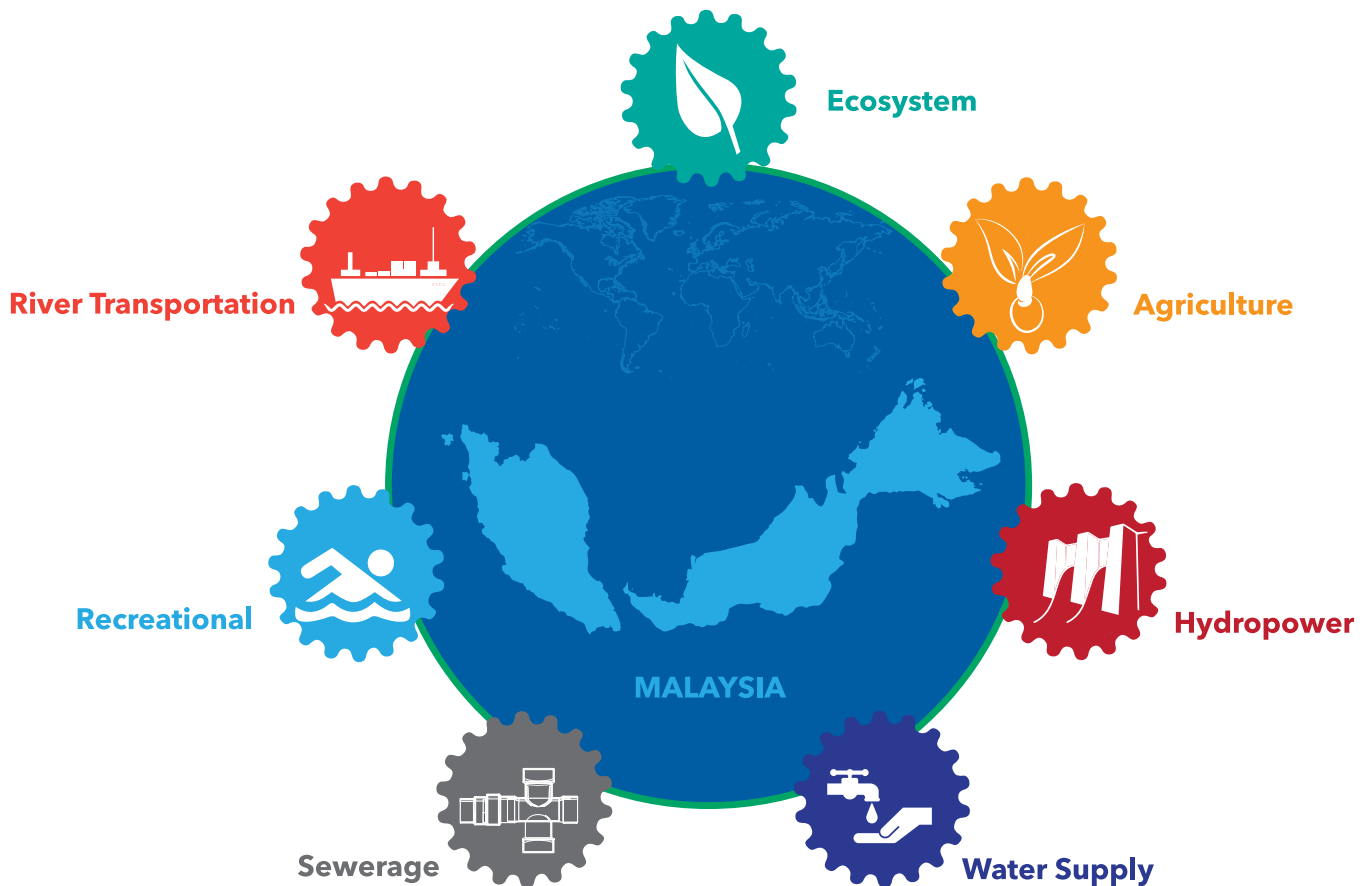


Strategies to Enhance Water Demand Management in Malaysia



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2016

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Foreword

Though Malaysia is blessed with abundant rainfall, seasonal water shortages have been encountered, especially in the recent past. This is likely to occur more frequently in the future stemming from the demands of a growing population and corresponding development needs. The situation is expected to be further exacerbated by potential threats from impending climate change. Hence, the sustainable use of water requires a shift in strategy towards greater water demand management (WDM).

The call for greater WDM in Malaysia is not new. Policy statements appearing in earlier 8th Malaysia Plan documents had emphasized “demand management of water to include improvement of efficiency of supply and use, reducing water leakage and wastage, recycling of water, rainwater harvesting, and the use of market-based instruments”, stressing also the need for awareness campaigns and public education programmes focussing on the importance of water and the need for conservation. The recently launched 11th Malaysia Plan in mid-2015 further reiterates the need to enhance “demand-side management (DSM) by formulating a comprehensive DSM master plan and expanding DSM measures”,

all within a larger sustainable consumption and production policy framework adopted by the Government.

The Academy of Sciences Malaysia (ASM) is pleased to report that, since 2008, it has through its dedicated ASM Water Committee actively pursued the IWRM agenda and has conducted a series of in-depth studies on various water-related themes considered as sub-sets of the central IWRM theme. One of the recently concluded thematic studies is this Study Report entitled Strategies to Enhance Water Demand Management in Malaysia. This holistic study approached from a technical, economic, administrative, financial, and social perspective, has addressed WDM in all consumptive and non-consumptive water use sectors namely, water for domestic and industrial use, water for hydropower generation, water for agriculture, water made available for inter-sector use, water for recreation and tourism, not forgetting also the often ignored water for the environment. The Study Report has recommended some 27 strategies covering a wide range of management attributes, including some dealing with trans-boundary issues.

The release of this WDM Strategy Plan Report is indeed timely as a direct response and an important contribution towards the Government's aspiration under the 11th Malaysia Plan to formulate a comprehensive Demand-side Management Master Plan. The study report marks yet another important deliverable of the ASM as part of its mandate to provide strategic advice to the government.

A special word of appreciation to the members of the ASM Task Force on WDM for the timely production of this Study Report and also to the ASM Water Committee for leading the IWRM agenda initiative that has successfully generated a series of IWRM-related thematic study reports, including this one.



TAN SRI DR AHMAD TAJUDDIN ALI FASc

President
Academy of Sciences Malaysia

Preface

In October 2009, the ASM, collaborating with the Department of Irrigation and Drainage and the Malaysian Water Partnership and supported by MOSTI and Ministry of Natural Resources and Environment, had jointly organised a three-day National Colloquium on Water Demand Management (WDM). The Colloquium saw a number of international water experts teaming with local water professionals taking the stage as keynote speakers, lead speakers and subject matter specialists addressing a large local audience comprising professionals, managers, policy makers, researchers, academics and representatives from NGOs whose expertise revolve around water and the environment, including water concession operators from around the country. Status reports and water demand initiatives undertaken by various public and private national institutional and community stakeholder agencies in various water related sub-sectors were also presented at the Colloquium. The Colloquium also included workshop sessions where various WDM issues ranging from governance, technical, economic, administrative, financial and social matters were discussed. Many useful findings and recommendations were generated and documented.

ASM has since published the proceedings of the Colloquium which is now a valuable and informative reference document on the topic of WDM.

The ASM Task Force on Water Demand Management formed in December 2010 was tasked to build on the findings and recommendations that emerged from the National Colloquium and undertook further in-depth studies in key focus areas with the view of developing holistic and sustainable WDM strategies for nationwide implementation. Initially seven key focus areas were identified as follows:

- i. WDM in the Water Supply Sector– Domestic, Industrial and Sewerages;
- ii. WDM in the Agriculture Sector–Irrigated agriculture, rain-fed and controlled drainage agriculture, aquaculture, horticulture, animal husbandry;
- iii. WDM in Ecosystem Services Sector–ecosystems provisioning and regulating services, environment flows; and
- iv. WDM in Hydropower

- v. WDM in Navigation
- vi. WDM in Recreational
- vii. Inter-Sector WDM – conflict resolution and trade-offs.

The number of focus areas was later expanded to nine to include Sabah and Sarawak to reflect respectively their particular overall and sectoral needs and constraints.

For the purposes of this WDM study, a more holistic definition of “water demand management” has been adopted, that is “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; and*
5. *Increase the ability of the water system to continue to serve society during times when water is in short supply.*

Pursuing the in-depth studies on the six focus areas highlighted above, position papers were prepared by the Task Force and discussed at strategic consultation (SC) sessions held with relevant institutional, community and private sector stakeholders associated with each focus area to gather feedback before formulating and recommending appropriate strategies for implementation. Separate sessions were also held in Sabah and Sarawak.

The position papers prepared and the outputs from the SC sessions formed the basis for the preparation of this Study Report completed in August 2015 entitled *Strategies to Enhance Water Demand Management in Malaysia*. Some 27 strategies have been recommended and organised under various management categories ranging from governance, information management, development planning, groundwater, operation and maintenance, STI, 3Rs,

capacity building, R&D, participatory management, financing, wealth creation, W-F-E nexus, to international cooperation.

The Study Report is also an integral part of the series of thematic studies undertaken by ASM, identified as sub-sets of the central IWRM theme, and overseen by a dedicated ASM Water Committee.

The successful completion of this WDM strategic planning report would not have been possible without:

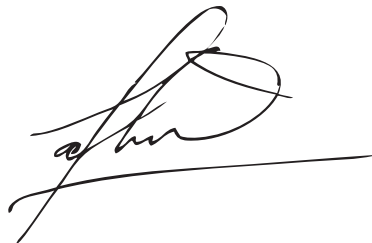
- The constructive and timely guidance provided by members of the ASM Water Committee;
- The full cooperation, support and commitment of the Task Force members; and
- The continuing support services provided by the ASM Secretariat.

We take this opportunity to commend them all for their invaluable contribution. A special word of appreciation is extended to the state administrations of Sabah and Sarawak for their kind support in facilitating the successful organisation of the SCs held respectively in Kota Kinabalu and Kuching.

Above all, we would like to place on record our deep appreciation for the strong support and cooperation of the many water-related institutional and community stakeholders from the public, private and NGO sectors who participated and provided valuable feedback at the many strategic consultations that were held.



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Chairman
ASM Task Force on Water Demand Management



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List of Abbreviations and Acronyms

1MDB	1 Malaysian Development Bhd
2D - ER	Two-Dimensional Electrical Imaging
3R	Reduce, Reuse and Recycle
AAF	Average Annual Flow
ASEAN	Association of Southeast Asian Nations
ASM	Academy of Sciences Malaysia
BPSP	<i>Bahagian Pengairan dan Saliran Pertanian</i> (Irrigation and Agriculture Drainage Division)
BOD	Biochemical Oxygen Demand
CoE IMM	Centre of Excellence for Irrigation Management Modernisation
DBKK	<i>Dewan Bandaraya Kota Kinabalu</i>
DOE	Department of Environment
DSS	Decision Support System
EC	<i>Suruhanjaya Tenaga</i> (Energy Commission)
ECER	East Coast Economic Region
EPA	Environmental Protection Agency
EPPs	Entry Point Projects
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCP	Erosion, Sediment and Control Plan
ETP	Economic Transformation Programme
FT	Federal Territory
FAO	Food and Agriculture Organization
FELDA	Federal Land Development Authority
FFB	Fresh Fruit Bunches
FOMCA	Federation of Malaysia Consumers Association
FTKL	Federal Territory of Kuala Lumpur
GDP	Gross Domestic Product
GNI	Gross National Income
GoM	Government of Malaysia
GWS	Global Water Security
IADA	Integrated Agricultural Development Areas
IRRI	International Rice Research Institute

IRBM	Integrated River Basin Management
IT	Information Technology
IWK	Indah Water Konsortium Sdn Bhd
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JANS	<i>Jabatan Air Negeri Sabah</i> (Sabah State Water Department)
JMG	<i>Jabatan Mineral dan Geosains</i> (Mineral and Geoscience Department)
JICA	Japan International Cooperation Agency
JKKK	<i>Jawatankuasa Kemajuan dan Keselamatan Kampung</i>
JKR	<i>Jabatan Kerja Raya</i> (Public Works Department)
JPBD	<i>Jabatan Perancangan Bandar dan Desa</i> (Department of Urban and Rural Planning)
JPS	<i>Jabatan Pengairan dan Saliran</i> (Department of Irrigation and Drainage - DID)
KADA	Kemubu Agriculture Development Authority
KETARA	<i>Kawasan Pembangunan Pertanian Bersepadu Terengganu Utara</i>
KeTTHA	<i>Kementerian Tenaga Teknologi Hijau dan Air</i> (Ministry of Energy, Green Technology and Water)
Km	Kilometer
KPI	Key Performance Index
l/c/d	litres per capita per day
LAKU	<i>Lembaga Air Kawasan Utara (Sarawak)</i>
LUAS	<i>Lembaga Urus Air Selangor</i>
m ³	meter cubic
MADA	Muda Agricultural Development Authority
MANCID	Malaysia National Committee on Irrigation and Drainage
MARDI	Malaysia Agricultural Research and Development Institute
MASSCOTE	Modernisation of Management, Operation, and Maintenance of Irrigation Systems
MOHR	Ministry of Human Resources
ml/d	million litres per day
MMD	Malaysian Meteorological Department
MOA	Ministry of Agriculture and Agro-based Industry
MOSTI	Ministry of Science, Technology and Innovation
MPIC	Ministry of Plantation Industry and Commodities
MPOB	Malaysian Palm Oil Board
MRS	Magnetic Resource Sounding

MSMA	<i>Manual Saliran Mesra Alam</i> (Urban Storm Water Management Manual)
MWA	Malaysia Water Association
MWIG	Malaysia Water Industry Guide
MyWA	Malaysian Water Academy
NAHRIM	National Hydraulic Research Institute of Malaysia
NBOS	National Blue Ocean Strategy
NCER	Northern Corridor Economic Region
NKEA	National Key Economic Areas
NKRA	National Key Result Areas
NPP 2	National Physical Plan 2
NRE	Ministry of Natural Resources and Environment
NRW	Non-revenue Water
NWRC	National Water Resources Council
NWRP	National Water Resources Policy
NWRS	National Water Resources Study
NWRVI	National Water Resources Vulnerability Index
NWMTC	National Water Management Training Centre
PAAB	<i>Pengurusan Aset Air Berhad</i> (Water Asset Management Company)
POME	Palm Oil Mill Effluent
PWSA	Penang Water Services Academy
RDZ	Regional Demand Zones
RMK11	<i>Rancangan Malaysia Ke 11</i> (11th Malaysia Plan)
SC	Strategic Consultation
SCORE	Sarawak Corridor of Renewable Energy
SDG	Sustainable Development Goal
SIWRM	Sarawak Integrated Water Resources Management
SKM	<i>Sijil Kemahiran Malaysia</i> (Malaysian Skills Certification)
SPAN	<i>Suruhanjaya Perkhidmatan Air Negara</i> (National Water Services Commission)
SPPCA	<i>Skim Pelabelan Produk Cekap Air</i> (Water Efficient Product Labelling Scheme)
Sqm	Square Meter
STI	Science, Technology and Innovation
STP	Sewerage Treatment Plant
SWMA	Selangor Water Management Authority
SWRA	State Water Resources Agency

SWRC	State Water Resources Council
TMDL	Total Maximum Daily Load
TNB	Tenaga Nasional Berhad
TRX	Tun Razak Exchange
UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN WWDR	United Nations World Water Development Report
UTM	University of Technology Malaysia
WDM	Water Demand Management
WHO	World Health Organisation
WRM	Water Resources Management
WSIA	Water Services Industry Act
WSIG	Water Services Industry Guide
WSIPR	Water Services Industry Performance Report
WSM	Water Supply Management
WTP	Water Treatment Plant
WUA	Water User Associations
WUG	Water User Group
WWAP	World Water Assessment Programme

Executive Summary

Overview

1. This report on Strategies to Enhance Water Demand Management in Malaysia has been prepared by the ASM for consideration of the government for the people and economic growth of the country.

The essential role that water plays in national life makes water a central concern for national policies. Such roles include economic growth, health care, education, culture and the environment. The Malaysian Water Resources Policy, as one of the national policies, was unveiled in March 2012. It will oversee the proper management and sufficient supply of water for the country until 2050. The launching of the Policy is indeed timely considering water crisis occurring in the early period of 2014 and 2015.

2. An important aspect in this Policy is the eventual goal of achieving sustainable water management status. Ideally, the central sustainable water management objective is to seek a balance between supply and demand of water with equitable allocation of water for all uses and users. This is particularly more so when managing demand to meet limitations of supply and this is embodied in Water Demand Management (WDM).
3. Implementing WDM is an important part of Integrated Water Resource Management (IWRM). The general framework for implementation of WDM nationwide includes the provision of laws, plans and institutional arrangements. Water is, therefore, vital for promoting inclusive sustainable

development requiring strategies to be created and implemented to enhance WDM in Malaysia. When Malaysia becomes a developed and high income nation by 2020, an ideal situation is to fully attain sustainable water management. Unfortunately, this may not happen on time. In terms of the four major water sectors in Malaysia: (i) Water supply and sewerage services sector; (ii) Energy (hydroelectricity) sector; (iii) Agricultural sector; and (iv) Environment sector—only the water supply and sewerage services sectors (regulated by SPAN) and the energy (hydroelectricity) sector (regulated by EC), have plans in place which support WDM. The agricultural and environment sectors have yet to establish institutional and legal framework for sustainable water management.

Therefore, it is important to set a vision to achieve a complete sustainable management of water in the near future, possibly by 2030. This vision should explicitly address the water related concerns of the four major sectors and achieving this target should be the aim of the Water Masterplan or Water Blueprint.

4. Implementing WDM provides tremendous opportunities for economic growth and employment. The role of water services in all aspects of economic and social development in the country is thus vital even though the current water services sector contribution to GDP appears to be insignificant when compared to overall services sector. The services sector is recognised by the government as the largest contribution to GDP at 55% (Services Sector Master Plan, March 2013). The contribution by water services sector

can be considerable to enhance the tradability of Malaysia's water services and transform them into a sizeable water industry with tradable expertise in such areas as water assets (in the manufacturing, construction, agricultural activities, etc.), infrastructural development and high end R&D. Such a specialisation could thus accelerate

the water industry for sustainable economic growth and be recognised as one of the National Key Result Areas (NKRAs). Furthermore, the water services sector can effectively contribute to the targeted Gross National Income and employment opportunities.

Defining WDM

1. WDM is generally defined as the efforts to reduce the loss in quantity and quality of water as it flows from source through to disposal.
2. WDM is the application of the 3Rs (Reduce, Reuse and Recycle). The practice is applied across the full spectrum of water development, particularly in water supply and sewerage services and, increasingly, in agriculture water services.
3. A broader definition for WDM that would be most appropriated for the future water management for the country is that as defined by David B. Brooks (2006) for operational WDM (see box). Most of the five listed items are yet to be put in full practice in Malaysia. Nevertheless, these options should be regarded as targets to be achieved in the future.

"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."*

David B. Brooks (2006)

The Current Policy Context

- (1) WDM has always been an integral component in the planning, design and management of the water supply and agriculture water development processes and procedures. WDM is also promoted under the National Physical Plan 2 (NPP2 2010). However, Agriculture water management has not been as significant as the water supply management aspect.

This is due to several reasons particularly there is more need to provide basic infrastructure for the population and industry in a developing country and against the backdrop of plentiful water resources. As the country progresses towards a developed high-income status nation and as water demands increases against lessening available unregulated flows, it is now imperative for a greater emphasis on WDM.

"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 enable by a mechanism of shared partnership involving all stakeholders". NWRP (2012)

- (2) The need for WDM is embedded in the NWRP (2012). The strategy is to "determine mechanisms to put into effect water demand management nationwide" and the Strategic Action Plan is to "identify options to incorporate water demand management in existing regulatory and administrative arrangements".

Adopt Measures to Implement Water Demand Management nationwide. Target 14: NWRP (2012)

- (3) The NWRP 2012 also recognises the importance of stakeholders' participation. There is need to develop Framework for Stakeholder Collaboration in Water Resources Governance.

Establish of Mechanism for Formal and Informal Consultation on Matters Related to Water Resources. Target 15: NWRP (2012)

- (4) In addition to the above, the NWRP 2012 also includes provisions for Capacity Building and Awareness among Key Water Resources Stakeholders.

Build Capacity of Key Water Resources Stakeholders. Improve Understanding and Awareness on the Importance of Water Resources Security and Sustainability. Target 17 and 18: NWRP (2012)

Challenges in WDM Implementation

- (1) An outcome of the review in NWRS 2012 revealed that five States in Peninsular Malaysia, namely Perlis, Kedah, Pulau Pinang, Selangor (including Federal Territory of Kuala Lumpur) and Melaka are already in deficit of available (freshwater) unregulated flows. This is despite the fact that, overall, the country is blessed with abundance of water (using only 3% of the available water resources which is 972 billion m³ of renewable water resources annually–NWRS 2012). The unregulated flows in the remaining States, although not in deficit, are already in declining trend.

The national water quality status is also in a state of decline. Measured in terms of National Water Resources Vulnerability Index (NWRVI), only Sabah and Sarawak are in the low vulnerability category but only just. All the other States in the Peninsular are below this category with four States, namely Perlis, Pulau Pinang, Selangor and Melaka, being already in the vulnerable category (NWRS 2012). These should be seen as serious signs that the present national management approach needs to change to ensure continued support and sustainability of Malaysia as an advanced status high income nation.

- (2) When planning for more water resources facilities, especially for new dams, the issue is whether these could be implemented on time to meet increasing demands. Whilst technically feasible, constructing new dams and new water resources facilities would now require more detailed considerations on environmental, social and land issues. The net effect of potential delays are increased threats on water security and safety and therefore, on the social and economic sustainability of the country.

