, *Asian Development Bank*, Manila.
- Mohamed, Azuhan 2010, 'Promoting Sustainable Development and Management of Groundwater – Sime Darby Bhd Perspective', in *Workshop on Groundwater in the Context of IWRM*.
- Barilla Center for Food and Nutrition 2011, *Water Economy*, Barilla Center for Food and Nutrition, Italy.
- Bosma, MA 2013, *The Water Technology Sector in the United States: Examining Stakeholders, Trends and Opportunities in the American Water Technology Centre*, Netherland Office for Science and Technology, Washington, USA.
- Chan, NW 2009, 'Issues and Challenges in Water Governance in Malaysia', *Iran J. Environ. Health. Sci. Eng.*, vol. 6, no. 3, pp. 143-152.
- Kaur, Cheryl Rita 2008, 'Ballast Water Management in Malaysia: Issues and Concerns', in *International Conference on Biofouling and Ballast Water Management*, Gao, India, 5 – 7 February 2008.
- Department of Irrigation and Drainage 2007, *Flood and Drought Management in Malaysia*, Department of Irrigation and Drainage, Kuala Lumpur.
- Department of Irrigation and Drainage 2012, *Review of the National Water Resources Study 2010 – 2050*, Department of Irrigation and Drainage, Kuala Lumpur.
- Department of Irrigation and Drainage n.d., *Projects: Flood Forecasting and Warning System Programme*, viewed March 2014, <http://www.water.gov.my/index.php?option=com_content&task=view&id=272&Itemid=625>.
- Economic Planning Unit and United Nations Country Team, Malaysia 2011, *Malaysia: The Millennium Development Goals at 2010*, United Nations Country Team, Malaysia, Kuala Lumpur.
- EuroMoney n.d., *Untitled*, viewed March 2014, <<http://www.euromoneyenergy.com/Assets/22/6976/index.htm>>.
- Food and Agriculture Organisation n.d, *Malaysia's Water Vision – The Way Forward*. viewed March 2014, <<http://www.fao.org/docrep/004/ab776e/ab776e02.htm>>.
- Future Ready Singapore n.d., *Environment and Water*, viewed March 2014, <<http://www.edb.gov.sg/content/edb/en/industries/industries/environment-and-water.html>>.
- Henderson, R & Parker, NR 2012, *The Blue Economy: Risks and Opportunities in Addressing the Global Water Crisis*, Canadian Water Network, Canada.
- Impax Asset Management Limited 2013, *Investing in Water: Global Opportunities in a Growth Sector*, ed Gottelier, Simon, Impax Asset Management Limited, London.
- C, Mohamad Ismail, & Abd Karim, Mohammed Hatta n.d., 'Minerals and Geoscience Department of Malaysia', *Groundwater Availability and Quality in Malaysia*.
- Malaysian Convention and Exhibition Bureau n.d., *Untitled*, viewed March 2014 <<http://www.myceb.com.my/factsheets>>.
- Ministry of Health n.d., *Untitled*, viewed March 2014, <<http://www.moh.gov.my/index.php/pages/view/324>>.

Ministry of Natural Resources and Environment 2012, *National Water Resources Policy*, Ministry of Natural Resources and Environment, Kuala Lumpur.

S-Network Global Water Indexes n.d., *S-Network Global Water Indexes*, viewed March 2014, <<http://www.snetglobalwaterindexes.com/>>.

S&P Global Water Index n.d., *Untitled*, viewed March 2014, <<http://us.spindices.com/indices/equity/sp-global-water-index>>.

Searates.com, n.d., *Sea Port of Malaysia*, viewed March 2014, <<http://www.searates.com/maritime/malaysia.html>>.

Spring Singapore n.d., *Singapore's Water Industry Doubles to 100 Companies*, viewed March 2014, <<http://www.spring.gov.sg/NewsEvents/PR/2012/Pages/Singapore-water-industry-doubles-to-100-companies-20120607.aspx#UxVKXs7m6R4>>.

Syed Jalal, Thahirah & Bodger, P, 2009, 'National Energy Policies and the Electricity Sector in Malaysia', in *Proceedings of ICEE 2009 3rd International Conference on Energy and Environment*, 7-8 December 2009, Malacca, Malaysia.