While planning and implementation for new water resources should continue, the need now is to systematically increase emphasis on WDM. This is to make the best use of existing resources by reducing freshwater use and wastages and other measures broadly defined in WDM definition. Furthermore, this should come handy now in view of the much delayed implementation of IWRM first adopted by the government in 1992.

The water crisis resulting in water rationing in Selangor, FT Kuala Lumpur, Putrajaya and parts of Perak, Negeri Sembilan and Johor during early 2014 causing hardship to more than 1.3 million consumers, apart from business and industries, serves as a lesson to be learnt that the public and the industries had to “cooperate” by reducing consumption and wastage. This is a culture promoted in WDM to be practiced at all times, even outside drought period. During the water rationing in Selangor, FT Kuala Lumpur and Putrajaya, 10% water reduction of total demand was applied (SPAN). The water rationing would not have been necessary if WDM was practiced giving a total potential reduction of more than 20%.

- (3) Water used for industrial (and commercial) purposes increases from about 10% for low and middle income countries to around 60% for high GDP countries (GWS, RAE, 2010). For Peninsular Malaysia, the average usage is 37.8% for non-domestic (SPAN 2013) and most of this use potable water for non-potable purposes. The question is “to what extent should potable water be used for non-potable purposes?” If most of the non-domestic users could substantially use non-potable water supply or lower quality water for their operation, more potable water supply could

be made available for domestic and other uses. Currently the use of wastewater as a resource is being promoted by IWK.

Furthermore, potential water savings with the application of WDM in the Agriculture Sector are considerable, see Table 1.1.

- (4) The main challenge in the water services industry is for success in WDM implementation in scaling up water operators to "Operation Excellence" level. Human capital is an important factor for growth in the water services industry. Sufficient numbers of training centres need to be provided for the whole countries for which there are only two at the moment, in Pulau Pinang (PWSA) and Kuala Lumpur (IWK) for water supply and sewerage services.

Potential Water Savings from WDM

- (1) The potential water savings with WDM is significant and offers tremendous benefits especially in terms of freshwater availability that is already under threat in certain regions of the country. The savings in water demands provides relief for water availability to environmental needs.
- (2) This study estimates that the total potential water savings in 2020 from a concerted application of WDM is about 12,371 mld (4,511 mcm). The total water savings represent 26% of the total potential water demand in 2020. (Table 1.1). This amount is made up from savings in the following:
 - 5,966 mld (2,176 mcm) from controlling NRW at 25% and capping domestic consumption to 180 litres/day/capita.
 - 2,405 mld (877 mcm) from the agricultural sector, specifically reducing water use at the eight (8) matured granaries; and
 - 4,000 mld (1,459 mcm) from the sewerage sector in the form of water recycling for non-potable water use.

Table 1.1: Total Potential Water Saving in 2020

				Peninsular		Sabah		Sarawak		Total Malaysia		Notes
Sector		Component/ subsector		mld	mcm	mld	mcm	mld	mcm	mld	mcm	
A	Water Supply	NRW		2,336	852	678	247	140	51	3,154	1,150	
		Consumption		2,337	852	208	76	267	97	2,812	1,025	
			Total (A)		4,673	1,704	886	323	407	148	5,996	
B	Agriculture	Paddy Irrigation	Total (B)	2,405	877					2,405	877	Exclude the four new Granaries that are still at early operational stages
		(8 Matured Granaries)										
			Total (A+B)		7,078	2,581	886	323	407	148	8,371	
C	Sewerage	Recycling	Total (C)	4,000	1,459	?	?	?	?	7,879	2,873	Based on 50% of estimated consumption at 180 l/cap/d
D	Total Potential Savings		Total (A+B+C)	11,078	4,040	886	323	407	148	12,371	4,511	
E	Total Projected Water Demand (2020)			37,436	13,664	3,715	1,356	5,923	2,162	47,074	17,182	NWRS 2012
F	% Savings			30	30	24	24	7	7	26	26	

- (3) From a water management perspective, the savings allows for longer retention of storages in dams particularly during the dry season or in a drought situation. This is considering that the total potential savings of 4,511 mcm is about equal to the estimated total storages of 4,323 mcm in existing water supply dams (total storage 2,326 mcm) and irrigation dams (total storage 1,997 mcm).
- (4) Concerning future dam development, the total potential savings with WDM (4,511 mcm) is more than the total estimated storages of 2,672 mcm from the future dams identified for the Water Supply Sector (40 dams; 2,108 mcm) and agriculture (Irrigation) sector (8 dams; 564 mcm). However it must be noted that the developments of dams are still necessary to improve water security in tandem with more effective WDM action plans.
- (5) Regionally, the three matured Granaries namely the MADA, Pulau Pinang IADA and the Kerian IADA have the potential to save 972 mld (354 mcm) of freshwater needs and this is a substantial amount of relief for the water supply sector in the already water stressed NCER.
- (6) From a financial perspective, the 4,511 mcm potential savings could be compared to developing dams with similar total storage for a total cost of RM9,022 million assuming at RM2 million/mcm (comparing with Paya Peda Dam (Irrigation), RM420 million, 220 mcm, RM2.5 million/mcm, under construction–2015; Beris Dam (Water Resources), RM360 million, 144 mcm, RM2.5 million/mcm, completed–2004; Sg. Selangor Dam (Water Supply), RM400 million, 235 mcm, RM1.70 million/mcm, completed–2004).

Strategies for WDM Implementation

- (1) The proposed strategies for WDM implementation take into consideration the inherent characteristics of present water management, the constraints and challenges as well as the potential opportunities provided in a future high-income advance status nation. The traditional and widely accepted water management is for consumptive and non-consumptive use of water and the need for inter-sector WDM (see box).
- (2) The main future potential that could be capitalised on in implementing WDM would be the higher levels of affordability and appreciation to pay for water services, higher care for the environment and better understanding of the limits of water resources availability for human use.
- (3) Implementing WDM requires a series of strategic enabling environments and actions that address those issues and need to be installed. These include water accounting, stakeholders' platform, review of certain laws (Irrigation Act) and introduction of new laws such as the proposed Water Resources Act and engineering and technology installation. This would also have to look into a systematic plan for the public to accept WDM as a social obligation in an advanced society and the acceptance to pay a fair rate for the services.
- (4) Another major strategy for gaining all round support for WDM is to link it (and water management as a whole) to Green Growth and the objectives of the National Economic Transformation plan for higher GNI and high value employment. This would require a restructuring of the water sector as an industry

A. Consumptive Water Use Sectors

- *Water Supply and Sewerage Services WDM*
- *Agriculture WDM*
- *Ecosystem WDM (Environmental needs)*
- *Inter-sector WDM*

B. Non-consumptive Water Use Sectors

- *Hydropower WDM*
- *Navigation WDM*
- *Recreational WDM*

C. Inter-sector WDM

and to be recognised as one of the National Key Result Areas.

- (5) Efforts on WDM also provide tremendous opportunities for the development and ownership of STI for the nation. These are in areas related to the 3Rs integrated, within sector and inter-sector, water management forecasting systems and in establishing the tools for water management for the environment.
- (6) The full list of strategies for effective WDM is summarised in Table 2.1.

Table 2.1: WDM Strategies

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 - Instal performance assessment tools and procedures - Instal sector and inter-sector auditing and feedback system
B	Policy	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
D	Institution	Strategy 4	Form a dedicated Department for 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
		Strategy 5	Form a dedicated WDM Unit in all water management related departments and Institutions
		Strategy 6	Form a dedicated Water Management R&D 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

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 of 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 sector - The water supply sector is recognised in developed 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

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 programmes 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. Capping domestic water consumption to 180 l/c/d for Peninsular Malaysia by 2020
		Strategy 17	Implement efficiency improvement and returned water quality control programmes 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 programmes 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 Programmes by all sectors for staff and for the public (Water User Groups/Water User Associations)

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
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 Planning for heavy water industrial users to recycle or reuse at least 30% of their water consumption
		Strategy 23	Adopt applications of the National Blue Ocean Strategy in WDM - Planning for future WDM should consider sectorial and inter-sectorial 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
O	R&D	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 and Food

Implementing WDM

- (1) Implementing WDM requires a total change of mindsets as well as advocacy of all stakeholders from policy makers and system managers as well as the end users at Federal and State levels. Higher emphasis on WDM also involves a change of lifestyle that many are used to after years of living with emphasis on WSM approach.

Implementing WDM also requires a series of enabling environments and infrastructure. This covers comprehensive water accounting and auditing system, establishment and strengthening of the public participation platforms, Federal-State interactions, inter-sector interactions and installation of appropriated technology and infrastructures.

- (2) For the agriculture (paddy irrigation) sector, WDM improvement would include infrastructure improvement works, on-farm improvement works, water management system upgrade, water user group capacity building, a centre of excellence for Irrigation Management Modernisation and establishment of water accounting system and studies of water recycling.
- (3) Establishing WDM for the water supply sector includes five training centres, projects to achieve SPAN's NRW target, feasibility study to develop water recycling plant and groundwater survey for aquifer mapping.
- (4) For water for the environment, the immediate need is to initiate a feasibility study and data collection.

The Masterplan

- (1) Although the ideal target for implementing the WDM fully would be by 2020 to be in line with the targets under the Economic Transformation Programmes, a more reasonable target would be 2030. This is because the preparatory programmes for WDM is estimated to take five years as this involves a series of actions pertaining to the formation of committees and task forces as well as studies. However there are some components of the masterplan that could be implemented during the RMK 11 (2016-2020) as WDM preparatory works, particularly those involving strategic physical works.
- (2) The WDM preparatory works includes:
 - Inter-sector Harmonisation for National WDM
 - Federal-State WDM Harmonisation
 - Water Industry Structuring for Economic Growth
 - Government and Public Participation
 - Sectorial and Inter-sector WDM Improvements
- (3) The infrastructure aspects are numerous and some could be implemented during the RMK 11 (2016 - 2020) and possibly based on the EPP model under the ETP.
- (4) In the water supply sector, the NRW reduction programmes could be stepped up with specific targets by 2020. Similarly for the Water Forum Programmes as provided for under the WSIA.
- (5) Similarly for the agriculture sector, the infrastructure upgrading and improvement works could begin in and targeted for completion by 2020. The EPP11: Granary strengthening projects

could be implemented with WDM as the primary objective. In addition, the program to revitalise the WUGs could also be stepped up during the RMK 11.

- (6) A strategic project would be the setting up of a National Water Hub that could induce advances in STI and technology ownership. For the agriculture sector, the setting up of the Irrigation Management Modernisation Centre of Excellence should also be given priority and implemented in the RMK 11.
 - (7) Another priority project would be the development and installation of water recycling plant for non-potable use under the sewerage sector. For the irrigation sector, the irrigation water recycling (reuse) system could be replicated in all the Granaries but with consideration of applications of green technology. Another is to undertake a comprehensive groundwater assessment studies and strategic locations nationwide.
 - (8) A proposed project that would involve all sectors and thus requiring an integrated approach would be the national level integration of water data and information system and the development of a national integrated water management system that includes flood and drought forecasting.
- to regulating bodies created for water supply and energy services;
 - (3) Adopt a flexible approach to achieve financial sustainability exploring alternative financial options;
 - (4) Investigate into how more non-domestic users should be encouraged to use non-potable water supply or lower quality water;
 - (5) Adopt measures to recycle waste water so that it can be used by those needing lower quality water;
 - (6) Establish regional training centres in Peninsular Malaysia, Sabah and Sarawak to increase the availability and quality of human capital and more importantly retain skilled talent who can be employed in high income services; and
 - (7) Consider undertaking a study to set up the 'National Water Industry Centre' or 'Water Hub' as a cluster of the Water Industry Promotion Centre with supporting facilities of R&D centres.

The Way Forward

- (1) Adopt measures to implement WDM nationwide with a vision for sustainable development by 2030;
- (2) Establish institutional and legal framework for the formation of regulating bodies for water services in agriculture, ecosystem and water supply and sewerage services for Sabah and Sarawak, similar

CHAPTER 1

DEFINING WATER DEMAND MANAGEMENT

CHAPTER 1: DEFINING WATER DEMAND MANAGEMENT

1.1 Introduction

The results of latest 2012 review of the National Water Resources Study of 2012 (NWRs 2012), recent events of water supply shortages as well as the "Great Flood of 2014" should be seen as serious signs that the present national water management approach needs to change to ensure continued support and sustainability of Malaysia as an advance status high income nation.

Although blessed with 972 bil cu metres of renewable water resources annually, the NWRs 2012 revealed that five (5) of the States in the Peninsular are already in deficit of available (freshwater) unregulated flows. The unregulated flows in the remaining nine States although not in deficit, are all in the declining trend.

The National water quality status is also in a state of decline. Measured in terms of National Water Resources Vulnerability Index (NWRVI), only Sabah and Sarawak are in the low vulnerability category but only just. All the other States in the Peninsular are below this category with four States being already in the vulnerable category.

The above state of the national water resources and drought events that are projected to be more frequent and severe due to climate change impacts and water treatment plant closures due to polluted rivers are exerting higher pressures to release freshwater reservoir storages, to develop groundwater resources and to develop more water resources facilities within the respective states and also for inter-state use.

At least 73 new dams have been identified with total storage of 7,092 mcm. Of these storages 2,108 mcm are for water supply and 564 mcm are irrigation, totalling 2,672 mcm. More new dams for hydropower under the renewable energy programmes have also been identified in Sabah and Sarawak. Plans for detailed study on groundwater potential resources are also being implemented in stages now.

The issue however is whether these plans for new dams could be implemented on time to meet the increasing demands. Whilst technically feasible, constructing new dams and new water resources facilities would now require more detailed considerations on environmental, social and land issues. These are expected to be more complex and financially demanding than ever before. Moreover, recent experience has also shown that the political and administrative processes could also be more complex, intricate and time consuming. The net effect of potential delays are increased threats on water security and safety and therefore on the social and economic sustainability of the country.

While planning and implementation for new water resources should continue, the need now is to systematically increase emphasis on WDM. This is to make the best use of existing resources by reducing freshwater use and wastages.

WDM has always been an integral component in the planning, design and management of the water supply and agriculture water development processes and procedures. WDM is also promoted under the National Physical Plan 2 (NPP2 2010). However its

implementation has not been significant from the water supply management aspect. This is due to several reasons particularly the need to provide basic infrastructure for the population and industry in a developing country and against the backdrop of plentiful water resources. As the country progresses towards a developed high-income status nation and as water demands increases against lessening available unregulated flows, the need now is for a greater emphasis on WDM.

1.2 Defining Water Demand Management

General

WDM as a subject is traditionally under the domain of the water supply sector. However the principles of WDM are also practiced by other water sectors, particularly the agriculture sector for the irrigation of paddy and non-paddy sub-sectors. In the agriculture sector, instead of the term WDM, “Water Saving” is more commonly used.

A major aspect of water management is managing “Supply” and “Demand”. Managing supply to meet demand (i.e. “Water Supply Management” (WSM)) is always in tandem with managing demand to meet the limitations of supply (i.e. “Water Demand Management” (WDM)). However, in Malaysia, the relative level of emphasis on WDM has not been as significant as that for WSM compared to developed countries. There are two major reasons for this. One is that as a developing country, the emphasis on WSM is necessary to satisfy the basic social and economic needs of the population. The other is that the water resources availability has always been far more than the demands of the two major water users i.e. the water supply and the agriculture sectors.

The situation has changed considerably since the early days of development. Malaysia is already on the verge of achieving a developed and high-income nation status by 2020, just five years away. The socio-economic landscape has transformed from a low population living in a simple economy and lifestyle to one that has grown to 31 million (2015) and projected to increase to 42 million (2050) in a more diversified and complex economy as well as with affluent lifestyles. Water demands from the two major sectors – water supply and agriculture – have increased considerably in tandem with this change from 14,789 mcm in 2010 to 18,250 mcm in 2050 (NWRS 2012) and the available unregulated flows continue to decrease with some states on the Peninsular already being in deficit stages.

Recent events of water stress situations have shown that such impacts on the socio-economy of the country could only be more severe in the future if nothing is done to change the water management approach of the country. More so, when the impact of climate change is projected to induce extreme climatic situation more frequently than before. In managing such situations, one of the ideas promoted by water managers and concerned public is for more emphasis on WDM.

This is the subject of this Study with the main objectives to assess the needs and to develop strategic action plans for its implementation for the future water management of the country.

There is no formal definition for “Water Demand Management” in Malaysia. In Malaysia and in many countries around the world, WDM is more a subject within the domain of the water supply sector. The definitions often cited within this sector can be summarised as efforts by the water supply developers

and managers as managing to reduce losses of treated water (potable water) along the supply and distribution infrastructure network (reducing non-revenue water (NRW) and water thefts) and to reduce wastage of treated water use by end users namely domestic and industrial users (measured in terms of litres/capita/day (lcd)).

The agriculture sector particularly irrigation, and more specifically irrigation for paddy, does not use the term WDM in managing water demand. Instead the term "Water Savings" is more often used. The principle aim is similar to that of the Water Supply Sector i.e. to reduce losses and wastages and therefore the general definition is similar to that of water supply sector. The major differences are that irrigation uses non-potable water (mainly freshwater), there is no water charge based on the volume of water consumed and the end users are the farmers.

Unlike the water supply sector, Irrigation water supply system is not metered. The conveyance and delivery system are also mainly using gravity open flow channels. Therefore, water use measurement is difficult. Instead, generally accepted assumptions are used to estimate irrigation efficiencies and water use. There are tools and techniques to evaluate irrigation system performances. These are often elaborate exercises and performed infrequently. The indicator preferred in irrigation is in terms of a series of indices of which irrigation efficiency is one. The ultimate measurement is in terms of "water productivity" that indicates the total amount of water (rain and irrigation) utilised to produce rice. In the Muda Agricultural Development Authority (MADA) granary, its water productivity is about 0.27 kg rice/m³ of water for an average yield of 5 tons/ha. This means that it requires 3.7 m³ of water (rainwater and irrigation) to produce 1 kg of rice.

Often misinterpreted is the term "Irrigation efficiency" as encompassing in "Water Savings" for paddy irrigation water management. Irrigation Efficiency actually refers to the performance of the irrigation canals in water delivery. It is expressed in terms of percentage (%) of the volume of water arriving (delivered) at the delivery receiving point of a canal compared to the volume of water supplied at the canal water intake. This is similar to the definition of NRW in the water supply sector. Thus, irrigation efficiency is only a component of the water saving aspects, albeit an important one. As in water supply sector, the role of the end users (the farmers) is also crucial. However, unlike water supply sector, in the Agriculture (irrigation) sector, an added component for water saving consideration is the timing of supply in relation to the readiness of the farmers and their farms to utilise the water. Another is when rains fall on the farms upon the arrival irrigation water supply. Both situations could force that supply to be wasted back into the drainage system. In other words, the canals can be highly efficient (70% - 75%) but higher wastages could still occur at the points of intended utilisation.

The above are "traditional" definitions of WDM for the two major water sectors water supply and agriculture (particularly paddy irrigation) and are still applicable. However these definitions and efforts are focused only on the quantity and not on the quality of water. Their applications are also confined mostly to within sector practices with little consideration on potential water reuse within the sector and by other sectors. WDM for the future will need a broader definition that accounts for within sector water quality needs as well as responsibility for water quality returned to the system after use. In addition, WDM would also have to apply for inter-sector water management in terms of water quantity, water quality

and even time considerations. There are a number of reasons for this need and these are:

- (1) To recognise that water is a finite resource and therefore needs to be managed as such for water safety and security. This requires an appreciation of the inter-sector resource connectivity and inter-dependency that is anticipated to be more significant as water demands on the finite resource increase. Managing this would require WDM in terms of allocation of water resources that should include the environment as a water sector.
- (2) That water has an economic value and that all users need to appreciate this and advocate the need to pay for its use and its returns to the system or its misuse.
- (3) The emergence of what were traditionally non-water demanding "non-consumptive" water sectors that were not abstracting significant amount of water but are now abstracting more or are anticipated to do so in the future. There is therefore a need for WDM in these sectors. An example within the agriculture sector is the increasing off-river aquaculture industry (e.g. Arowana and other freshwater fish). Another is the energy (hydropower) sector that is anticipated to expand with emphasis on renewable energy sources to meet increasing demands for energy. The installation of hydropower stations has the effect of abstracting water from the normal flow regime. Although water is released back into the system, the volume and timing of flow releases are subject to the operations of the hydropower station whether as a peaking station or for continuous electricity generation. The timing and volume of releases did not seriously affect the water demands from the downstream development previously. However in the future when the population increases and development intensifies the water demand from this area and also regionally will increase.
- (4) WDM is principally a within sector management activity with sectorial end users as the target for efforts in reducing wastage. However, as water resources availability becomes relatively scarce as a country progresses, then there is a need to also manage sectorial demands from the water resources perspective. In other words there is a need for an overall water resource WDM management (both surface and groundwater) dimension for within and inter-sector WDM.
- (5) The emphasis of WDM so far has been only on the quantity aspect of water utilisation. For the future, the quality aspect of WDM will be necessary for a more refined water management approach. This is important now as the availability of freshwater is becoming more limited and the cost of producing treated water more expensive. Within the water supply sector for example, there are industries that do not need to use treated water when non-potable is adequate for operations thereby reducing the demand for treated potable water. With the water quality demand of irrigation (agriculture sector) for paddy being lower to that by the water supply sector, setting priority of meeting demands based on available water quality would have to be part of the inter-sector WDM strategies.
- (6) Flooding disrupts supply to meet demands in times of distress. At the same time the event offers opportunities for enhancing long-term WDM needs such as groundwater recharges as well and reservoir recharges.

Following on from the above, then the broader definition for WDM that would be most appropriated for the future water management for the country is that as defined by David B. Brooks (2006) for operational WDM.

In this definition the elements of quality and time are incorporated instead of just focusing on quantity as is the general practice now. This is the recommended definition for WDM for now and the future in Malaysia; moreover, the above is the definition adopted in this study.