Wong, Jack E 2014, 'Baram, Baleh Dams Get Go-ahead', *The Star Online*, 19 February, viewed March 2014, <<http://www.thestar.com.my/Business/Business-News/2014/02/19/Baram-Balleh-dams-get-goahead-Projects-will-raise-Sarawak-hydro-power-capacity-to-nearly-6000MW/>>.

Wong, T & Brown, RR 2009, 'The Water Sensitive City: Principles for Practice', *Water Science and Technology*, vol. 60, no.3, pp. 673-682

United Nations 2004, *World Population to 2300*, Department of Economic and Social Affairs – Population Division, United Nations, New York.

United Nations Environment Programme 2011, *Water: Investing in Natural Capital*, United Nations Environment Programme.

Nadaraj, Vanitha 2014, *Selangor Water Industry in Malaysia: The Privatisation that Leaked*, viewed March 2014, <<http://www.establishmentpost.com/selangor-water-industry-malaysia-privatisation-leaked/>>.

Water Conferences 2000, *World Water Vision*, World Water Council, Earthscan Publications Ltd, United Kingdom, viewed March 2014, <<http://water-conferences.com/>>.

World Resources Institute 2013, eds Gartner, T, Mulligan, J, Schmidst, R & Gunn, J, *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States*, World Resources Institute, Washington.

World Wide Fund for Nature 2009, 'A Background Study: Economic Benefits of the Muda Catchment', ed KF Lee, *World Wide Fund for Nature*, Malaysia.

Hashim, Zainab 2010, 'Development of Atmospheric Based Flood Forecasting and Warning System for Selected River Basins in Malaysia', in *National Seminar on Meteorology: Enhancing Weather and Climate Services*, 9 November 2010, Kuala Lumpur.

ANNEX 1 : MALAYSIAN WATER VISION

A1. WATER FOR PEOPLE

Water for people is equated to access of good freshwater for basic use. The main challenge is access to fresh clean potable water. Water pollution has become a major problem in the country and many of the rivers are polluted. Statistics from the Ministry of Health Malaysia (2002) revealed that vector-borne diseases such as dengue fever, dengue haemorrhagic fever, malaria and typhus remain major concerns. Meanwhile, diseases such hepatitis A, hepatitis E, cholera, typhoid, dysentery and food poisoning still persist, and are increasing – impairing the quality of life, imposing financial burdens on households, and limiting the people's income-generation opportunities.

A2. WATER FOR FOOD AND RURAL DEVELOPMENT

Agriculture is the biggest user of water, accounting for almost 70% of all water withdrawals and is a major non-point source polluter of water in Malaysia. The main issues faced are low efficiency of water use and the disproportionate balance of water versus its economic value. Water losses in the production of food crops, for instance, can be as high as 50%, whereas a large volume of water is withdrawn and lost (such as through evaporation). This is often not accounted for in the

total economic value of water. By factoring in on virtual water to account for total water used to generate the economic products and water loss, very often the cost of agricultural products sold in the markets are less than the cost of water used in its production. This results in a disproportionate balance of the true value of water versus the economics of agricultural production in the country.

As water security is closely linked to food security, and food security is linked directly to population growth, any increase in population will generate a demand for more food and water. Population in the country has already risen to 26 million in the 2010 Census, and is projected to increase to 42 million by 2050 (medium range projection, in NWRS, 2010), both water and food demands will be escalating.

Water for food also encompasses livestock farming, forestry management, fishery resources and aquaculture. Agriculture not only uses vast quantity of water, it is also one of the main producers of non-point source pollution due to intensive use of industrial fertilisers and herbicides, which are carried via run-off into the groundwater and waterways. In the coastal areas, large expanse of coastal mangroves have been cleared to make way for aquaculture farming but again there are many opportunities that are not fully explored to improve farming efficiency that will reduce water use in the agricultural sector.

A3. WATER FOR ECONOMIC DEVELOPMENT

Water is a basis of all productive activities (commerce and industry) where it is used as raw material, medium, coolant or mode of transport in production processes. Industrial use of water accounts for 20% of global water consumption and will likely increase in future.