"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; and*
- 5. Increase the ability of the water system to continue to serve society during times when water is in short supply.*

David B. Brooks (2006)

CHAPTER 2

THE NEED FOR WATER DEMAND MANAGEMENT

CHAPTER 2: THE NEED FOR WATER DEMAND MANAGEMENT

2.1 General

“Malaysia is blessed with abundance of water” is a common phrase when describing the volume of water resources available in the country. This is true when considering that the estimated renewable water resource is 580 billion m³ annually (FAO 2015) and for a population 31 million (estimated for 2015), the available renewable water resources per capita is then 18,700 m³. This is luxurious compared to the average for Asia and the Pacific at 4,817 m³/capita (ESCAP 2012 & K-Water 2015). Concept Note for ESCAP’s “Water and Green Growth” Workshop 23-25 February 2015, ESCAP, Bangkok, in preparation for the 7th World Water Forum (Draft) (Salmah Zakaria 2015). However, this water availability is decreasing in tandem with population increase. For Malaysia this will decline to 13,800 m³ by 2050 (projected population 42 million) and for the Asia and the Pacific down to 4,055 m³/capita by then. Even this is still relatively abundant compared to other countries.

However, even with the abundance of water, recent events and general trends of water stress and flood events have increased concerns that there are still inherent and serious weaknesses in the overall water management of the country.

Some of these events included the 2014 water stress situation in Selangor and FT Kuala Lumpur and several regions of the country and repeated disruptions in WTP operations due to river pollution. Even the “Great Floods” of 2014 have exposed the low resilience of the water supply systems under flood stresses. The responses to these situations are

increased pressures to develop new dams, increasing pressure to develop groundwater and inter-sector pressures to share water stored in sectorial reservoirs.

The negative impacts of such events are more pronounced in the social and economic environment of a rapidly developing country. These can only be more serious when the country achieves its advance and high-income nation status by 2020. It is not just inconvenience to the public but the severe losses by all sectors of industries and businesses including affecting the long-term confidence of local and foreign investors.

Ideally, the principal water management objective is to seek a balance between supply and demand of water. However, defining that “balance” is by itself a very complex subject. It requires considerations of a multitude of factors related to supply, demand and supply-demand interactions. These have both quantitative as well as qualitative attributes. The factors include land and water resources availability, financial capacity for development and management and the demands of the population and the country’s political, social and economic status. These factors are also time-based and thus the supply and demand management characteristics of today will have to change to meet the needs within the constraints in the future.

2.2 The Need for Higher Emphasis on WDM

In the course of the series of six Strategic Consultations (SCs) on WDM covering Environment, Agriculture, Water Supply and Sewerage and Inter-sector WDM, a number of issues on the water resources status and water management approaches in the country were highlighted. There were also responses amongst the water managers and end users that appear to be ingrained with traditional perceptions and past practices that may not be relevant to the present status and the needs of future water management approaches in the country.

The synthesis following these SCs and supported by references particularly the NWRS 2012 as well as meetings 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 efforts particularly in water savings. These areas of concerns and constraints invariably justify the need for higher emphasis on WDM.

The key areas of present concerns are summarised below:

(1) The Inherent Perception that Water is Abundant for Human Use

The abundance of water is often only a relative comparison of quantities of water between the needs for human activities and the total renewable water resources. Also when comparing it with countries having relatively drier climates. These comparisons have inevitably led to the perception that Malaysia is a water-rich country and water is plentiful for the people and human activities.

This inherited perception is true when comparing water demands for human activities to the total volume of renewable water resources. The total consumptive water demand for human use from the two biggest water sectors, Water Supply (for domestic and industry) and Agriculture, was 14,789 mcm/year in 2010 and projected to increase to 18,250 mcm/year by 2050. This represents only 3% in 2010 and increasing only by 1% to be 4% by 2050 of the total surface water annual yields of 494,260 mcm, the main source of water for these sectors. The reducing projected balance of surface water from 97% (2010) to 96% (2050) is still substantial by the above comparison.

However, what is consistently overlooked is the fact that for the abundance of water resources, the country is also blessed with the wealth of biodiversity and the environment. Therefore, the increase in water demand for human use is in fact an abstraction from that amount of water needed to support that wealth of biodiversity and the environment that is in existence presently. This is incomparable to other drier regions and countries. This is because water is needed not just for human activities but to support the wealth of environment provided by that abundance and this is incomparable to regions and countries with less water.

From this perspective, water for the environment is the biggest, and to a certain extent "consumptive", water user of the available water resources in the country. Presently, there is no policy to limit the amount of water use for human activities as a measure to ensure water adequacy for the environment. The pressure to introduce such a policy is perhaps not yet significant unlike a country like Australia that has already introduced a cap on the amount of water

for human activities as a parameter in its water accounting and auditing process.

Moreover, water is also needed for the passive, non-consumptive users such as fisheries, aquaculture, river transport and tourism. These will also need to be accounted for in the total water management approach.

There is therefore, a limit to the total available water resources for human use and human activities and this requires WDM for the Water Resource supply-demand management as a whole.

(2) Declining Available Unregulated Flow

Available unregulated (uncontrolled) flow for all States in Malaysia shows a declining trend. In fact, five States, all in the Peninsular are already in deficit and declining further towards 2050. Three of these (Perlis, Kedah and Pulau Pinang) are in the Northern Corridor Economic Region (NCER) and the other two (Selangor, Melaka) are in rapidly developing regions.

(3) Declining Water Resources Quality

The declining state of water resources quality is also of concern. Measured in terms of National Water Resources Vulnerability Index (NWRVI), the results of the NWRS 2012 show that all States in the Peninsular are below the Low Vulnerability Category and, of these, five are already in the vulnerable category. Only Sabah and Sarawak are in the low vulnerability category, but only just. One of the major implications is that the projected available unregulated flows may not all be "available" quality wise for human activities particularly for the water supply sector. Another is the impact on the nation's biodiversity and environment. Malaysia has more than one

thousand species under threat (FAO 2014) and water for the environment is one of the important factors for their survival.

(4) Increasing Demands from the Water Supply Sector

As population is projected to increase from 31 million in 2015 to 42 million by 2050 and changing lifestyle that is more affluent than the past and economic growth, the demands for water is also projected to increase in tandem. The NWRS 2012 projected an increased total water demand for Water Supply from 5,277 mcm in 2010 to 9,291 mcm in 2050, a 76% increase over the next 40 years. The challenges on this sector includes increasing pressures to balance the need to develop new water resources with reduction in the NRW and per capita consumption in time to meet the demands as well as ensuring a consistently high service levels for an increasingly urbanised population that is increasing to more than 80% of the total population.

(5) Decrease in Agriculture Water Demand may not be as Projected

Irrigation for paddy remains the biggest water user in the Agriculture Sector and for a long time has been always higher than that for Water Supply. Its total demand is projected to rise from 9,512 mcm in 2010 to 8,959 mcm to around 2050. Thereafter, it is projected to decline steadily and becoming lower than the demand for water supply. This decline is expected from the reduction of non-granary irrigation schemes as well as efficiency improvements. Whilst the shrinkage of the non-granaries could be expected as a matter of policy and economic forces, the granaries are expected to be sustained in line with the agriculture and food security policies.

Unlike the water supply sector that is present in all developed and developing areas of the country, the granaries are regional based. These granaries were initially rural with low-density settlement and development. However, these have changed. Urbanisation, settlement and even industrialisation have increased within and around their respective surrounding areas and regions. The NCER especially is developing rapidly and demands from the water supply sector are increasing in tandem. Three of the major granaries (MADA, IADA Pulau Pinang and IADA Kerian) are in this region. Their respective areas are not anticipated to shrink considerably in the near future. In fact there is a high probability that the MADA granary may expand by absorbing its fringe paddy areas totalling 6,000 ha that will have the impact of further increased water demands. The other granaries too are within their respective corridors of economic regions and experiencing similar changes in development and water demands situations, although at a relatively slower rate.

The issues in these regions hosting the granaries are that the projected water savings would have to depend almost entirely of efficiency improvements. This is not easily achievable and any delays would affect water availability for the other sectors especially the water supply sector. Moreover, the efficiency referred to is the efficiency of conveyance delivery. Improving this is not enough if water is still wasted at the farm levels or non-adherence to schedules or mismatched timing of irrigation delivery with rainfalls on the farms.

Since the NWRS 2012 was completed, four new granaries were established by the MOA (IADA Pekan, IADA Rompin, IADA Kota Belud and IADA Batang Lupar). These are located in relatively rural settings but within the designated

economic development corridors (ECER, SDC and SCORE). The total water demands for both the paddy irrigation and water supply in these regions will inevitably increase (Figure 2.1).

Whilst the demands for irrigation for non-paddy crops are relatively small compared to that for paddy and Water Supply, it is increasing significantly and steadily. This increase is projected to be from 1,117 mcm in 2010 to 1,176 mcm by 2050. Whilst the sum total may not be significant compared to irrigation for paddy and for water supply, it has been shown that in areas of intensive cultivation such as in the Cameron Highlands, the impacts on the water demands as well as water quality could be significant.

A similar situation could develop for the livestock industry and particularly in relation to quality of discharges.

Traditionally, rain-fed crops are also expected to gradually shift to being irrigated. Commercial fruit farms are already irrigated. There are reports of the need for the oil palm sector to be irrigated for increased and sustained high yields. Thus as a whole, there is a high probability that water demands by the agriculture sector may not decrease in time and by volume as projected.

(6) Delays and Deferred Delivery of Proposed Water Resources and Facilities Development

As the country develops, it could be expected that planned water resources and infrastructure deliveries may be delayed or even deferred. There are several reasons for this. Recent experiences have shown that the political processes could be intricate, time consuming and without definite outcomes. Also land resources are limited and that there are new rules and requirements and even international protocols

to comply with especially in relation to environmental and social impact studies. These could also be time consuming and therefore such project deliveries may not be in time to satisfy the projected demands.

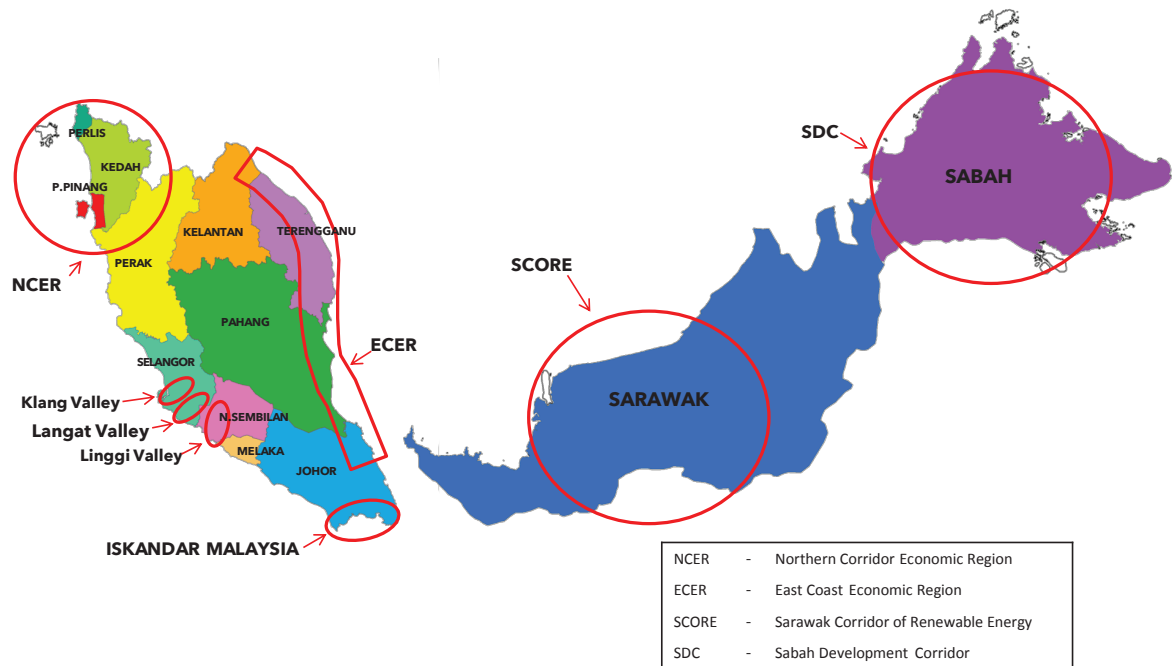


Figure 2.1: Corridors of Economic Development

CHAPTER 3
POLICY AND STRATEGIES
FOR WATER DEMAND
MANAGEMENT

CHAPTER 3: POLICY AND STRATEGIES FOR WATER DEMAND MANAGEMENT

3.1 General

The need for WDM is embedded in the National Water Resources Policy (NWRP 2012) that states *“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 enable by a mechanism of shared partnership involving all stakeholders”*. Four core areas were identified and under Policy Directions for Core Area 2: Water Resources Sustainability; THRUST 6: Conservation and Protection of Water Resources and Bodies, both natural and artificial, the need for WDM is stated under **Target 14: Adopt Measures to Implement Water Demand Management nationwide**. The strategy for this Target is to “determine mechanisms to put into effect water demand management nationwide” and the Strategic Action Plans to “identify options to incorporate water demand management in existing regulatory and administrative arrangements”.

The NWRP 2012 also recognises the importance of stakeholders’ participation and this is emphasised as Core Area 3: Partnership. Following this is THRUST 7: Stakeholder Inclusiveness and Engagement with Target 15: Establish of Mechanism for Formal and Informal Consultation on Matters Related to Water Resources and THRUST 8: Shared Water Resources Governance with Target 16: Develop Framework for Stakeholder Collaboration in Water Resources Governance.

In addition to the above, the NWRP 2012 also includes Capacity Building and Awareness as the

fourth Core Area with THRUST 9: Capacity Building and Awareness and Target 17: Build Capacity of Key Water Resources Stakeholders. In addition to this is Target 18: Improve Understanding and Awareness on the Importance of Water Resources Security and Sustainability.

The special emphasis on participation of all stakeholders is an important aspect of water management for a developed and high income nation. The success of WDM is dependent on the understanding, cooperation and support of policy makers, water managers and ultimately, the end users. The sectorial approach that prevails currently will need to change to an integrated approach for WDM that allows for inter-sector sharing of resources, higher care for water for the environment as well as appreciating the economic value of water by all end users.

The need for higher emphasis on WDM in managing the country’s water resources and sectorial water is now imperative. This change of emphasis for a balanced Water Supply management with WDM is necessary as one of the main strategies to ensure higher levels of water security and water safety for the increasing demands of the population in a high income and developed nation.

As experienced in the recent “Great Floods of 2014” and the water stress situation in Selangor and certain parts of the country in early 2014, the so called “abundance” of water resources in Malaysia is neither an indication nor a measure of **water safety** and **security**.

WDM as an integral and “visible” water management approach should also prepare the public that it should not be a “surprise” that a country such as Malaysia could periodically suffer from water stress situations just as frequently as those with far less water. Instead, the water managers and the public would need to appreciate that **water is a finite resource**, even in relative abundance, and not always available in terms of quantity and quality when needed. Furthermore, these groups should recognise that water resources need to be shared with all sectors including the environment, and that there are limits to the amount allocated for human use.

Therefore, irrespective of the total amount of renewable water resources, future water resources management must be based on the limits of the equitable allocation of water for all sectors and their respective end users. In addition, future water management must also be able to instil appreciation and advocacy amongst all end users that **water has an economic value** and that there is a price to pay for its use (or misuse) and its return to the system.

3.2 WDM Policy

The consensus amongst water managers through the Strategic Consultation series and personal communications is that there is no real need for a specific WDM Policy. After all aspects of WDM is currently in practice by the two major water sectors, namely the Water Supply sector and the Agriculture Sector. Also WDM has been cited as one of the main strategies for water management under the National Physical Plan No. 2 (GoM, JPBD, 2010). It is also one of the recommended approaches for Climate Change impact adaptation by several international organisations, including the UN-ESCAP (2012). It

is also included in the Water Services Industry Act (GoM, SPAN, 2008).

The need now is to reinforce WDM in the relevant existing policies (such as the NWRP) and the proposed Water Resources Act such that it is visible and implemented with full support of the Federal and State Governments. In addition, laws (e.g. the Irrigation Areas Act (1953)), regulations and institutional operational policies too could be revised to include more distinct mention of WDM as a matter of policy. These policies could then be translated into specific implementation plans in the Five-Year Malaysia Development Plan series (Rancangan Pembangunan Malaysia).

The policy objectives should also be structured such that it is not only to address water saving issues within sector but also to incorporate the responsibilities of all sectors to return good quality water back to the water resources system for inter-sector use and reuse. This is also for inter-sector WDM to reduce the need for freshwater use as well as to ensure adequate water for the environment.

In addition, the WDM policy objective should include the need to manage water as a natural capital for value adding to the economic growth and wealth creation for the country. This should be in terms of technology ownership, business and employment opportunities. This policy would also require the active and concerted participation of the public and the private sector with the Government towards developing the water sector as one of the NKEAs under the ETP.

3.3 Developing the Strategic Action Plan (Masterplan)

The development of strategies and subsequently the WDM masterplan and implementation plan is based on the ABCDE+F framework tool (Perry 2012). This is a simple tool for a rapid development of strategies and plans for water related development and modified for use in this study.

The output is a matrix of key elements that requires consideration in planning and developing strategies as well as action plans. It is “interactive” in that a factor in one element (e.g. the need for accounting in “Accounting”) will require some form of one or more responses from the other elements (e.g. measurement tools in “Engineering”, decisions on sectorial water allocation in “Bargaining”, distribution of responsibilities in “Delegation”, rules, regulations and standards in “Coding”, and data and information sharing in “Feedback”).

The elements in the ABCDE+F framework are as follows:

Accounting—the process of knowing how much water of which quality is available at a management unit (country, basin, city, irrigation system, WUG) and how it is used. Rational planning begins with sound estimates of the extent of resources available, the pattern of current use (abstraction, diversion, consumption, return flows) and how proposed interventions will affect these flows. Accounting also provides the basis for auditing as part of the performance review process, and communicating the results in a timely manner to non-specialists, ordinary citizens, and policy makers. Understanding these interactions and the constraints and trade-offs they imply will drive the required “coalition for change” to

begin a serious debate that leads to and guides the WDM process.

Bargaining—the political and sectorial process of setting priorities for the allocation of water among competing uses and users, including the environment at the various levels of the system (basin, irrigation system and sub systems). This process accommodates the “managed” demand side for present and future needs for water and services and also includes consideration of risk management strategies for water, food and energy security, the environment, and varying priorities under normal conditions, periods of water shortage and emergency situations. This is also the place where the policy questions/dilemmas like food security vs. productivity come into play. Issues of principle—such as the circumstances and mechanisms under which water can be re-allocated, allowable over-abstraction rates for non-renewable resources, etc.—also fall within the political and sectorial sphere.

Codification—formalising the outcome of the bargaining process as operational policies, rules, regulations and procedures. While ‘B Bargaining’ may establish some quantitative elements of the service levels at each sectorial interface, specific rules and decision variables will still be necessary.

Delegation—the institutional arrangements for implementation of rules and procedures related to the provision of services, the management of assets that includes investments, the sharing of costs and resources and associated administration. The ultimate financial arrangements, funding mechanisms and availability of funds are essentially result of the negotiation process (in B).

Engineering—this includes STI for the infrastructure storage, conveyance, flow control, groundwater/surface water conjunctive use technology necessary to provide and monitor the provision of the agreed levels of service.

Feedback—the process of monitoring and corrective action taken by the parties involved within the ABCDE interactions, including monitoring of investments and results, and responding to new situations such as construction of a new storage facility that changes water availability, or exogenous factors such as climate change. Equally important is that this will need to include the cost/price and value of water so as to make the end users understand and appreciate the actual value of the services to supply water and therefore the need to save water.

The proposals here are no means comprehensive and indications of priorities are not provided. This would require a comprehensive study by the respective sectors and water resources and environment managers. However it does provide a good initial outline of areas of focus that are inter-related and necessary to implement WDM. This effectively is the outline of the WDM Masterplan.

3.4 The Inherent Characteristics of Water Management

The study established that there is a general consensus for WDM to be given higher emphasis in the national water management approach. However, in the process of this study a number of inherent characteristics of water management were highlighted that need to be appreciated in understanding the need for WDM and subsequently addressed in developing strategies and actions plans for future WDM. These inherent characteristics are

seen to be constraints to previous and present efforts for WDM.

1) Perception of the “Abundance of Water”

The perception that water is abundant and should always be available continues to prevail amongst the end users. This perception is also held by some of the Water developers and water managers.

2) Higher Emphasis on WSM compared to WDM

The momentum gathered for WSM during the country's rapid development phase continues. Forward planning for water resources development continues to be based on WSM with definitive plans for more dams for example. Whilst this is still necessary, plans for WDM is still insignificant and there is reluctance for investments in WDM programmes and projects such as for reduction of NRW in the water supply sector and water use efficiency in paddy irrigation.

3) Resistance to charge and reluctance to pay for water services

Charging and paying for the real price of water services continue to be a contentious issue for all the water sectors. Many of the water managers concur with the opinion that without charging appropriate price for water services, efforts for water savings would remain ineffective. This is not just in terms of tariffs for the water and sewerage sectors but also for agriculture.

4) The water industry is not an “attractive” sector for economic growth

Compared to the other utility sectors (e.g. energy and communications), the water industry continues to be seen only as supporting services and therefore not recognised as one of the National Key Economic Areas under the ETP. The water sector is also seen as essentially “trapped in time” for being the first established to provide basic needs of “safe drinking water” and irrigation to improve the lives of the relatively poor population in the past. Under the present circumstances, comparing revenues of water supply and sewerage sector (based on data from SPAN) with that of the two major utilities namely communications and energy show vast disparity. The communication sector revenue is more than 11 times that for water supply and more than 97 times that for sewerage! The energy sector revenue is more than seven times that for water supply and more than 67 times that for sewerage.

5) Lack of national ownership of STI in the water industry

Although the water industry offer vast opportunity for the country to develop and own technologies there is yet to be any significant product. One of the characteristics of advance countries is ownership and export of advanced technologies.

6) Lack of comprehensive data and information on groundwater resources

The pressure to develop groundwater resources continue to increase especially during the periods of water stress such as that experienced during the 2014 prolonged water stress situation

in the Klang Valley. However there is still a lack of comprehensive data and information on the characteristics and potential yields of groundwater resources for extensive and sustainable abstraction points.

7) Weak public participation in water management

Although there are provisions for public participation in the form of a water forum for the water supply and sewerage sector and water user groups for the paddy irrigation sector, these have yet to be “visible” and organised to allow for full interaction between the water managers and the end users. These platforms are also confined to within the respective sectors without a defined connection to the water management system as a whole.

8) Embedded sectorial approach in water management

The years of higher emphasis on Supply management against the backdrop of the abundance of water relative to demands have embedded the Sectorial approach for a developing country. Each sector has developed and in control of its own facilities particularly dams. Many of these dams were developed well before their downstream areas have developed to the present day levels and the pressures for the sectorial dam to adjust to the present day needs are increasing.

9) **Disparity between Federal and State and Inter-state water management approaches**

Whilst there is strong respect of the sovereign rights of each State to manage its water and that policies are mostly consistent with the Federal policies, the water management approach and priorities of the respective States are often quite divergent and inconsistent. Water supply tariffs for example and raw water charges and rates differ between States. The water institutional structure also differs between States. These situations are seen as one of the major constraints to implementing effective WDM.

3.5 Characteristics of a Developed and High Income Nation

In developing the strategies and masterplan, the characteristics of a developed and high income Nation has also to be considered. This is necessary not only to prepare for the anticipated change in the socio-economic situation but to identify opportunities that would support the WDM implementation as a whole.

The main characteristics that were considered are:

1) **Harmonised policies and laws for water management for the country**

Australia is a good example as its Federal-State (Commonwealth) structure is similar to that of Malaysia with the States having sovereign rights over land and water. However, following issues of environmental degradation and water stress situations, the States accepted that in the interest of the nation, there is a need to harmonise the way water is managed. This was implemented

in a concerted manner and included introducing new rules and regulations and codes of practices.

2) **Realistic tariffs and rates for water supply and raw water**

As high income Nations, the public and the industry in general need to pay for more realistic tariffs and rates for water supply and raw water in return for transparent and high service levels.

3) **Care for the environment**

The society in developed countries tends to have higher care for the environment. The Australian major water management reform was in fact induced by public outcry over the environmental deterioration in the Murray-Darling river basin.

4) **High level of public participation in water management**

There are higher levels of public participation of the public in developed countries. In France and United States there are many Water User Associations (WUAs) formed by communities interested in various aspects of water management, such as water supply, river care, water bodies and irrigation. These WUAs also are referred to in all matters regarding water management including WDM especially in times of stress. In Australia, there are public forums at local levels and also web-based sites for public discussions. In the Australian water reform exercise, these are one of the major channels for discussions, information sharing and for preparing the public for the changes in water management approach.

5) Ownership of leading edge technologies

Leading edge technology ownership is one of the characteristics of developed countries. Solutions towards solving present and anticipated future problems and issues appear to have special programmes well supported or facilitated by those Governments. Some examples are water recycling plants, hydrological and hydraulic software development and climate change projections. Many of these technologies are already internationally accepted and applied in developing countries.

6) Established water R&D institution

Developed countries have advanced R&D institutes for the development of leading edge sciences and technologies. Some examples include the UK Water Industry Research (UKWIR), Delft Hydraulic Institute, the Netherlands; K-Water, Korea and eWater, Australia. Development of R&D for the water industry is discussed in more detail in Chapter 5.

7) A distinctly structured water industry sector

The water industry (public and private sectors) in developed countries is distinct and well-structured especially for the water supply sector. With a distinct structure the role of the water management in economic growth, and not merely a support service, is more “visible” and appreciated by both the government and the public. Water is seen not only as a natural resource but also as a natural capital for economic growth. This in turn provides for the motivation and earnest for the industry to progress and develop further for wealth creation and thereby gains the strong support of the public and the government.

CHAPTER 4

IMPLEMENTING WATER DEMAND MANAGEMENT STRATEGIES

CHAPTER 4: IMPLEMENTING WATER DEMAND MANAGEMENT STRATEGIES

4.1 Implementing WDM Strategies

WDM is about water savings and increasing water use efficiency. Traditionally, it is confined to the major consumptive and non-consumptive water users.

There are no standard and specific definitions of consumptive and non-consumptive water use in Malaysia. Several attempts have been made to obtain a consensus amongst international water organisations and practitioners (Christ Perry; pers comm.) to account for the changes and concern on water use and climate change impact and adaptation needs.

For some, water “losses” through evapotranspiration is the only “consumptive” component of water use since the remainder is still usable for other demands. China is one of the countries that adopts this definition in developing irrigation systems. There are some that opt to define consumptive water as “the volume diverted away from an existing system and not returned to the same system for further use downstream irrespective of the returned water quality”. In this case, water resources development that transfers water into another basin and not returned to the original basin is categorised as for consumptive use with respect of the source basin.

The traditional and widely accepted “definition” in Malaysia and elsewhere is that consumptive water use is for human activities with elements of “consumption” such as for domestic and industrial water supply, irrigation and livestock and for ecosystem. Water for hydropower and aquaculture/fishery are categorised

as non-consumptive. In addition, the water-based activities within the tourism sector are also categorised in a similarly way.

This chapter is confined to the following major consumptive and non-consumptive users of water, the conceptual sectoral connectivity of the WDM Strategies and Masterplan (see box below). References have been made when reviewing some relevant recent studies and reports notably Sarawak (SIWRM Study, 2009), NWRS (2012), SPAN Performance Report 2014 and MWIG 2015.

Consumptive Water Use Sectors

- 4.2 Water Supply and Sewerage Services WDM
- 4.3 Agriculture WDM
- 4.4 Ecosystem WDM (Environmental needs)

Non-Consumptive Water Use Sectors

- 4.5 Hydropower WDM
- 4.6 Navigation WDM
- 4.7 Recreational WDM

4.8 Inter Sector WDM

4.9 WDM Strategies and Masterplan

WDM for Consumptive Water Use Sectors

4.2 Water Supply and Sewerage Services WDM

Water Supply and Sewerage Services sector (together with agricultural sector and inter-sector water management) needs to be linked to economic growth with increased emphasis on WDM. WDM is a component of the water services sector which is part of the overall Services Sector.

Implementing WDM provides tremendous opportunities for economic growth and employment. It is important that the message of responsible and efficient water use continues to be promoted by applying WDM in overall water services. The role of water services in all aspects of economic and social development in the country is vital even though the current water services sector contribution to GDP appears to be insignificant when compared to overall services sector, recognised by the government as the main source of contribution to GDP at 55 % (Services Sector Masterplan, March 2013). In developing strategies to enhance WDM in Malaysia, a main characteristic to accept is that water is seen not only as a national resource but also as a natural capital for economic growth—the concept of water as an asset and is tradable.

In fact, contribution by water services sector can be considerable to enhance the tradability of Malaysia's water services and transform them into a sizeable water industry with tradable expertise in such areas as water assets (in the manufacturing, construction, agricultural activities, catchment management, etc.), infrastructural development and high end R&D. Such a specialisation could thus accelerate the water industry for sustainable economic growth and be recognised as one of the National Key Result Areas and thus effectively

contribute to the targeted GNI and employment opportunities.

The Prime Minister when launching the Services Sector Blueprint and Logistics and Trade Facilitation Masterplan on 16 March, 2015 at the Parliament was reported in The Star to have said that "To reach our goal, we need to chart strategic measures to ensure that our services sector is based on knowledge and high productivity, is tradable and can create more high-income jobs". Water services sector productivity still has room to grow when compared with other sectors like banking, insurance, energy, communications and others. To start with, it is worth noting that a potential outcome of successful WDM implementation for water supply and sewerage services at national level in 2020, would yield a favourable result of about RM1.23 billion annually from saving in water consumption shown on Table 4.1. The figure would be much higher should right pricing of water is used.

Table 4.1 : Outcome of WDM Implementation

Potential National Water Saving (in 2020)

No.	Water Saving	MLD
1.	Non Revenue (NRW)	3,154
2.	Water Consumption (capped@180 l/c/d)	2,812
3.	Wastewater Recycling (for non-potable purposes)	4,000
Total		9,966

Total potential saving is about 50% of total water demand (18,618 MLD) in the country.

Saving on water consumption above (2,812 MLD) means a saving on Opex of about **RM1.23 billion** annually.

Summary of WDM Strategic measures for Water Supply and Sewerage Services are as follows:

Strategies	Time Horizon	Measures	Budget	Expected Outcome	Host
1. Adopt Water Demand Management in Policy Decisions	2020	Specific policy measures to be enacted		Contribute to greater than expected economic growth	Federal and State Governments
2(a) Upgrade water supply and sewerage services systems to "Operation Excellence" level 2(b) Need for central regulating agencies in Sabah and Sarawak (Similar to SPAN)	2020 2020 (and beyond)	Establish training centres in Peninsular Malaysia, Sabah and Sarawak Regulate water supply services and sewerage services for Sabah and Sarawak	RM50 million	Upgraded skills and knowledge to meet management commitments in WDM More effective and holistic water management	KeTTHA, SPAN and State Governments State Governments of Sabah and Sarawak
3. Reduction in NRW to 25% for Peninsular Malaysia	2020	KPI requirement	RM6.68 billion	Expected savings in reduction of water losses	KeTTHA, SPAN and State Governments
4. Water Tariff Adjustment and appropriate tariff structure to reduce wasteful consumption	2020 (where possible)	Establish tariff setting mechanism		Saving in Opex of RM1.23 billion for Malaysia annually (for usage at 180 l/c/d by 2020)	KeTTHA, SPAN and State Governments

Strategies	Time Horizon	Measures	Budget	Expected Outcome	Host
5. Promotion of Reducing, Recycling and Reuse of Water (All sources of water including Groundwater, Rainwater Harvesting and Stormwater)	2020 for water scarce areas	Feasibility study to develop water recycling plant in Nusajaya	RM37.2 million	About 25% of total water production of the country available for non-potable use from wastewater recycling. About 11.6% from recycled wastewater in Bintulu, Sarawak	KeTTHA, SPAN, IWK and State Governments
	2020 for water scarce area	Water recycling or reusing in major water using industries		At least 30% as recycled or reused water. Vital in water-scarce heavy industrial areas of Pulau Pinang, Melaka, Selangor, FT Kuala Lumpur, Labuan and Bintulu Region (Sarawak)	KeTTHA, SPAN and State Governments
	2020 for aquifer mapping	Geophysics surveys to locate and map groundwater aquifer prior to drilling and well development activities.	RM42.6 million for mapping in North Kedah, Perlis, Selangor and Bintulu, Sarawak	Electromagnetic surveys and integrated work flow & drilling	JMG and State Government

4.2.1 Background

Generally, management of water services requires providing adequate regulatory, institutional and legal framework for efficient delivery of services.

The Federal Constitution was amended to transfer water supplies and services from State List to Concurrent List via Constitution (amendment) Act 2005 (AA 1239/2005) to enable the consolidation of the water management and the regulatory functions of water services for the country (except for Sabah and Sarawak). This amendment enabled Federal Government to regulate the water services industry

in a more holistic manner together with sewerage services industry (which is already under the jurisdiction of the Federal Government). Water supply services in Sabah and Sarawak are State matters. The constitution amendments enabled the enactments of two Acts, namely The Water Services Industry Act 2006 (Act 655)–WSIA 2006–and SPAN Act 2006 (Act 654) which came into effect on 1 January, 2008. The SPAN Act created the National Water Services Commission (SPAN). The Acts aim to foster greater interaction between water and wastewater sectors driving towards sustainable water cycle management in the country.

Chart 1: Entities Regulated by SPAN
(As modified from SPAN Annual Report 2013)



SPAN is responsible for the eleven states in Peninsular Malaysia and the Federal Territory of Labuan. The states are Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang, Selangor and Terengganu. Section 36(1) of WSIA 2006 (Act 655) specifies that it is the duty of every service licensee providing water supply (and sewerage) services to maintain an efficient and economical water supply system. This implies that it is the duty of the licensee to operate and maintain the water supply system at the best possible level to meet the full coverage of the demand by the population without fail. This is reflected in the ability to scale up to achieve best practices in the whole chain of production and delivery of water to meet demands of consumers and users of water. Chart 1 shows entities regulated by SPAN.

Water Demand Management in Sabah can be managed in an integrated manner through the Water Resources Council as all the main water user agencies are members to the council.

As provided for in the Sabah Water Supply Enactment 2003, the custody, management and administration of the water supply system is vested in the state water authority which may delegate the powers to any officer of the state water department as director of water supply department and responsible for the nine water divisions shown in Table 4.2.

NOTE:

- * Main water demand related agencies
- ** Dept of Public Works with the responsibility of managing Sewerage Services in Sabah can be appointed under this or to amend the legislation to include them

- 1) Chairman
- 2) Secretary of Natural Resources Office (Secretary)
- 3) Permanent Secretary, Ministry of Culture, Environment and Tourism
- 4) Director, Dept of Land and Surveys
- 5) Director, Dept of Forestry
- 6) Director, Dept of Agriculture*
- 7) Director of Water Resources
- 8) Director, State of Planning Unit
- 9) Director, Dept Town and Regional Planning
- 10) Director, Dept of Irrigation and Drainage*
- 11) Director, Fisheries Department
- 12) Director, Water Department*
- 13) Director, Dept of Ports and Harbour
- 14) Director, Dept of Environment
- 15) Director, Dept of Mineral and Geosciences
- 16) 2 Appointed members with appropriate technical or academic expertise**

Table 4.2 : Sabah Water Divisions

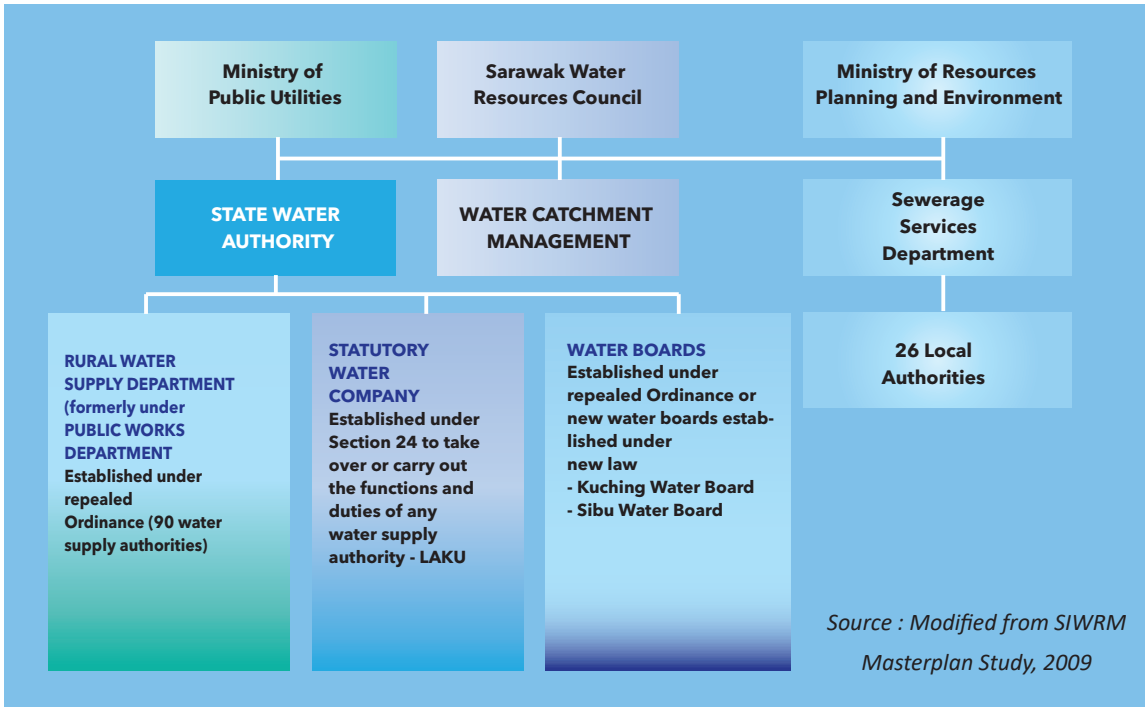
WATER DIVISIONS	ADMINISTRATIVE DISTRICTS
Kota Kinabalu	Kota Kinabalu, Penampang, Tuaran, Papar
Sandakan	Sandakan, Kinabatangan, Beluran
Tawau	Tawau, Merotai, Pulau Sebatik
Keningau	Keningau, Nabawan, Tambunan, Tenom Sook
Beaufort	Beaufort, Sipitang, Kuala Penyu, Membakut
Kudat	Kudat, Kota Marudu, Pitas
Kota Belud	Kota Belud
Ranau	Ranau, Telupid, Pinangah, Tongod
Lahad Datu	Lahad Datu, Semporna, Kunak

Source: JANS 2015

Among the functions and duties of the state water authority, relevant to WDM, are to regulate and control the supply of water, exercise regulatory functions as prescribed under the enactment and regulations made there under, to review the regulations and make recommendations to the Minister.

As provided for in Sarawak Water Ordinance, 1994, the state water authority, under the Ministry of Public Utilities, has the general control and supervision of all water supply authorities, the management of all water resources and water catchment areas in the State as shown in Table 4.3.

Table 4.3 : Sarawak Water Supply Administration



For water supply, 16 Regional Demand Zones have been established since 2009 for the purpose of planning, as shown in Table 4.4.

In Sabah, currently, the local authorities are the responsible authorities for providing urban services including the operation and maintenance of treatment of sewage in their respective districts. There are 22 local authorities in Sabah (NWRS 2012) including City Hall covering Kota Kinabalu (DBKK). With the exception of DBKK, all local authorities have entrusted, through construction and payment agreements, the task of planning and construction of the centralised sewerage treatment system to the Public Works Department (Sewerage Services Division). Management of sewerage services in Sabah is scheduled to be taken over by the Public Works Department (Sewerage Services Division) in 2016.

The sewerage systems in most part of Sarawak are managed by Local Authorities. There are 26 local authorities in Sarawak (NWRS 2012). The Sarawak Sewerage Services Department under the State Ministry of Resources Planning and Environment is responsible for sewerage services.

In Sabah and Sarawak, there are no central regulatory bodies responsible for both water supply and sewerage services, similar to SPAN. In the future, it would appear best for such a regulatory body be set up for the benefit of overall water services industry, especially in minimising environmental degradation.

4.2.2 WDM Strategies for Water Supply and Sewerage Services

As a developing country with so much promise for economic growth and development, Malaysia has far exceeded the UN Target of Millennium

Table 4.4 : Regional Demand Zones

RDZ	Name	District
1	Kuching	Kuching Asajaya Bau Lundu Samarahan
2	Serian	Serian
3	Simunjan	Simunjan
4	Sri Aman	Sri Aman
5	Lubok Antu	Lubok Antu
6	Betong	Betong
7	Saratok	Saratok
8	Sarikei	Sarikei Bintangor (Meradong) Pakan
9	Sibu	Sibu Kanowit Matu Daro
10	Mukah	Mukah Dalat Selangau
11	Tatau	Belaga' Song Tatau
12	Kapit	Kapit
13	Bintulu	Bintulu
14	Miri	Marudi Miri
15	Limbang	Limbang
16	Lawas	Lawas

Source: NWRS 2012

Development Goals: albeit not strictly keeping to Sustainability Expectations such as improving operational efficiencies and ensuring financial sustainability operations of the utility. However, with the introduction of National Transformation Agenda towards "VISION 2020" over the past decade,

there is now a substantial pledge on Sustainable Development with stronger emphasis on WDM.

It is globally accepted that best practice in water supply and sewerage services is developed within the concept of WDM. Among the strategies adopted include:

- Adopt WDM in policy decisions
- Upgrade water supply and sewerage services systems to “operation excellence” level
- Reduction in Non-Revenue Water (NRW)
- water tariff adjustment and appropriate tariff structure to reduce wasteful consumption
- Promotion of reducing, recycling and reuse of water (all sources of water including groundwater)
- Engaging the consumers and the public on awareness (water conservation initiatives)
- Technology and incentive to achieve more efficient use; and
- Rainwater harvesting in urban and rural areas for usage permitting lesser water quality.

The eight strategies mentioned above provide greater impacts in WDM implementation in the context of water conservation. The following three strategies are already subjected to mandatory and enabling legislation, regulations, policies, standards and guidelines and are positioned to make contribution to WDM. These are:

- Mandatory use of efficient products
- Encouraging use of water products by labelling
- Water audit of large water users

These three strategies play significant roles in determining water consumption and conservation patterns and the first two strategies will be discussed later under technology and incentives to achieve

more efficient use. As regards water audit of large water users, SPAN plans to make it compulsory for the “large consumers” to undergo a water efficiency audit. Large consumers include premises using high volume of water such as hotel, industrial complexes, shops, educational institutions, military and police bases. Based on audit experience conducted on a few hotels in the country, water consumption saved amount to 20% to 30%.

4.2.3 Adopt WDM in Policy Decisions

The national policy objectives for water supply and sewerage services industry set by the Federal Government has taken WDM into consideration. Among the objectives are:

- To establish a transparent and integrated structure for water supply and sewerage services that deliver effective and efficient services to consumers. (SPAN has been established for states in Peninsular Malaysia and Labuan)
- To ensure long-term availability and sustainability of water supply including the conservation of water
- To contribute to the sustainability of the water courses and the water catchment areas
- To facilitate the development of competition to promote economy and efficiency in the water supply services and the sewerage services industry
- To establish a regulatory environment which facilitates financial self-sustainability amongst the operators in the water and sewerage services industry in the long-term
- To regulate tariff and to ensure the provision of affordable services on an equitable basis; and

- To establish an effective system of accountability and governance between the operators in the water services and sewerage services industry.