Each time goods are brought or services rendered, there is a virtual exchange of water, which should be accounted for in the total volume of water used in manufacturing a product or providing the services. Most often, this virtual water is not fully accounted for in the economic cost of production.

All of the above can be translated into business opportunities, and even its wastes and wastewater can provide financially, scientifically and technological opportunities. There are many examples, namely industries and business that generate wastewater, which is then returned to the environment; treated and untreated. Even as environmental standards are met, most often the amount of pollution load from industries exceeds the carrying capacity of the waterways leading to the degradation of the environment. When this occurs in water catchments, it will reduce the supply of readily available water resources, and as a result, increase the cost of water treatment. All these can be viewed in terms of the incurred challenges in improving the treatment systems by the business community, through the NKEA.

A4. WATER FOR THE ENVIRONMENT

Ecosystems are highly reliant on water quantity and quality. In turn they play a key role in the hydrological cycle to provide raw materials and regulate a host of ecosystem services. The water systems are also significant in human cultural and religious practices while water-related activities such as water sports, ecotourism and recreation are highly desirable. Development in river basins and water catchments should be balance with ecosystem sustainability. Without accounting for the actual economic value for maintaining the environment, the urge to develop these areas for economic activities will only intensify. Payment for Ecosystem Services (PES) has been proposed as a mechanism to enable for the monetisation of the ecosystem services to ensure its preservation. Nevertheless, the system has yet to be adopted in the country due to resistance.

A5. WATER FOR ENERGY

Presently, there is a focus on the Water-Energy-Food nexus worldwide, and Malaysia is also been looking at it in terms of both policy and process. While water is inextricably linked to food, it is also essential to provide energy. Both energy and water are used in the production of crops, some of which can in turn be converted to energy such as through biofuels.

As energy and water demand increases in tandem with increasing population and income, the shift from provision of basic needs, to meeting the expectations of new lifestyles and diets will result in an increasing demand for more energy, which will drive water demand higher. Thus there is an urgent need for continuous improvements in water and energy efficiencies to ensure sustainable growth.

Water is needed in almost all energy generation processes. As fossil fuels deplete and energy costs increase, the heavy dependence on conventional power plants will have to make way for renewable energy or nuclear. Water has been identified as a potential source of cheap renewal energy, resulting in rivers being dammed up to harness their energy production potential. However, while hydropower provides unlimited clean energy, its development requires the clearing of large tracts of forests for inundation, which will have downstream impacts to the river ecosystems. Uncontrolled land use development within water catchments can also lead to increased siltation and sedimentation which further shortens the lifespans of dams.

Other forms of alternative energy such as harnessing wastewater and sewage will likely see greater adoption and contribution to the nation's energy supply. Likewise competition for water use for production of crops for energy generation through biofuel production will further complicate the water, energy and food nexus. The drive for more efficient water use in energy generation will be a driver for greater adoption of renewable energy.

ANNEX 2: MEGASCIENCE PHASE 1

RECOMMENDATIONS FOR WATER:

Creating New Wealth Opportunities (2011 – 2050)

- Ecotourism around high ecological value sites
- Urban water-based tourism
- Market and export high quality water
- Clean water for aquaculture industry
- Malaysian brand for domestic water purification unit
- World leading tropical aquatic research and education
- Knowledge export
- Downstream water tapping
- Rainwater harvesting
- Zero pollutant discharge

ANNEX 3: LIST OF NKEAs

1	Oil, Gas and Energy
2	Palm Oil & Rubber
3	Financial Services
4	Tourism
5	Business Services
6	Electrical & Electronics
7	Education
8	Healthcare
9	Communications Content & Infrastructure
10	Agriculture
11	Wholesale & Retail
12	Greater Kuala Lumpur/ Klang Valley

ANNEX 4A: SUMMARY OF FINDINGS FROM WORKSHOP

Questions for Break Out Session

Please answer the questions based on the theme of your group:

- (1) Why should water be an NKEA?
- (2) How can the private and public sector participate in the water industry?
- (3) What is the existing roadmap for water in your organisation?
- (4) How can Malaysia achieve global standards in the water industry?