WDM is not expressly addressed in the WSIA 2006 (Act 655) or (Act 654). However, the implied provisions in the Acts address issues pertaining to WDM. For example:

- Section 15 of Act 654 clearly indicates the function of SPAN to implement and promote the national policy objectives.
- Section 180(o) of Act 655 empowers SPAN to make rules on all matters relating to the prevention against wastage, undue consumption, misuse, contamination of water and to provide for the proper use of water fittings to ensure the safety of the public.
- Act 655 and Act 654 do not encroach and do not affect the existing powers of the State over water source and water resources guaranteed under the Federal Constitutions. SPAN only aids, where necessary, in advisory capacity.

SPAN has all the functions imposed on it under water supply and sewerage services laws which include the following:

- To advise the Minister on all matters in relation to the national policy objectives of the water supply and sewerage services laws and to implement and promote the national policy objectives.
- To implement and enforce the water supply and sewerage services laws and to consider and recommend reforms to the water supply and sewerage services laws.

In view of the above provisions, WDM could be embedded in the current governance structure by recommending reforms to review water supply and sewerage services systems to ensure a dedicated WDM unit be formed as an integral part of the operating system. This unit would be tasked with the following:

- To ensure the productivity of the water supply services and sewerage services industry and the monitoring of operator compliance with stipulated service standards contractual obligations and relevant laws and guidelines
- To increase concerted efforts towards improving the operational efficiency of the industry and in particular the reduction of non-revenue water through short-term, medium-term and long-term programmes
- To advise the Minister on a fair and efficient mechanism for the determination of tariffs that is fair to both consumers and licensees and to implement tariffs that have been established through appropriate mechanism and tools
- To ensure the national development goals pertaining to coverage, supply and access to water supply services and sewerage services are achieved
- To ensure long-term sustainability of quality of water and sewerage services through continued capital works development
- To formulate and implement a plan so that all reasonable demands for sewerage services are satisfied and in consultation with the relevant authorities, prepare a sewerage catchment plan formulating the policy and general proposals in respect of the development of any new sewerage system and measures for improvement of any existing sewerage system

- To carry out any function conferred upon it under any other written law; and
- To advise the Minister generally on matters relating to water supply services and sewerage services.

Act 655 (Section 171) provides for the establishment of the Water Industry Fund which is controlled and operated by SPAN. This fund consists of contribution made by water and sewerage operators. The Fund is beneficial in WDM implementation and expended for the following purposes.

- The protection and preservation of the watercourses and water catchment areas.
- To ensure sustainability of water supply from the watercourses.
- The improvement of water quality at the watercourses.
- The provision of water and sewerage services in rural developments, or
- Such other purposes as may be determined by the Minister.

(It should be noted at this juncture that SPAN has yet to set up and implement the Water Industry Fund).

Establishing effective central regulatory bodies in Sabah and Sarawak is worth considering with the objective of regulating water supply and sewerage services that deliver effective and efficient services to consumers. It is increasingly difficult to adhere to this objective as populations grow, demand for food and energy rise, the climate changes and environmental sustainability becomes increasingly important with rapid economic development of the country.

4.2.4 Upgrading Water Supply and Sewerage Services Systems to “Operation Excellence” Level

The main challenge in WDM implementation is the ability of the licensee or the operator to scale up to “Operation Excellence” level before embarking on any strategic WDM undertaking. This includes the setting up of “one call centre” for consumer services. The two categories of licensees or operators are in the water supply and sewerage services industries. Ideally for these categories, the operators and the licensees should be “single purpose entity” either managed as a statutory body, corporatised or privatised holding an individual licence under WSIA Act 2006 (Act 655). All water supply and sewerage operators in Peninsular Malaysia are licenced under the Act.

The ratio of trained manpower to consumer connections should be in the order of 450 – 500 for water supply services.

To achieve “Operation Excellence” level, there should not be any shortage of trained manpower to operate and maintain water supply and sewerage systems. The need for adequate manpower to efficiently manage water supply and sewerage undertakings was brought up for discussion during the *National Colloquium on WDM (2009)* and at the six *Strategic Consultations (2012 – 2014)* organised by the ASM. 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 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 on outsourcing services by water operators and also level of automation of the facilities. The above ratio assumes 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. It was also concluded that an approximate budget allocation for continuous training of staff averages around RM2,000 per staff member per year, apart from NRW investment. Until they become self-sustaining with adjusted Water Tariff, the smaller water operators may continue to be subsidised by the government.

The current skilled manpower ratio of IWK is approximately 1 per 1,000 connected accounts. The ratio should be decreasing over time – IWK

The main challenge in WDM implementation for sewerage services is to ensure that returned water to receiving water is adequately treated after use in order to avoid pollution of water sources. Recycling of treated wastewater as a resource may be considered

as a potential source for future use for non-potable purposes after further treatment. The operations of sewerage systems include sewer maintenance, sewage treatment plant operations, and sewage services. For these, IWK as the national sewerage company provides services to 21 million population equivalent in most parts of Peninsula Malaysia excluding Kelantan, Johore 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 kilometre 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 attentions. The average budget allocation for continuous training of staff averages around RM1,000 per staff member per year.

The main challenge for sewerage services in Sabah and Sarawak are, first: to eventually come under a State Regulatory Body together with Water Supply Services since both are closely connected; second: to provide central sewerage services to all urban and developed areas to meet the social, economic and the environment requirements of the people.

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. Centralised or regional training institutions need to be established, recognised by the Government, as a matter of urgency in Peninsular Malaysia, Sabah and Sarawak.

Training is always a challenge to any organisation due to high cost in providing infrastructure and training experts on full time basis. It is envisaged among leading water and sewerage operators that a budget of RM50 million would be required from 2015 to 2020 to maintain the training institutions in Penang and IWK and establish new ones in Selangor, Johor, Sabah and Sarawak. So far, Penang is known to have 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.

MWA can lead the industry 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. MWA has been set up for this purpose with key areas identified to meet industry workforce development needs including strategies for training expansion and R&D.

Ideally, as a long-term measure, the development and establishment of a Malaysian Water Hub (MWH) has been mooted among some water industry circles as the most acceptable regional centre of excellence for water and sanitation, particularly, in innovation, research and technology advancements. MWH, preferably led by a Government Agency, will serve as a platform, under one roof for governance, business, technology advancements, creativity, innovation, research, education, training, knowledge, best practices in the water and wastewater sector to be nurtured, developed, enhanced, networked, shared and disseminated to stakeholders. The suggested MWH is further identified at Chapter 5.

It is, therefore, imperative that all operators must be ready with adequate manpower to be trained, with sufficient budget allocation for capacity building, and eventually ready for upgrading to "Operation Excellence" level status. So far, based on various indicators, it is observed that only Selangor, Pulau Pinang, Johor and Melaka have achieved this status in Water Supply management and IWK in the management of Sewerage Services.

4.2.5 Reduction in NRW

A sizeable component of NRW is water leakage. Among the methodologies employed include Human Capital Development, which is vitally important and this has been mentioned earlier. Equally important is the response time to pipe burst, leak repair, pressure management, reduction in commercial loss, leak detection activities, replacement of inaccurate meters, enforcement on water theft, reservoir overflow control monitoring and rectification. Setting up Water Asset Management and continuous Manpower Training System would provide long-term benefit towards reduction in NRW.

Pipe replacement programmes is an important asset replacement programmes with the secondary benefit of NRW reduction. It can be an integral part of NRW strategic plan. In the preparation of this programmes, pipe sections to be replaced must first be ascertained based on pipe condition, burst and leak record, pressure regime and record of background leakage.

The outcome of a successful NRW implementation can be most rewarding. For Peninsular Malaysia, SPAN has set up long-term NRW target over ten years commencing from 2011 for each operator towards achieving the national target of 25% by year 2020 for Peninsular Malaysia.

Table 4.5: Reduction in NRW

	At 2020 without water demand management (mld)	At 2020 with NRW reduced to 25% (mld)	Quantum saved with NRW reduction (mld)	% reduction in Total demand with NRW reduction
Peninsular Malaysia	14,940	12,604	2,336	15.6
Sabah	1,859	1,181	678	36.5
Sarawak	1,771	1,631	140	7.9
Malaysia	18,570	15,416	3,154	17.0

Source: NWRS 2012

If the target is achieved in 2020, the volume of water saved is likely to be 2336 mld which represents a reduction of about 15.6% of total demand. (Table 4.5).

Volume of Water Saved in Peninsular Malaysia if NRW target of 25% is achieved by 2020 is about 2336 mld (15.6% of total demand) SPAN.

If the target of 25% is equally applied in 2020 for Sabah and Sarawak, the likely volume of water saved for the states would be:

Sabah : 678 mld (36.5% saved)

Sarawak: 140 mld (7.9% saved)

Looking to the future (2050), there is the prospect of reducing leakage, towards minimum background leakage. Employing the methods and tools we have now it may be feasible to reduce leakage to an economically acceptable level. Singapore has achieved 5% NRW and Australia 7% NRW. One option is to invest in R&D work and human capacity development to learn how to achieve this level for Malaysia. Suggestions for R&D in the area of reduction of NRW are identified in Chapter 5.

Regionally, Selangor, Perlis, Kedah, Pulau Pinang and Melaka are already facing treated water deficits (NWRS 2012). Sabah has been reported (at SC6-WDM for Sabah) to be not seriously affected during prolonged droughts as storage dams have been provided at strategic locations in Kota Kinabalu, Sandakan, Kudat and Lahad Datu to meet domestic and industrial demands. Storage dams are being planned for Tawau, Keningau and Sipitang. On the other hand, provision of storage dams can be an indication of water scarcity in the form of controlled flow water deficits that borders on unsustainable development conditions. Bintulu has been identified at SC5 (WDM for Sarawak) as one of the major focus areas for SCORE development plan. There is urgent need for the development of new works as presently the WTP capacity meets demand with practically no margin. The benefits from the success in NRW implementation, in 2020, in terms of volume saved are shown in Table 4.6.

- Selangor (including Federal Territory of Kuala Lumpur and Putrajaya) – 398 mld that is about 8.4% of total demand.
- Perlis, Kedah and Penang – 549 mld that is about 18% of total demand.

Table 4.6: NRW Implementation

	At 2020 without water demand management (mld)	At 2020 with NRW reduced to 25% (mld)	Quantum saved with NRW reduction (mld)	% reduction in total demand with NRW reduction
Selangor	4742	4344	398	8.4
Perlis, Penang and Kedah	3052	2503	549	18.0
Bintulu (Sarawak)	280.02	280.02	0	0
Langkawi (Kedah)	107.57	87.06	20.5	19.1

Source: NWRS 2012

- Bintulu, Sarawak has achieved 25% and therefore no reduction shown. Should Bintulu manage a reduction of NRW to 15% by 2020, there would be a saving of at least 17 mld.
- As a special case, Langkawi (Kedah), NRW reduction will be 20.5 mld that is 19.1% of total demand.

Further WDM considerations are later proposed under recycling and reuse of wastewater, reduction of wasteful consideration and conjunctive use of groundwater.

RM6.68 billion has been estimated in order to achieve SPAN's NRW target in 2020 for Peninsular Malaysia.

Most states in Peninsular Malaysia are projected by SPAN to achieve 25% or less by year 2020 (WSIPR, 2013). Currently, Pulau Pinang, Melaka, Labuan and Bintulu have already achieved or exceeded this level.

A budgetary figure of RM6.68 billion has been

estimated by Ranhill Utilities Sdn Bhd in order to achieve SPAN's target in 2020 for Peninsular Malaysia and presented at an NRW Workshop—Accelerating NRW Solution & Implementation in Malaysia, Dec 2011, organised by KeTTHA and SPAN.

4.2.6 Water Tariff Adjustment and Appropriate Tariff Structure to Reduce Wasteful Consumption

Based on water supply consumption figures of the various states (Table 4.7) 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, logically, must be related to low tariff rate in the country. With tariffs being so low, consumers and users of water (including industrial users) hardly see the need or the importance of ensuring sustainability of water supply, including water conservation. There is already an increasing global attention to the water footprint and virtual water (used to make a product) as concepts that are expected to receive attention from consumers and guide in reduction of water use to a

Table 4.7: Water Supply Consumption

State	Consumption Per Capita Per Day (l/c/d) - 2013
Johor	223
Kedah	225
Kelantan	140
Labuan	167
Melaka	237
N.Sembilan	227
Pulau Pinang	296
Pahang	189
Perak	234
Perlis	242
Sabah	109
Sarawak	168
Selangor	235
Terengganu	211
MALAYSIA	210

Source: MWIG 2012

sustainable level in the coming years. This is further discussed in R&D– Priority Areas for Research, in Chapter 5.

During the National Colloquium on WDM (2009) and at the six Strategic Consultations (SC) (2012–2014) organised by the ASM, it was generally agreed that the present pricing structure of treated water is low and this constraints any effort for improved WDM. This also stifles any scientific and technological advancement as well as discourages innovations towards water management for sustainable developments. Low water tariffs also limit the amount of resources operators can direct to technological innovation and R&D.

To ensure sufficient supply for the future generation, water services needs to be restructured to ensure 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 FT Labuan, that is robust, fair and transparent. Furthermore, information on costs and performance levels are to disclose to consumers and users of water who will know what they are paying for and what they are getting in return. In some way, therefore, relevant stakeholders will have a say in tariff increases which are not seen to be costly using a mechanism to capture fair and qualifying expenditure which commensurate with the cost of providing it and the level of service being provided benefitting individuals and society.

It is understood that Sabah has implemented 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 will increase from 1 April 2015 in a move to reduce consumption and avoid rationing according to Penang Water Supply Corporation Sdn Bhd. Furthermore, it is worth noting that water conservation surcharge for water consumption exceeding 35 m³ a month at residential premises is imposed at 48 cents per m³. This goes a long way towards meeting an objective of WDM in water conservation or saving.

Consumption per capita promoted by World Health Organisation (WHO) is 165 l/c/d, which should be a long-term target for Malaysia. For 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** (Table 4.8).

Table 4.8: Estimated Water Demand in Malaysia

	At 2020 without water demand management (mld)	At 2020 with domestic per capita consumption capped at 180 litres/capita/day (mld)	Quantum saved in mld with per capita reduction (mld)	% reduction with per capita reduction
Peninsular Malaysia	14,940	12,603	2,337	15.6
Sabah	1,859	1,651	208	11.2
Sarawak	1,771	1,504	267	15.1
Malaysia	18,570	15,758	2,812	15.1

Source: NWRS 2012

Table 4.9 : Estimated Water Demand

	At 2020 without water demand management (mld)	At 2020 with domestic per capita consumption capped at 180 litres/capita/day (mld)	Quantum saved in mld with per capita reduction (mld)	% reduction with per capita reduction
Langkawi (Kedah)	107.57	95.79	11.78	11.0
Bintulu (Sarawak)	280.02	258.04	21.99	7.9
Selangor	4742	3776	966	20.4
Perlis, Penang and Kedah	3052	2401	651	21.3

Source: NWRS 2012

Savings in water consumption would be about RM1.23 billion annually: targeted at 180 l/c/d by 2020.

The volume saved is sizeable. The average operational cost per cubic metre for Malaysia in 2013 is estimated to be about RM1.20/m³ (MWIG 2014). Hence, 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 saving generated will go back to the benefit of the consumers and the nation. This excludes additional savings that are possible with deferment of capital investment for more supply. These savings can be used to reduce subsidy in states, water divisions and regional demand zones where average tariff is still below cost of supply.

As indicated in Table 4.9, quantity of water saved in Selangor and Perlis, Kedah and Pulau Pinang is 966 mld and 651 mld respectively. In the case of Bintulu Division, Sarawak and Langkawi (Kedah), the quantum saved are nearly 22 mld and nearly 12 mld, respectively.

Promotion of Reducing, Recycling and Reusing of Wastewater. (all sources of water including groundwater, rainwater harvesting and stormwater resource)

Recycled water is water recovered by treatment of wastewater, greywater or stormwater runoff to a quality suitable for beneficial use (Lazarova & Asano, 2013 IWA). Recycled water is now accepted as a resource.

Sustainable economic development under the conditions of water scarcity is becoming possible by adopting the use of recycled water, both for agricultural production (examples in Australia and France) and industry (examples in Germany, Spain and Singapore). Some parts of Malaysia are already facing water scarcity in the form of uncontrolled flow water deficits that borders on unsustainable development conditions. The NWRS 2012 has identified the areas as Selangor (including Federal Territory of Kuala Lumpur and Putrajaya), Perlis, Kedah and Pulau Pinang in the northern region of Peninsular Malaysia and Melaka. Furthermore, the prolonged

drought during early 2014 caused water shortages in Selangor and some parts of Johor, Negeri Sembilan and Perak. It is understood that due to massive industrial and urban development, Bintulu region in Sarawak has also been categorized as a water scarce area, especially during the period of prolonged drought.

Under such circumstances, wastewater reclamation can become an attractive option for applications that do not require high quality drinking water for non-potable purposes. One of the greatest potentials for water reuse in the urban areas of Malaysia is to reduce, supplement or replace the potable water demands of industries. Besides wastewater reclamation, reuse of water in major industries, use of water from rainwater harvesting and groundwater constitute high potential of usage permitting lesser water quality. Among the major uses in the industry are cooling system make up water, boiler feedwater, process water, site irrigation, fire protection, municipal use for cleaning purposes and so on. But the question is "to what extent should potable water be used for non-potable purposes?"

At the moment, sewerage treatment plants operated by Indah Water Konsortium Sdn Bhd (IWK), generates about 4,000 mld of treated effluent that is discharged to receiving waters. This is about 25% of the total water supply production of the country available for non-potable use. The quantum of augmented supply is sizeable, especially for water scarce development areas. However, based on potential demand of recycled water in water scarce areas of the country, the locations could be as follows:

Klang Valley:

As an example, the total potential augmentation from sewerage treated water effluent for Selangor, FTKL and Putrajaya is estimated to be 24.5% of total demand (Table 4.10).

Table 4.10 : Water Recycled (Selangor, KL and Putrajaya)

Year 2020	mld
Total estimated potable water demand for Selangor, KL and Putrajaya	4,896 mld
Total estimated effluent water available for recycling (source IWK estimated)	1,200 mld
Percentage of water recycled	24.5%

Source: Potable water demand – NWRS 2012 & Treated Effluent – MWIG 2012

Pulau Pinang:

As an example, the total potential augmentation from sewerage treated water effluent for Pulau Pinang is estimated to be about 10.3% of the total water demand (Table 4.11).

Table 4.11: Water Recycled (Pulau Pinang)

Year 2015	mld
Total estimated potable water demand for Pulau Pinang	977 mld
Total estimated effluent water available for recycling (source IWK estimate) *	100,820 m ³ /day (100.8 mld)
Percentage of water recycled	10.3%

Source: Potable water demand – NWRS 2012 & Treated Effluent – MWIG 2012

* RSTP	Bayan Baru	75,186 m ³ /day
RSTP	Perindustrian Prai	3,288
RSTP	Butterworth South	
	Sg. Nyior	<u>22,346</u>
		100,829 m ³ /day

Other locations are:

The Iskandar Region of Johor in the longer term as the Southern Industrial and Logistic Corridor is just starting to take form.

Table 4.12: Water Recycled (Nusa Jaya, Iskandar)

Year 2015	mld
Total estimated potable water demand for Iskandar	998 mld
Total estimated effluent water available in Nusa Jaya, Iskandar	125 mld *
Percentage of water recycled	12.5%

Source:

1) Potable water demand – NWRS 2012 & Treated Effluent – MWIG 2012

2) Iskandar Masterplan Report

*Based on capacity of Medini STP and other STPs, Nusa Jaya

Bintulu Region in Sarawak, at present undergoing rapid industrial and urban expansion.

(Percentage of Potential Water recycled to overall demand is 11.6% or nearly 25% when compared to industrial demand)

Table 4.13: Water Recycled (Sarawak)

Year 2015	mld
Total estimated potable water demand for Bintulu	215 mld
Total estimated effluent water available in Bintulu	25 mld *
Percentage of water recycled	11.6%

Source:

1) Potable water demand – NWRS 2012 & Treated Effluent – MWIG 2012

2) Sewerage Services Dept., Sarawak

Securing economic viability is an important challenge for many of the water reuse projects. Water reuse suffers from the competition with undervalued

or subsidised conventional water resources. Full cost recovery (depending on ability to pay) is a desirable objective when comparing water prices for recycled water and treated water supplied for industrial use. Further, cost-benefit analysis of water reuse projects must include other socio-environmental criteria, based on a holistic approach and catchment scale. Tariff chargeable for the supply of membrane treated recycled water has been worked out to be RM2.85 per m³ of water supplied (*Final Report for Feasibility Study to Develop Water Recycling Plant Utilising Effluent From Sewage Treatment Plant in Peninsular Malaysia*, May 2012, KeTTHA). The feasibility in recycling should be further studied, as proposed in the following paragraph. This is slightly higher than the highest rate charged to industrial consumers in the country which is RM2.70 per m³ (assuming a consumption of 50 m³) in Johor.

As cost of membranes used for water recycling is expected to decrease with improvements in technology and water tariff expected to increase due to increasing capital and operating cost, this gap in pricing would close and improve further, making recycling of wastewater effluent more attractive commercially. It would be best if a demonstration plant or a pilot plant including dual piping system to targeted recycled water users be set up to fully study the implication of introducing water recycling plant in the overall water supply management of the country. The Feasibility Study to develop water recycling plant, referred to in the previous paragraph, recommends the installation of a pilot 10 mld wastewater recycling plant at the Taman Nusa Perintis STP in Nusajaya, Johor at an estimated cost of RM37.2 million.

A commendable effort in a high percentage use of recycled water and reduction of water consumption within its own development is being developed by

1 Malaysian Development Bhd (1MDB) at the Tun Razak Exchange (TRX), an iconic international financial hub for Malaysia, in Kuala Lumpur: details shown in Table 4.14.

Table 4.14: Estimated Water Consumption

Estimated Water Consumption 13.8 mld	
Recycled for	
Toilet flushing	7.3 mld
Cooling Towers	3.3 mld
Landscaping activities	0.43 mld

Source : SPAN

This project will provide the Malaysian showcase which many other big developers in the country should emulate.

Water recycling has been extensively used in major water using industries. This should be encouraged as it is a good practice in WDM particularly in water-scarce regions, notably in Perlis, Kedah, Pulau Pinang, Selangor, FT Kuala Lumpur and Labuan, Melaka, and, as reported, in the Bintulu region, Sarawak. From past practices, it is known that heavy water using industries normally allow for, at least, 30% as recycled water in the overall water system to encounter any risk of water stoppages or shortages and avoid losses in production. In the recent Selangor water crisis, it was reported in the Dewan Rakyat in November, 2014 by the Deputy Minister, KeTTHA that the crisis resulted in huge losses to 30 companies. However, from reliable industry source, at the moment, there is no incentive for these factories to recycle water for re-use as the water tariff is low and therefore rendering the effort uneconomical.

Handling normal rainfall can be achieved locally in different neighbourhoods or by individual

households. It can be infiltrated for use in water supply, if this is dependent on groundwater. It can be retained for use as secondary water when lesser water quality is sufficient, thus reducing the load on drinking water resources. It can be harvested for recreational purposes that also provides environmental and economic benefits.

In Malaysia, rainwater harvesting programmes has been implemented for new housing developments and government buildings. Uniform Building By-laws (Amendment) 2012 provide for Rainwater Harvesting and Utilisation System to be installed only for bungalows and semi-detached houses with a roof area equivalent to or more than 100 m². It is understood that success in implementation of this programmes has not been fully assessed.

Bandar Utama has reported a 30% saving on water demand for the 1 Utama New Wing Building: roof spreading over 30,000 m² (The Ingenieur, June-Aug 2010).

However, rainwater harvesting programmes done on a larger scale is highly encouraged in the context of WDM. Rainwater harvesting programmes introduced for domestic houses, though beneficial, may not experience similar financial benefits. The 1 Utama New Wing building in Petaling Jaya, Selangor which has roof spreading over 30,000 m² collects adequate rainwater storage for 10 days for usage of the shopping centre. The harvested rainwater usage is restricted for toilets flushing, air conditioning cooling towers, car park washing and landscape irrigation. Bandar Utama had reported a 30% savings on water demand for the 1 Utama New Wing Building (The Ingenieur, June-August, 2010). Perhaps, commercial buildings of the future, such as large supermarkets, should emulate the beneficial use of

water pioneered by the 1 Utama contributing towards the good practice in WDM.

Stormwater (as a result of intensive rainfall) could be considered as a valuable resource and not as a waste problem or a threat. In the planning process, it can reduce the cost of climate adaptation and give greater benefits to urban and as well as rural areas and people's lives.

It was reported (in the news media on June 17, 2015) that PUB is exploring the possibility of using underground space for drainage and water storage to help Singapore overcome the effects of climate change, such as more intense rain and prolonged dry spells. This underground drainage and reservoir system is likely to have three key components: tunnels to channel stormwater below ground, caverns for water storage and a pumped storage hydropower system, which can convert energy from water flowing into underground caverns to electrical energy. This can be used to pump water back to the surface. A similar storage scheme could possibly be developed in urban areas of the country.

Funding the best integrated solutions for wastewater, greywater and stormwater is a subject for R&D as discussed in Chapter 5.

Groundwater resources are often overlooked. Except for some remote rural areas solely dependent on groundwater, the main function of groundwater is to supplement surfacewater supply. However, at times, it is the sole source of water. The most important cause has been the difficulty in assessing project feasibility and sustainability due to inadequate knowledge and data. Since groundwater development and exploitation requires sizeable, long-term investment, there has to be a

strong platform enabling the country to take the best decisions. Investments include the infrastructure around groundwater abstraction and water treatment plants, taking into account the distribution of the groundwater to the consumers and its quality.

Nevertheless, a key argument for groundwater is being able to use it when there is a shortage of surface water. Groundwater is also better protected from contamination than surface water. It may be better able to assure a higher level of water security, compatible with WDM practice, especially during a prolonged period of drought. Priority should, therefore, be given for groundwater development in water-scarce areas such as Selangor, Perlis, North Kedah and the Bintulu Division in Sarawak.

From a WDM perspective, the option of groundwater use as an integral component of the water supply system should be seriously considered. This is as a strategy to “increase the ability of the water system to continue to serve society during times when water is in short supply” as included in the definition of WDM (refer to Chapter 1, Definition of WDM). In this strategy, the groundwater development is not primarily for substantial and continuous use but as a reserve and connected to the existing surface water supply system for drought situations and when efforts for the surface water WDM breaks down.

First conduct aquifer mapping on a large scale with the aim of producing an accurate picture of the aquifers.

Historically, there have been a number of large scale failed investments in groundwater development. The most important cause has been the difficulty in assessing project feasibility and

sustainability due to inadequate knowledge, data and tools. It appears best for Malaysia to first conduct aquifer mapping on a large scale, particularly in water-scarce areas and alluvial areas, with the aim of producing an accurate picture of the aquifers with respect to their location, distribution, scale, interconnection and to produce maps identifying groundwater potential in the system. The target areas should be both in the alluvium and hardrock areas. New technology makes it possible to map groundwater from the air.

The idea for the integration of groundwater resource in a WDM system is that water managers are ready with a reliable contingency plan. The technical options vary. For example, the groundwater supply activated could be for non-potable supply needs for industries or even for non-treated surface water recharge in rivers and canal systems where treatment plants are located or to augment the urgent needs of other sectors such as agriculture and environment.

For implementation of this strategy, the water stress areas should be given priority. These are the Sg. Perlis, Sg. Kedah, Sg. Bernam, Sg. Tenggi, Sg. Selangor and Sg. Kemena river basins with a total potential recharge of 3,426 mld annually (Refer to Table 4.15: Annual water balance based on various river basins).

The proposed groundwater developments are shown in Figure 4.1 (Northern Selangor), Figure 4.2 (Bintulu) and Figure 4.3 (North Kedah and Perlis).



Figure 4.1: Aquifer Mapping in Northern Selangor

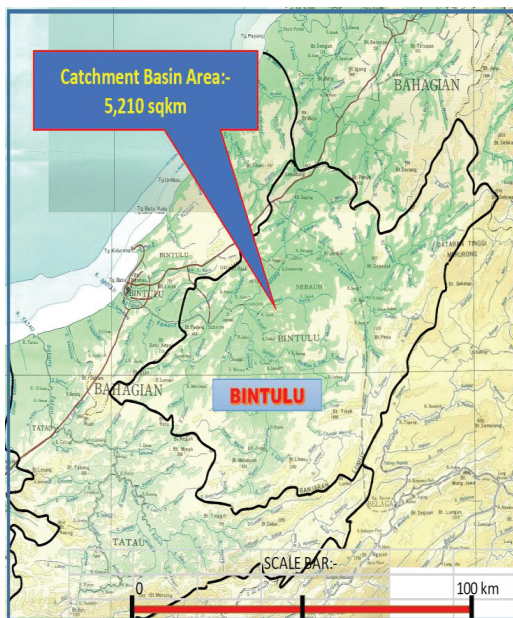


Figure 4.2: Aquifer Mapping in Bintulu

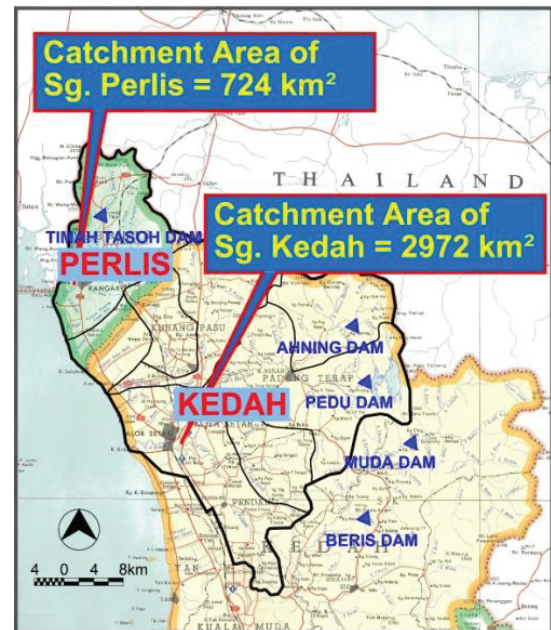


Figure 4.3: Aquifer Mapping in North Kedah and Perlis

Approximately, calculations of annual water balance of the three water scarce areas at Sg. Perlis, Sg. Kedah, Sg. Bernam, Sg. Tengi, Sg. Selangor and Sg. Kemena (Bintulu) are as shown on Table 4.15.

A budgetary figure of RM42.6 million has been quoted from a reputable international groundwater survey source for aquifer mapping in North Kedah and Perlis, Selangor and Bintulu Division in Sarawak using the geophysical techniques (Table 4.16). A follow-up drilling and well construction and tests would require RM800 million.

Results from the survey should enable a better understanding on the availability of groundwater which will directly lead to the utilisation of groundwater conjunctively with other sources of water. Once mapped, the groundwater resources should be monitored to ensure that they are protected.

Table 4.15 : Annual Water Balance Based on Various River Basins (NWRS, 2012) in mld

River Basin	Area km ²	Rainfall mld	Catchment Loss mld	Groundwater mld	Runoff mld
Sg. Perlis	724	3773	2,589	238	943
Sg. Kedah	2,972	19,029	11,780	1,059	6,178
Sg. Bernam	2,836	17,215	10,062	1,165	5,974
Sg. Tenggi	527	3,199	1,870	217	1,110
Sg. Selangor	1,937	11,758	6,872	796	4,080
Sg Kemena (Bintulu)	5,210	52,566	18,051	3,426	31,048

Source: Water balance based on NWRS 2012

Table 4.16 : Budgetary Estimate for Airborne Geophysical Survey

Region	Area (km ²)	Budgeting Cost (RM million)
Selangor	5,300	15.88
North Kedah and Perlis	3,696	11.09
Bintulu	5,210	15.63
Total	14,206	42.60

4.2.7 Engaging the Consumers and the Public (Water Conservation Initiatives)

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 more careful use of water and in ensuring absolute reduction in water resources pollution. This requires awareness and understanding by all parties of the key issues and the likely reaction of local communities and individuals on the sustainable use of resources.

Some of the issues which the public and stakeholders need to know or want to know are:

- Water scarcity and resorting to 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.

Information and communication technologies may need to be increasingly used in the water sector as key component of successful water management policies. Due to the long tradition, water management has always been based on technical and engineering competence with insufficient integration of social

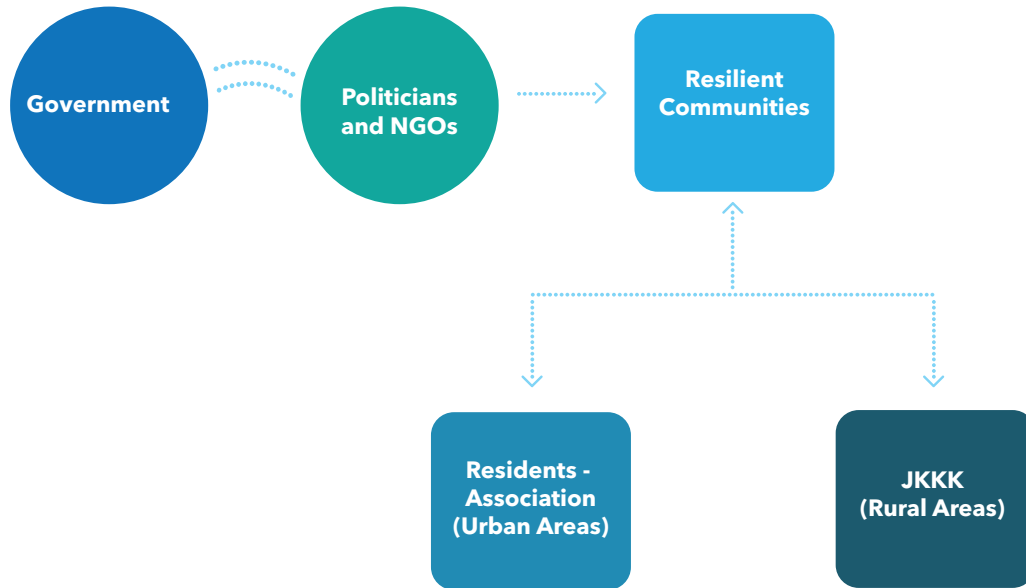


Figure 4.4: Government and Involvement of Resilient Communities

aspects and scarce amount of social sciences research relating to water management.

Public meetings at locally organized gatherings at regular intervals would serve the purpose. In most cases, it would appear best for private sector organizations, like NGOs well-versed in some aspects of public relation work, be engaged to work together with the authorities at 'meet-the-people' sessions.

Where there is water scarcity, people normally adapt to the amount of water that they have to consume. During the recent drought in Selangor, FT Kuala Lumpur and Putrajaya (27 February to 1 May 2014), for example, people managed to cope with the amount of water they had to consume and use. When supply is back to normal, unfortunately, they go back to their old ways.

Government departments and public authorities in Malaysia have for a long time been involved directly with NGOs, in public engagements on the basis of

an "as and when" required in awareness campaigns to gain people's support on numerous water issues. Examples include "Love Your River Campaign", educational seminars and conferences with the latter, often accompanied by trade exhibitions. Normally, such public engagements lack continuity support on the ground in implementation and, therefore, do not meet the desired purpose.

However, there have been public engagements organised by the government and government agencies, on an "on-going" and continuous basis giving satisfactory results (Figure 4.4). The Water Forum designated by SPAN keeps close contact with consumers and the public on water and sewerage services matters and provide 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 organizations 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:

- i. Requirement for water operators to develop and implement a water conservation programmes on the maintenance of an efficient and economic water supply system;
- ii. 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 on the water cycle, the benefits of conservation and the need of a clean environment; and
- iii. Proposal to curb wastages by "Hose Ban Rule" during a period of crisis with deterrent penalties has been submitted to the Minister.

Another means of public engagement to be organised by the government and government agencies is to set up "Water Museums" or "Water Galleries" in major centres in the country such as Kuala Lumpur, Georgetown, Johor Bahru, Kuching and Kota Kinabalu. The purpose of such engagements is of attracting the public and especially the younger generation to visit and be interested to learn and realise the intricacies on how water is produced and made available to them as well as how sewage is removed from houses, treated and subsequently disposed to receiving waters. In

this way, 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.

Besides, educating and creating awareness particularly amongst the young generation, economic instruments are extremely important. What brings monetary profits will be more acceptable to the public. Hence action should be taken to look at incentives to be provided to encourage the reuse and recycle of water for non-potable purposes. At the same time water tariffs which are not at full cost recovery levels will have to be relooked as cheap water will not lead to water conservation or encourage consumers particularly industries to reuse and recycle waste water. The proposal to curb wastages by "Hose Ban Rule" during a period of crisis is a good start. Unmitigated wastages of water on non-important activities during crisis should be penalised. The penalties should be a deterrent factor where a repeat of the non-compliance can be prevented. The way forward should be to look at this proposal to be applicable perpetually with strict enforcement rather than a stop gap measure. A carrot and stick approach should be adopted and continuous engagement with consumers is the way forward.

4.2.8 Technology and Incentive to Achieve More Efficient Use

Among the important aspects in water regulatory policy is the promotion in the mandatory use of efficient products or water saving devices. 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 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 (full flush volume is 6 litres and half flush volume is 3 litres). This is mandatory for new development projects and renovated buildings. Furthermore, the use of urinal which has a flush volume of not exceeding 2.5 litres for each compartment is also proposed.

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 performances. However, SPAN has not made it a mandatory requirement. In many developed countries, such as the USA, Australia, New Zealand and Singapore, water efficiency labelling scheme is part of an ongoing effort to encourage people to use water wisely and make water conservation a way of life.

SPAN's SPPCA Implementation Guidelines was launched in January 2013 for water closet, urinals, tap (basin, sinks and showers). At the end of 2013, two more closets 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 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 a typical case where a rebate programmes can play its useful role in persuading existing house owners to retrofit water appliances. The rebate programmes subsidises the adoption of water efficient devise by refunding the cost of the appliance partially or fully. This non-price tool is used to encourage domestic consumers to purchase water saving devices when installing or retrofitting these appliances. The rebate programmes has yet to be introduced in Malaysia but is widely practiced in developed countries such as in the USA as reported in US Environmental Protection Agency website.

4.3 Agriculture WDM

4.3.1 Background

For agriculture water, currently there is no special act for its water services as with the WSIA Act 2006 that led to the formation of SPAN, a regulatory body for the Water Supply sector services. Agriculture water management does have an act for irrigation for paddy and another for drainage. These are the Irrigation Areas Act 1953 and the Drainage Works Act 1954 for Peninsular Malaysia. The State of Sabah has a combined Act, the Sabah Drainage and Irrigation Ordinance 1956 (Sabah No.15 of 1956). Sarawak has the Drainage Works Ordinance Sarawak 1966. These Acts are now not enforced since the 1970s although they have not been repealed. Nonetheless, many of the major principles contained in these Acts are still valid and practiced administratively.

For paddy irrigation schemes, these include the collection of water rates and control of land

conversion from paddy to other uses in areas gazetted as paddy irrigation areas. The practice of setting irrigation dates for each season still continues and farmers are expected to adhere to these. The Act also provides for the roles and the authority of the irrigation system managers (gazetted officers) as well as the care of the infrastructure and supervision on acts detrimental to the system performance such as vandalism, wastage of water, pollution, illegal blockages and diversion. Whilst legal actions on such misdemeanours are now restrained, administrative process and procedures are now the practice to resolve those issues.

The principles in the Drainage Works Act are generally the same as for irrigation. The Act is for agriculture areas that are provided with large-scale drainage systems and that these areas are gazetted as drainage areas. The management of these areas were entrusted upon a drainage board comprising representatives of government and private sector stakeholders.

In Sabah, the Irrigation and Drainage Act requires the formation of committees to oversee the management of gazetted irrigation and drainage areas.

Drainage and Irrigation are under the List III—Concurrent List of the Legislative Lists under the Ninth Schedule of the Constitution of Malaysia. This list allows for both the federal and state Governments to have jurisdiction over these matters. Land, water and agriculture matters are essentially solely under the jurisdiction of the respective states (List II) with certain exceptions allowing for the jurisdiction of the Federal Government.

The two Acts above are specific for areas within irrigation schemes for paddy crops and for drainage

schemes for multi-crops (mostly tree crops) that are gazetted as stated in the Acts. Both function to ensure the proper use of the infrastructures provided and prudent water management by the system managers and the end users within the respective gazetted areas. Therefore, the Acts are not applicable in non-gazetted areas provided with irrigation and drainage systems, nor does it cover the water resources aspects. Instead, water resources aspects are covered by state laws such as those related to rivers and natural watercourses. The water quality aspects are now regulated by the Environmental Quality Act 1974.

With the Irrigation and Drainage Acts now not effectively enforced and with the lack of laws for areas outside the purview of those Acts, agriculture water management is largely dependent on the administrative structure and strength to implement and enforce both the state as well as the Federal Government policies. Since 2004, at the Federal level, the agriculture water development and management is now led by the Irrigation and Agriculture Drainage Division (BPSP—*Bahagian Pengairan dan Saliran Pertanian*) of the Ministry of Agriculture and Agro Industry (MOA). This was previously by the Department of Irrigation and Drainage (JPS—*Jabatan Pengairan dan Saliran*) at the Federal level. JPS now functions under NRE and is responsible for water resources, floods, urban drainage and coastal management. The BPSP is staffed by officers seconded from the JPS.

Since the 1930s, all states have established State JPS departments that have similar functions as the Federal JPS and this arrangement continues at the state level even after the 2004 structuring at the Federal level. Now, the state JPS undertakes both the functions of JPS under the NRE as well as the development works (both surface and groundwater)

of the BPSP, MOA. The operations and maintenance of irrigation and drainage schemes, water resources facilities for agriculture water and rivers are by the respective State JPS.

This Federal State JPS administrative arrangement has worked well thus far. At the irrigation and drainage scheme level, the strength is the system manager-farmers (end user; mostly smallholders) bonding established over long term (more than 75 years). However, there are emerging agriculture water management issues that require serious consideration. The close manager-farmer bonding would gradually diminish with more commercial approaches to farming and increasing participation of non-farmer service providers. River water quality deterioration attributed to agriculture water discharges is a growing concern and another is the case of unregulated agriculture water development as in the Cameron Highlands. The increasing pressures from non-agriculture water sectors on agriculture water such as in the northern region of Peninsular Malaysia have now to be addressed systematically. New laws that incorporate current and future water issues would be required to ensure sustainable agriculture water management. A Water Resources Policy is already in place since 2012 and a Water Resources Act has been proposed by JPS, NRE with a view to address some of these issues. Sabah has already enacted a Water Resources Enactment in 1998. In Sarawak, the provisions in the Sarawak Water Ordinance 1994 include the management of water resources and water catchment areas in the state.

While there are regulations pertaining to the use and general water and water resources management that can be applied to agriculture water management, there are none that specifically address the need for agriculture water end users (the farmers) to avoid water use wastages and to save water. In future, this

will be necessary if water demand management for agriculture water is to be successful.