ANNEX 4B: SUMMARY OF DISCUSSIONS FROM STAKEHOLDER ENGAGEMENTS

1. Ministry of Energy, Green Technology and Water (KeTTHA)

- Focus more on the social aspect of water management than the business aspect.
- Raising public awareness on water saving measures is a priority.
- The Restructuring of Water Industries Road Map policies are based on directions from the cabinet, but no policy document exists.
- A study was carried out by KPMG, but has not been incorporated into a Wastewater Management Roadmap.
- Water infrastructure should be privatized especially in laying infrastructure and providing services in maintenance. May result in improved maintenance levels and reduce NRW level.
- Water supply and water infrastructure should be separate entities as the cost of infrastructure is high.
- Underground storage of rainwater can be utilised for non-potable uses

- The River Bank Filtration and Horizontal Collector Well technologies implemented in Jeli, Kelantan should be implemented elsewhere in the country.

2. Ministry of Urban Well-being, Housing and Local Government (KPKT)

- Rainwater harvesting systems (SPAHS) have the potential to be turned into an EPP, but collected rainwater should not be utilised for potable use.
- Six states (Perak, Selangor, Johor, Malacca, Kelantan, Perlis) have enacted the amendments of *Undang-undang Kecil Bangunan Seragam 1984*, making SPAHS mandatory for houses with roof areas above 100m².
- Rainwater retention efforts play a bigger role in flood mitigation than water production.
- Pollution should be looked at as an opportunity, there is great potential for grease traps maintenance and fats, oil and grease recycling to be made into an EPP.
- DOE classifies brown grease as "scheduled waste", which makes collection and recycling illegal, whereas this should be made legal.
- The installation of grease traps and recycling of grease can create jobs and revenue.

3. Ministry of Tourism and Culture

- The Ministry urged for focus on forming water-based EPPs;
- The Ministry urged for focus on GNI and Jobs Created from said EPPs;
- The Ministry urged ASM to bring up water agenda as a NKRA for rural development. The Ministry is currently active in implementing its own EPPs on tourism with focus on attracting high quality visitors. Tourism is ranked as the 6th GNI contributor with Malaysia ranked as the top 10 countries for arrivals and top 15th in tourist receipts globally; and

- Concurred that tourism EPPs have a direct connection to water, and should be further developed.

4. Ministry of Natural Resources and Environment (MONRE)

- Stormwater is much cleaner than effluent water. Water drained by the SMART Tunnel should be captured and recycled.
- Pollution control and mitigation can be an EPP. The cleaning up and rehabilitation of polluted areas can create jobs and revenue.
- New water act is currently being drafted to take into account of new pollutants and development in environmental management and standards.
- A study group/think tank/lab/forum should be held to develop EPPs for water.
- EPU does not see opportunities and good outcomes/ outputs in seeing water as a resource.
- Suggestion to explore ideas of recharging aquifers with floodwater, aquifers can dilute pollutants and filter out dissolved solids.
- Water footprint should be looked into in Malaysia.

5. Ministry of Plantation Industries and Commodities (MPIC)

- Commodity crops currently consume 70% of land usage.
- Most commodity crops (rubber, oil palm, kenaf, pepper and timber) are rain fed crops.
- Rubber requires a distinct dry season to grow.
- Oil palm is grown over peat swamps in many areas. Special care must be taken when developing such areas.
- Pepper has to be washed in water as a part of its downstream process.

- With *El Nino* and climate change on our doorsteps, our country has to make preparations for water shortages.
- Suggest that water EPPs be broad based (e.g. Green Technologies).
- MPIC is cautious to take on any sustainability standards as it might incur increased production costs (e.g. Roundtable on Sustainable Palm Oil).
- Smallholder crops such as pepper, cocoa and kenaf might not be able to bear these costs.

ACADEMY OF SCIENCES MALAYSIA

Level 20, West Wing, MATRADE Tower,
Jalan Sultan Haji Ahmad Shah,
off Jalan Tuanku Abdul Halim,
50480 Kuala Lumpur, Malaysia

Phone : +6 (03) 6203 0633
Fax : +6 (03) 6203 0634
admin@akademisains.gov.my

www.akademisains.gov.my

ISBN 978-983-2915-32-4



9 789832 915324