Agriculture in Malaysia is essentially managed by two Ministries namely MOA and the Ministry of Plantation Industry and Commodities (MPIC). MOA is responsible for food production and covers food crop, livestock and fishery whilst the MPIC the non-food crops such as oil palm and rubber although oil palm is also considered as a food crop. From the water perspective and in considering WDM for agriculture, this study follows the categorisation of agriculture based on the NWRS 2012 categorises agriculture in terms of paddy, non-paddy, livestock and fisheries. Of these and in terms of water demands, the NWRS 2012 categorises fisheries as non-consumptive and therefore not included in the estimates of water demand for agriculture.

The total water demand of agriculture in Malaysia is shown in Figure 4.2. The total water demand for agriculture is 9,512 mcm per year (2010) and forms 64.3% of the total water demand for all sectors. Irrigation for paddy is the highest demand for water in this sector forming 55.9% of the total national water demand. Within the agriculture sector, irrigation for paddy forms 63.4% of the total agriculture water demand. As shown in the Figure 4.5, total water demand for irrigation is declining to 45.9% in 2050. Savings or reduction of water demand in irrigation would therefore provide considerable relief on the water demands for other sectors namely the water supply sector.

Prior to that projected decline, the agriculture sector has always been the biggest user of water for human activities. This is due to the high water requirements of irrigation for paddy cultivation within the agriculture sector. As a comparison, the estimates for 2050 shows that paddy irrigation water demands

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	49.1	(553)	(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	5	(1.1)
	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

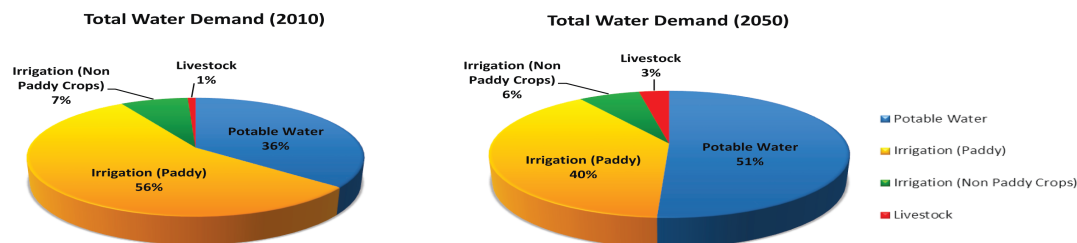


Figure 4.5: Water Demand for Agriculture

forms 39.5% of the total agriculture water demands. The significant projected decline of water demand for agriculture is in fact due to the projected decline of Irrigation water demand. The water demands for non-paddy crops are projected to increase but not significantly from 1,117 mcm in 2010 to 1,176 mcm in 2050. Thus paddy irrigation will remain the biggest water user within the agriculture sector at 49.1% of total agriculture water demand by 2050. It will also continue to be a significant water demand sector by then when compared to potable water at 50.9% of the total national water demand. Therefore, paddy irrigation requires special attention in the national water management approach for the future in relation to the water needs of other sectors within the agriculture sector as well as inter-sector.

Although the projected non-paddy crop water demand is not significant in terms of total agriculture and national water demands, it can be so when clustered within a locality or regionally within a river basin. A good example is the vegetable farming industry in Cameron Highlands where its water demands is significant in relation to the needs of the water supply and tourism sectors. Another example

is the off-river aquaculture industry that requires freshwater abstraction from the adjacent river such as for Arowana in the Kerian District of Perak. Also emerging is the need for irrigation of traditionally rain-fed crops such as oil palm and fruits to increase and sustain yields as well as an adaptation measure for climate change.

4.3.2 Potential future Agriculture water savings for use in Inter-sector WDM

Among the consumptive water user sectors, agriculture sector is known to currently consume the most. Any saving in the usage would make substantial contribution to the needs of the other sectors-within the agricultural sector as well as inter-sector. The potential savings from 12 granaries in 2050 (shown in table below), equivalent to 2927 mld is substantial. It can be used for the benefit of other users in inter-sector WDM, notably water supply sector, with a total estimated demand of 25,884 mld (NWRS 2012). This represents about 11% of the total national water demand in 2050 which could be exceeded with further increase in efficiency among the bigger granaries.

Table 4.16: 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)
Existing Eight (8) 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. Manik 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 (4) 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

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.

4.3.3 WDM Strategies for Agriculture

Unlike the water demand of the water supply sector that involves all river basins and their expanding population and growth centres, the agriculture sector has relatively and over the years of economic growth, developed to be confined to within specific regions. This is particularly so in Peninsular Malaysia and the future development trend in Sabah and Sarawak. The Klang Valley for example has effectively no agriculture water demand and similar situations could be expected for the Langat and Linggi river basins in the future.

The need and priorities for WDM for agriculture would need to be viewed more from a local and regional basis rather than a national perspective only. Among the strategies proposed for enhancing WDM for Agriculture include:

- Adopt WDM in Policy Decisions
- Need for a central regulating agency for agricultural water management
- Increasing service levels to "operations excellence"
- Increasing systems delivery efficiency
- Increasing on-farm water management practices by farmers (end users)
- Applications of irrigation water reuse
- Provision of public participation in the form of water user groups
- Application of technology and research related to irrigation water savings
- Rainwater harvesting and controlled drainage systems for supplemental irrigation especially for perennial crops

- Conjunctive use of groundwater where necessary and possible
- Artificial wetlands above drainage outfalls and green buffers along river systems; and
- Agronomic research and best practices to ensure "more crop per drop".

4.3.4 Adopt WDM in Policy Decisions

PTS48 Identify options to incorporate WDM in existing regulatory and administrative arrangements.

PTS55 Identify processes and procedures that can be integrated to ensure shared governance of water resources.

PTS56 Identify options for the formation of formal and informal, shared and collaborative partnership platforms.

PTS61 Identify platforms for resolution of conflicts and competing interests.

PTS Strategic Action Plan

NWRS 2012

The need for agriculture water management policy is to ensure a focus on the water needs and responsibility of the agricultural sector towards its own requirements as well as that of other sectors. Apart from regulating water use, the policy should also be such so as to prepare agriculture water users in a developed nation to value and pay for the agriculture water services. The policy should be developed in accordance with the existing NWRP.

The NWRP adopts Measures to Implement WDM Nationwide (Target 14) and with this to implement strategic action plan.

The NWRP also stipulates developing framework for stakeholder collaboration in water resources governance and among the items included in the strategic action plan are as in the box.

The agricultural sector, being the largest user of water, should be in a leading position to implement the “Shared Water Resources Governance” in overall WDM.

The Irrigation Areas Act (1953) regulates irrigation management for paddy in gazetted irrigation schemes. It includes the necessary provisions for irrigation water demand management such as penalties for waste of water, compulsory provision of *batas* (field bunds) and even pollution of water. The Act allows for imposition of water rates payable by farmers primarily for the adequate supply of irrigation. This rate however is not based on the amount of water supplied but on the size of land ownership. The application of this Act has long been set aside since the beginning of 1980s as there are a number of aspects that need to be revised to account for changes in the social, economic and irrigation management needs itself. Efforts are underway to revise this Act to accommodate present and future agricultural water law, rules and regulations including the National Water Resources Policy and the proposed National Water Resources Act.

Agriculture Water Management Policy:

This should be developed in accordance with the existing National Water Policy. The need for Agriculture Water Management Policy is to ensure a focus on the water needs and responsibility of the agriculture sector towards its own requirements as well as that of other sectors. Apart from regulating water use, the policy should also be such so as to prepare agricultural water users in a developed nation to value and pay for the agriculture water services.

Agricultural Water Law, Rules and Regulations:

These Acts are very specific in application (Irrigation Act is for gazetted paddy irrigation schemes and

Drainage Works Act is for gazetted drainage areas) and thereby restrictive from the perspective of agriculture as a whole. The revisions should consider applicability in all agriculture areas, considering that irrigation and drainage are in the concurrent list in the constitution. A step further would be the considering the possibility of amalgamating irrigation and drainage and introducing an Agriculture Water Services Act (modelled on the Water Services Industry Act (WSIA)).

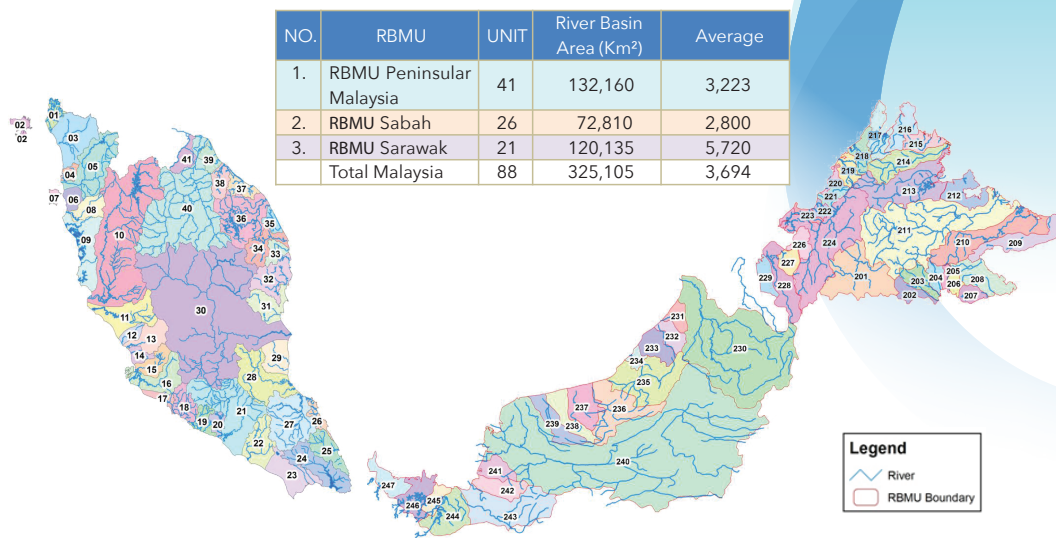
4.3.5 Need For a Central Regulating Agency for Agricultural Water Management

Agriculture Water Services Institution:

The proposed Agriculture Water Services Act (AWSA) would lead to the formation of an Agriculture Water Services Commission (modelled on the SPAN) to implement the requirements of the Act. With this structure, the service level and governance of water for agriculture should improve tremendously. Unlike the WSIA, the AWSA would not, at the onset, be involved in water charges but at least there is a determined effort towards this end.

Expanding the role of the Irrigation and Agriculture Drainage Division (BPSP) of the MOA:

The present role and composition of the BPSP should be expanded to cover all aspects of agriculture water management and for all sub-sectors of the agriculture sector. As present it is mainly focused on irrigation scheme development and management and less on drainage as well as other sectors. The division is also staffed by seconded personnel from the Department of Irrigation and Drainage and largely engineering based. This could be detrimental to the long-term development and management of agriculture water for all the sub-sectors. This Division should be multi-disciplined, covering all sectors of agriculture and



Plan No.1: River Basin Management Units (RBMU) in Malaysia
(Source: DID Malaysia)

formalised as an independent department (perhaps as Agriculture Water Services Department) caring for non-only food production under the MOA but also for other crops including the industrial crops.

Planning for specially designated large-scale agriculture development areas:

The Granary policy for irrigated rice production allows for efficient, cost effective and even improved sustainable water management practices in that it is large-scale, over a contiguous area and with distinct management boundaries. This model could be replicated for other agriculture activities. Regulatory measures could then be relatively easier to be implemented. Since the water users are mostly from the private sector, the Drainage Works Act model of forming Water Boards could be introduced. Again the Cameron Highlands vegetable farming industry could be used as a pilot to implement this. The same is possible for aquaculture (Arowana farms in the Kerian granary) and also for livestock. The overall agriculture planning should be in-line with the Integrated River

Basin Management approach and the River Basin Management Units as the planning and management framework (Refer to Plan No. 1).

4.3.6 Increasing Service Levels to “Operations Excellence”

Capacity building for irrigation system managers and farmers (end users) forms an integral aspect of the WDM efforts. In early 1980s, a National Water Management Training Centre (NWMTC) under the purview of JPS was established for this purpose with the main objective of improving water management practices with water savings and water productivity increases as the main expected outcome. With the restructuring of the water related institutions in 2004, the JPS was moved to the Ministry of Natural Resources (NRE) and its Irrigation Division moved to MOA with the formation of the Irrigation and Agriculture Drainage Division (BPSP). Consequently, the NWMTC ceased to operate for the needs of irrigation and instead continued with trainings in

line with the functions and objectives of JPS and the NRE. This effectively removed a formal institution dedicated solely to water management capacity building for paddy irrigation.

To address this issue and also for higher service levels, the MOA has prepared a plan to establish a Centre of Excellence for Irrigation Management Modernisation (COE IMM). This centre will be hosted by MADA and its programmes will be linked to other national as well as international institutions such as IWMI and IRRI. Capacity building programmes for system managers and farmers will be one of its key focus areas. Others are systems design and operations and also performance evaluation.

Systems performance is an integral aspect of WDM and in this respect the MOA has also adopted the MASSCOTE 2 developed by the FAO as the methodology for periodic performance assessment. The COE IMM will also be the focal point for capacity building programmes on this MASSCOTE 2 for the region.

Over and above this, the plan is also to develop a programme for certification for irrigation planners and designers as well as system managers for the country and the region.

4.3.7 Increasing Systems Delivery Efficiency

Increasing systems delivery efficiency will be one of the main thrusts in future WDM. The projected reduction in demand (NWRS 2012) by this sector is based on achieving improved efficiency from between 55% to 70% now to 75% average. Efficiency savings are not all due to infrastructure defects but also in terms of managing water distribution for each season. This will require an upgrade of the existing computer based decision support system (DSS) and

supported by a telemetric network for hydrological data collection. This upgraded DSS would be able to ensure higher use of effective rainfall and uncontrolled flow before releases from dam storages.

4.3.8 Increasing on-farm Water Management Practices by Farmers (End users)

High efficiency levels of the irrigation and drainage system are irrelevant if irrigation water is wasted at the on-farm levels. Therefore WDM efforts and discipline by farmers at the on-farm level are crucial for WDM. These include:

- a) Uniform land levelling is important for uniform and accurate supply of water and for maintaining the 100 mm depth of standing water.
- b) The construction of in-field channels is important for speedy application and removal of on-farm water. They are also important for more responsive on-farm water management for the maintenance of the 100 m water depth during the growing stages and rapid discharges in flood situations.
- c) In-field plot bunds (*batas*) maintenance is necessary to retain the standing water and to prevent inter-field seepage losses.
- d) Strict adherence to the agreed schedules.

Strategies for WDM for non-paddy crops, livestock and aquaculture:

The major difference between WDM for paddy and non-paddy crops, livestock and aquaculture is in the water development and management approach. For paddy, this is based on a formal approach that

allows for full support by the government and with comparatively clear and structured governance mechanism. This is not the case for non-paddy crops, livestock and agriculture that have evolved mainly on private initiatives. With minimum regulatory measures and largely unstructured governance mechanism, the problems and issues relating to water management (and thus within sector and inter-sector WDM) are rapidly emerging and if not addressed immediately could spiral into an uncontrolled situation. Such is the case of vegetable farming in the Cameron Highlands and Arowana fish industry development in the Kerian granary. In the coastal drainage belt, urbanisation and poor regulatory measures are threatening the systematic management of drainage networks and water table management.

4.3.9 Applications of Irrigation Water Reuse

All irrigation systems are designed and operated for use of as much effective rainfall and unregulated flows first before releases for the dam storage. With available unregulated flow declining, the option would be to reuse (recycle) irrigation water. The MADA granary for example, is now supply 8% of its total water demand from recycling (reuse) irrigation water. Dams only supply 25% of the total water demand compared to 52% from effective rains and 25% from unregulated flows (uncontrolled flows).

4.3.10 Provision of Public Participation in the Form of Water User Groups

The irrigation sector formed a stakeholder platform known as Water User Groups (WUGs) in all the granaries in the 1980s and 1990s. This is an administrative platform formed by the granary management institutions for farmers to participate in the systems planning and water management

for water savings. All planning proposals for the tertiary system design were referred to the WUGs for consensus agreement. The WUGs were also target groups for on-site and off-site (e.g. at NWMTC) water management training programmes. Irrigation scheduling and matter pertaining to operations and maintenance and construction works were also raised and discussed at WUG meetings or through their office bearers.

Since 2013 the MOA has begun programmes to revitalise the WUGs in all the Granaries. This is an important aspect for WDM improvements in the future. It is also in compliance with modern water management approach that strongly promotes public participation.

4.3.11 Applications of Technology and Research Related to Irrigation Water Savings

In early 2000, MARDI begun a research on low water requirement paddy variety and in 2014, this variety was launched for use in rain-fed and in areas with inconsistent irrigation supply. The yields of this variety are still low compared to that used in the granaries and research is still on-going to improve its yields.

The CoE IMM will also undertake research in collaboration with local universities and international organisations for improved designs and management systems towards higher efficiencies and applications of green technology. One of the aspects is to strengthen the gravity systems that are now seen as green technology.

4.3.12 Rainwater harvesting and controlled drainage systems for supplemental irrigation especially for perennial crops

Rainwater harvesting has always been a standard practice in almost all sub-sectors and levels of agriculture.

In the agriculture context, rainwater harvesting refers to all efforts to channel surface water for storage above ground or underground as well as to allow longer opportunity time for the water to infiltrate into the soil to the root zone for non-paddy crops. Irrigation for paddy in fact is a form of rainwater harvesting with more than 50% of water source from effective rainfall but this is generally not considered rainwater harvesting in this context.

Although rainwater harvesting has been practiced for a long time and in conjunction with soil conservation with efforts such as terracing for rainwater collection, planting ground cover, cross-bunds in farms to retard surface flow and small ponds and container storages, advances in rainwater harvesting technology for agriculture have not been significant. A major problem is in allocating land for storage facilities. Even if allocated, the storage volume is often too small to meet the demands during the dry season and refilling from rainfall during this season is not easily achieved. Nonetheless, rainwater harvesting system and practices must be seen as an important and even necessary feature for on-farm WDM to maximise the use of rainwater whenever available.

Two possibilities of developing rainwater harvesting to strengthen rain-fed agriculture and tree crops especially (higher resilience to flooding) are to reintroduce the controlled drainage systems and the

inundation systems that were developed in the early days of paddy irrigation.

The controlled drainage is a system of a dual-function channel. The channels are either natural drains or man-made primarily to remove excess water. Constructing a control structure (thus controlled drainage) at strategic locations across the drain would then allow it to function as an irrigation canal too and the structures used to cause controlled overflow over a certain depth and spread over the adjacent areas.

The inundation system is a paddy irrigation technique installed mostly in the small by numerous "finger" valleys in Temerloh and its surrounding region. The principle is the same as with the controlled drainage system. The difference is that here a long but low bund is constructed across the relatively flat valley. The bund functions to dam up the surface runoff from rains and retained for as long as possible. A structure is constructed along the bund to allow for controlled releases of the retained water. Many of the controlled drainage and inundation schemes have been converted for oil palm and the systems perhaps could be reactivated. Similar systems could be developed in other tree crop areas.

4.3.13 Conjunctive Use of Groundwater Where Necessary and Possible

Since early 2000, the MOA has also begun trial programmes for the conjunctive use of water in irrigation schemes. The need is for emergency use during short duration water supply shortages or drought. This facility is also to solve the tail-end issue of receiving late irrigation supplies especially at the early part of the season for pre-saturation requirements.

4.3.14 Artificial Wetlands above drainage outfalls and green buffers along river systems

The formation of artificial wetlands above drainage outfalls and installing green buffers along rivers should be an integral component for WDM particularly during the dry periods. Apart from functioning as a year round “filter” for upstream drainage flows before returning these to the river system, these would also be a valuable source of non-potable water as well as to support the riverine ecosystem in times of water stress.

4.3.15 Agronomic and Best Practices to ensure “More Crop per Drop”

More crop per drop is the maxim to promote and encourage efforts for higher water productivity in agriculture measured in terms of kg/m^3 water (yield or production per m^3 of water). Increasing water delivery and use efficiency would need to be supported by agronomic practices as well as crop yield response to water uptake as well. Research in these areas should continue with priorities for those strategic and high value crops requiring high water requirements such as paddy and the yield-water sensitive crops particularly oil palm.

For paddy, research advances by MARDI in aerobic rice cultivation is returning encouraging results. From a water productivity perspective, the aerobic rice is higher at $0.39 \text{ kg}/\text{m}^3$ (using sprinklers in combination with surface irrigation) compared to lowland rice (flood irrigation) at $0.57 \text{ kg}/\text{m}^3$. However the aerobic rice is not yet ready for large-scale applications as its yield is comparatively low at 3.15 tons/ha compared to 6 tons/ha average for lowland rice (Chan et al. 2012). Nonetheless the aerobic rice is an alternative that is already available and the MOA has launched

this for applications in highland areas and water scarce areas.

4.3.16 WDM for Paddy Irrigation

Irrigation for paddy is the biggest water demand sector in agriculture and very significant at the national perspective. It's systematic development across the country began in the 1932 with the formation of the Department of Irrigation and Drainage (JPS) in 1932. This was when agriculture was the main economic activity and investments in irrigation for paddy were to address rural poverty and ensure stable and adequate food (rice) supply. The increase in water demand from this sector was when double cropping was introduced in the 1960s and that necessitated the construction of dams and an intensive network of distribution and delivery networks of canals (to convey water) and drains (to remove excess water). By the 1970s, there were 936 irrigation schemes around the country. These systems were planned and designed when water availability was far greater than demands from other sectors. There were also minimal concerns on water quality and the environment and climate change was unheard of then.

By the 1980s, the government's economic diversification strategy that began in the 1960s began to show success and the impact was mass abandonment of small irrigation schemes due to labour migration to the urban areas. It was thus not due to the lack of water resources and this in fact has provided relief of supply to the water supply sector and others.

The Agriculture Policy on Food Security (especially rice) now targets a self-sufficiency level of more than 70% and these are to come from the granaries. The granaries are large irrigation schemes designated to

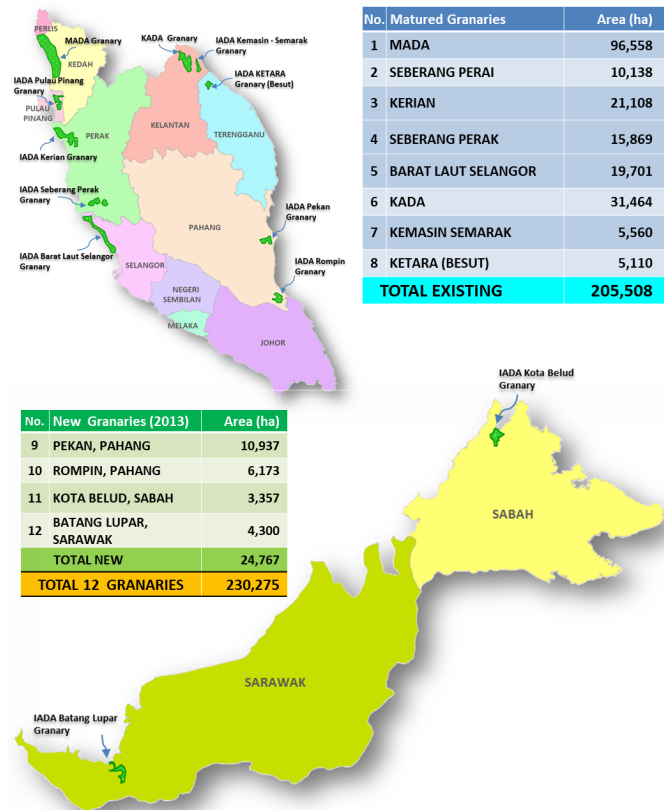


Figure 4.6: Granaries Schemes in Malaysia

be the "rice bowls" of the nation. Under this Granary Policy, the granaries are to be sustained for future rice production and that all the non-granaries will be allowed to be converted to other non-paddy crops or non-agriculture development. The area of non-granary irrigation schemes are projected to decrease and this is one of the main factors for the projected decline in agriculture water demands. From the policy perspective and the projected gradual decline of non-granary schemes, the prudent emphasis on WDM for irrigation would be on the granaries. In any case, most of the active non-granaries are at the fringes of the granaries and the possibility is that these will be incorporated into the granaries in the future.

Since the 1990s, there are eight Granaries namely the MADA, Pulau Pinang IADA, Kerian-Sg. Manik

IADA, Seberang Perak IADA, Barat Laut Selangor IADA, KADA, Kemasin-Semerak and KETARA (Besut) IADA. In 2013 (after the NWRS 2012), four new granaries were added namely Pekan IADA and Rompin IADA, Kota Belud IADA in Sabah and Batang Lupar IADA in Sarawak. (Figure 4.6)

Of the eight "matured" granaries, three are supported by dams namely the Pеду, Muda and Ahning dams for the MADA Granary, the Bukit Merah Dam for Kerian and the Paya Peda Dam, currently under construction, for the KETARA IADA Granary.

For the remaining five matured schemes and also the four new ones, water is directly tapped from nearest major rivers by gravity diversion schemes or pumping systems.

i) WDM Practices in Irrigation for Paddy Cultivation

There are a series of WDM practices in the present irrigation systems design and management. These are:

1. The existing granary irrigation systems frameworks and designs were actually established since the 1950s with upgrades in the succeeding years up to the 1980s to suit the changes from single cropping to double cropping. These systems were designed mostly for the exclusive use of the irrigation sector (as was the case for other sectors too namely water supply and energy (hydropower). They were also designed when water availability were far more than demands from all sectors. The issues of present day were either non-existing (e.g. Climate change) or not significant (e.g. environmental, water security, water safety, inter-sector).
2. The use of open channel gravity system is preferred over pumping systems. Pumps are used only when necessary (e.g. the KADA granary and Pulau Pinang IADA and in Kerian to complement the gravity system).
3. The terminology WDM is not used in irrigation sector. However, it has always been part of the planning, design, operations and maintenance processes and management. Instead, the term water savings is more widely used.
4. Unlike the water supply sector, the Irrigation Sector water management principle objective and WDM strategy has always been to use as much of the effective rainfall first before considering irrigation supply. This is translated by matching rainy seasons to concur with paddy planting seasons (wet season and dry season) and irrigation period. The priority of irrigation supply is from unregulated flows (uncontrolled flows) of the rivers and then only, where installed, releases from reservoirs.
5. Further water savings from the need for dam releases and avoiding conveyance losses are by introducing water reuse system (MADA terminology is recycling) at strategic locations within the granary. This is now widely installed in the MADA granary. Introduced in 1984, MADA now operates more than 100 numbers of this installation.
6. Further water savings are expected from higher efficiency of canals delivering the irrigation supply. This is measured in terms of percentage of the water supply at the canal intake and the actual water delivered to the point of utilisation. This is similar to the management and measurement of NRW in the water supply sector.
7. Another important aspect of Irrigation WDM is the scheduling of on-farm activities to match irrigation supply dates. The idea is that the farms are all ready to receive and utilise irrigation supply when it arrives to the farms. Otherwise, the water delivered will be wasted into the drainage systems. Timeliness of operations is thus a critical factor in irrigation WDM. This is not just for within season needs but also to ensure that the twice a year planting cycle continues as planned. Otherwise, the schedule will be out of phase with the expected rainfalls and a season will have to be sacrificed to get back into the planned schedules.

8. At the on-farm level, farmers' cooperation in on-farm water management is necessary for further water savings. This requires levelled fields (specified as at +/- 50cm over 10×10 m area) to maintain water level at the optimum 100 mm depth, impermeable or unbreached field bunds and closed field drainage outlets to contain water in the fields during the saturation and crop going period.
9. The operations of the irrigation systems in the granaries are supported by a network of hydrological data collection transmitted via telemetry and processed in the computerised-based DSS. Additional inputs are from on-site inspection by the operations and maintenance team on the status of the farm activities, on-farm water conditions and state of the canals, drains and structures.
10. Water User Groups (WUGs) were formed in the 1990s in the granaries. These are farmers' (public) participation platforms for management interaction with the systems managers. The main topics addressed by these WUGs include irrigation scheduling within season, on-farm water management best practices and water savings.
11. In the 1980s, a National Water Management Centre was established. This is a dedicated institution for capacity building and training for both the farmers and system managers. Water management (thus water savings) best practices were the main emphasis. This has since closed down after the restructuring of the water-based Ministries in 2004.
12. In the late 1990s and early 2000, an irrigation performance assessment system was introduced.

This was to benchmark the system performance, analyse the performances and take the necessary action to improve the system performance in terms of water productivity.

13. Overall, the Irrigation Areas Act (1953) have incorporated a series of WDM requirements that includes the need for controlling water losses and wastages and even pollution of irrigation water. Contributions by farmers in terms of Water Rates are also included for part financing of the maintenance of the system. These are not based on the volume of water usage but by the size of land ownership.

ii) Paddy Irrigation WDM for the Future

Although the practice of WDM is well embedded in paddy irrigation water management, there are still many challenges and issues that need to be addressed. There is also a need to incorporate new measures for the future WDM efforts.

The major issues currently seen as weakening efforts for improved and sustained WDM for irrigation are listed below:

- (1) The water requirements and measurements of water utilisation as well as canal efficiencies are mostly based on traditionally accepted estimates and "thumb rules" within the sector. Actual and more accurate measurements are difficult under the present level of service provisions (human resources and available and applied technologies). The MADA granary appears to apply a more systematic and consistent water accounting measurement as reporting systems compared to the other granaries.

- (2) The interest in WUGs declined significantly since early 2000. However, the MOA is currently taking steps to revitalise this WUGs in the granaries with a revised structure and developing updated capacity building program.
- (3) The MOA currently does not have any institution specifically for water management training programmes for irrigation managers and farmers that were provided previously by the National Water Management Training Centre.
- (4) The MOA also does not have a research centre for water management. This service was to be provided by the NAHRIM when it was under the MOA until the organisational restructuring that moved NAHRIM to be under the NRE. MARDI used to undertake agricultural water management as a specific research programmes but this has since been largely discontinued.
- (5) Efforts for improved WDM are also disrupted with the move of the JPS from the MOA to the NRE in 2004. The JPS was formed as a dedicated Irrigation institution in 1932. Over the subsequent 82 years until 2014 it has garnered the experience and advances in knowledge and technology of local irrigation development to support the MOA. Over those years too it has established a close relationship with the farmers at the irrigation scheme levels and this is important in terms of obtaining understanding and cooperation for WDM efforts. With the move, the MOA established the Irrigation and Agricultural Drainage Division (BPSP) to continue the previous role of the JPS. The JPS at state levels continue to manage the respective irrigation schemes. However, the concern now is that since the staffing of the BPSP are seconded officers from JPS, there is a discontinuity

of knowledge and experience of irrigation managers once they are transferred back to the parent JPS office that is not any more involved in irrigation and agriculture drainage. The replacement officers are also not necessarily from irrigation background. This is disruptive to the effective irrigation operations and maintenance, causing discontinuity and gradual decline in knowledge and skills in a very specialised subject matter as well as weakening the farmer-irrigation manager bonds established over those long years.

In addition to issues mentioned above, the impacts of rapidly changing water demand needs and pressures by other sectors affect paddy irrigation WDM.

The water management systems for paddy irrigation were developed ahead of the water supply sector and when demands for treated water were small comparatively. The irrigation systems developed then were almost exclusive for the Irrigation Sector and set in a rural background. Due to the early start in development, the irrigation dams are well positioned in terms of freshwater storage and use and with extensive network of water conveyance and distribution systems.

As the country developed, these irrigation facilities and systems have gradually been pressured to change their functions from nearly exclusively for irrigation to a more multifunctional role to meet the demands of water supply sector, flood management, urban drainage and tourism. Even within the agriculture, the paddy irrigation system functions have expanded into aquaculture and non-paddy crops.

All the matured eight granaries are facing the above issues although in varying degrees of impact. It will be inevitable that the new granaries would also be facing the same issues over time. This is simply because the initial agriculture development would gradually attract non-agriculture development as well as experienced by the eight matured granary. Moreover, all the twelve granaries are located within the designated economic development corridors or within or nearby rapidly developing regions. The granaries however are designated paddy production areas for food security and therefore would need to be protected both in terms of production land size and the production water requirement.

A challenging situation is the granaries within the Northern Corridor Economic Region (NCER) and this could be a case study for all the other granaries in the country.

There are three matured granaries within the NCER namely the MADA granary, IADA Pulau Pinang and the Kerian granary. The MADA granary is the country's premier granary producing 40% of the total national production and contributing 30% of the total from all eight matured granaries.

The available uncontrolled flow in this region is already in deficit and the situation is projected to be more serious in the future. As demands from the water supply sector continue to increase, Pulau Pinang State is rapidly approaching the verge of water supply stress situations that is projected to become more frequent if not severe. Such situations would impact on the confidence of present and future investors in the region and especially the foreign investors that have been promised stable water as part of the investment attraction package.

The MADA granary and the Kerian granary irrigation system form the major water storage and distribution system for the NCER. These systems directly influence the available flows and water quality along the two major rivers namely the Sg. Muda and Sg. Kerian.

Over the years, these systems that were once exclusive for irrigation have gradually changed to be multi-functional to serve the water supply sector as well as to manage the flood issues. The MADA system now supplies 900 mld for water supply in Kedah that includes supplying 100 mld to Langkawi. The Kerian irrigation system has now to extend its operational function from just for paddy cultivation to include water supply, aquaculture, flood management and tourism. Further enhancement of the storage capacity of the Bukit Merah reservoir is limited by the railway causeway levels across the reservoir.

The projected increases of water demands are not just from the water supply sector but also from the planned inclusion of the fringe paddy areas of the MADA granary. There are already plans to construct another six dams in this region to meet this demand. However, these are already on alienated and developed lands. There is a high possibility that the construction of these dams may not be on time to meet the increasing demands due to social and economic constraints.

The alternative would be to implement WDM programmes immediately. The use of effective rainfall forms 52% of the total supply and unregulated flows at 42% of the total. Recycling has increased to 6% and the remainder from reservoir releases. With unregulated flow depletion, the pressure is on the dams to release more with the priority on irrigation supply. The issue of dam releases is on their

ability to recover storage in time for the next supply season and also to support the needs of the water supply sector. Since 2007, the Pedu dam has been operating to nearly its full level with good recovery characteristics after the water release of each dry season. However, since 2012, the level showed poor recovery resulting in a general lowering trend in its storage levels. In 2014, the reservoir levels dipped considerably and rapidly to 275 ft (+83.8 m) and approaching its alert level of +267.5 ft (+81.5 m) but fortunately managed to recover during the rainy season.

The WDM option now requires more emphasis to ensure stable water supply in this region. This is particularly important for the paddy irrigation sector as the potential savings is substantial and offers tremendous relief for other sectors. The estimated potential savings from increased irrigation efficiency alone by MADA granary is 1,483 mcm or equivalent to 291 mld (2050). This saving in irrigation represent nearly 25% of the water supply requirements of the population in the three "water deficit" states of Kedah, Perlis and Pulau Pinang.

There is potential irrigation water saving mainly in the granaries area and the irrigation demands are projected to increase from 8,266 mcm in 2010 to 9,112 mcm in 2020 and then onwards to 2050, the demands will decrease to 7,205 mcm or 13% decline. The projections did not include the four new granaries declared by the MOA in 2013, after the NWRS 2012 was completed. These are IADA Pekan (10,937 ha) and IADA Rompin in Pahang (6,173 ha), IADA Kota Belud (3,357 ha) in Sabah and IADA Batang Lupa (4,300 ha) in Sarawak. The estimated total water demand from this additional granary is 571 mcm. Assuming that all these granaries will be fully operational by 2020 with 70% efficiency level,

then the revised estimated demands would be 4,604 mcm in 2020 and reduced to 3,537 mcm in 2050. The savings in the granaries are as shown in Table 4.16 as at 877 mcm (2,405 mld) per year.

From the NWRS 2012 projections, demands from the water supply sector will surpass that of irrigation for paddy after 2033. This position however is based on the assumption that irrigation efficiencies for paddy will improve on time to 75% (2050). This is equivalent to a total reduction of 2,086 mcm, which is derived by taking the different between total potable water demand (9,291 mcm) and irrigation paddy (7,205 mcm) in 2050. This reduction would provide relief to the increasing demands of the water supply sector. If the efficiency improvements are not achieved on time, then the pressure on the water resources could be intense.

Table 4.16: Potential Irrigation Water Savings

Potential Water Savings in Irrigation (an illustration) -the MADA Granary	
<u>A. Estimated Total Paddy Crop Water Requirement</u>	
(a) Main Season	0.011 mcm/ha
(b) Off-Season	0.013 mcm/ha
(c) Total Annual	0.024 mcm/ha
B. Total MADA Granary Area	96,558 ha
C. Total Annual Crop Water Requirement (A(c) x B)	2,317 mcm
<u>D. Sources of Water</u>	
(a) Direct Rainfall (52% x C)	1,205 mcm/yr
(b) Other Sources (48% x C)	1,12 mcm/yr
<u>E. Irrigation Supply</u>	
(a) Present Irrigation Efficiency	70%
(b) Thus Irrigation Supply (D(b)/E(a))	1,589 mcm/yr
<u>F. Potential Savings</u>	
(a) Increasing Irrigation Efficiency to	75%
(b) Irrigation Supply (D(b)/F(a))	1,483 mcm/yr
(c) Irrigation Supply Savings (E(b)-F(b))	105 mcm/yr

In the case of agricultural water usage, particularly paddy cultivation, a small reduction in water usage can free a considerable amount of water for other end users, like domestic and industrial supplies and for environment and recreational benefits. Efforts to develop varieties that require less water is currently on going. In the meantime, efforts to increase irrigation efficiency have to be stepped up. As an example, the total paddy crop water requirement for the MADA Granary is 0.011 mcm/ha for the main season and 0.013 mcm/ha for the off season.

Thus, the total crop water requirement is equivalent to 0.024 mcm/ha/year. Direct Rainfall provides 52% (0.0125 mcm/ha) of the total water needs and the remaining 48% (0.0115 mcm/ha) is from other sources namely the dams (32%), rivers (10%) and re-use (6%). With a total area of 96,558 ha, then the total crop water requirement is 2,317 mcm/year. Since 52% of this amount 1,205 mcm is from rainfall and the remaining 48% or 1,112 mcm has to be from irrigation.

Presently, MADA irrigation system is reported to be operating at 70% irrigation efficiency. This means that the irrigation supply to produce rice here is 1,589 mcm/year. If irrigation efficiency is raised to 75% (an on-going effort), then the total irrigation supply would be 1,483 mcm/year, a reduction of 105 mcm/year. This is equivalent to a relief of 291 mld for the water supply industry.

However, water for non-paddy agriculture may be small compared to that for water supply and paddy irrigation. However these are emerging sectors in terms of increasing needs for water for reasons of quantity, quantity and consistency of produce. Also, as evidenced in the Cameron Highlands, a large contiguous area of non-paddy crops such as commercial vegetable farming could impose significant water demands on the local and regional water resources.

However, increasing irrigation efficiency alone is no guarantee for water savings as large volumes of wastages could still occur if farmers' adherence to planting and irrigation schedules as well as on-farm water management is still poor. Thus efforts for higher levels of farmers' participation in best water management practices are also crucial for water saving efforts.

In addition to this, efforts to increase and maintain high levels of use of effective rains are also necessary. Apart from on farm water management practices to harvest rainwater, there is a need for improved the forecasting systems. This is important so as to prevent wastages of releases from the dams as well as from the uncontrolled flows when rain falls on the farms upon the arrival of the supply.

The MADA recycling systems could be extended to contribute up to 6% of the total source of supply. This is estimated to be the maximum amount of using reuse water without any treatment. There is a potential to increase this if some form of treatment is incorporated.

At the moment, practices to ensure acceptable quality of water returned to the major drainage systems are still low. There are only minimal studies and even monitoring and evaluation on water quality discharges from the system. This needs to be reviewed as the returned water is also a potential water resource for other downstream users including the tourism and environmental sectors and more importantly for health and water safety.

One important component of WDM management is water charges for the returns on investments and operations and maintenance services. This has always been and will continue to be a contentious issue with policy-makers as well as the farmers as much as tariffs

in the water supply sector. The often and repeated resistance is that water, especially freshwater in this case, as a natural resource should be free. Still, the generally accepted view is that water charging has also a significant impact on efforts to save water by the end users.

In irrigation, the need for end users to pay for water use is at least for infrastructure and services costs recovery. In fact, the Irrigation Areas Act (1953) has provisions for Water Rates that is meant for contributions for the service. This is based on area of farm size owner rather than volume of water used. The rates currently are very low as it has not been revised since the 1960s and that it only applies only to areas gazetted as Irrigation Areas. Not all the irrigated areas in the granaries are gazetted.

Whilst the present policies on water charges should be respected, there should also an initiative to increase the awareness of end users that there is a price for water. Ultimately, not in the near future, all end users will have to pay for water for the sake of water conservation. This possibility should be ingrained from now on to change the mind-set of future farmers and policy makers.

This can be done by undertaking a detailed exercise to determine the actual and fair price to deliver irrigation water and to publish as well as inform the end users regularly. This is similar to the efforts by the utility service providers (water, electricity, fuel) to now note the value of Government subsidies in the invoices and receipts. In addition, there should be a study on the strategies to charge for water including alternative or creative and fair payment modes.

4.3.17 Water Demand Management for Non-paddy Crops, Livestock and Aquaculture

From a water management perspective, the non-paddy sub-sectors of agriculture (horticulture, industrial crops particularly oil palm and rubber, livestock and aquaculture) can further be categorised as irrigated or rain-fed agriculture. Paddy production is also either irrigated or rain-fed. However, since the policy is to diversify the rain-fed paddy areas, their water demand management for the future is essentially covered under this non-paddy topic.

From a functional role, MOA focuses on agriculture for food production and MPIC on industrial crops mainly oil palm and rubber.

The MOA has a dedicated division, the *Bahagian Pengairan dan Saliran Pertanian* (BPSP; the Irrigation and Agricultural Drainage Division), responsible for irrigation and agricultural drainage management and development works. For irrigation, these are mainly for paddy whilst drainage for non-paddy crops are mainly for areas within IADA designated operational areas. The MPIC does not have any dedicated organisation for irrigation and drainage development and management works.

Irrigation in irrigation schemes is also referred to a "formal irrigation" whereby the systems are planned, developed and managed by the government and subject to the Irrigation Areas Act. "Informal irrigation" are those that are developed and managed entirely by the farmers or private sectors (e.g. for vegetables and tree crops).

The drainage aspect of agriculture water management and therefore WDM is often

overlooked. Whilst drainage is an integral component of irrigation systems, there are areas where drainage are planned, developed and managed specifically for rubber and oil palm in the coastal plains of the country. The systems were initially installed by the Government as the first steps of the swamp land reclamation processes and these primary drains then continue to be under the management of the government. Following this, the private sector estates then develop and manage the secondary and tertiary systems within their land ownership boundaries that are then connected to the primary system. For smallholders, the government investment in drainage covers all primary, secondary and, to a certain extent, tertiary systems as implemented in the Western Johore Drainage Development Project and other IADA areas such as in Barat Laut Selangor and Samarahan.

Drainage management is not just for managing excess water and floods but for the water table management especially in dry seasons. Thus, controlled drainage for water table management could also be viewed as subsurface irrigation to ensure consistently high yields. The need for WDM in agriculture drainage areas is in the form of drainage system owners having to operate the system such that drainage water is not wasted through opened controlled gates or defective drainage components. This could then lead to unwanted lowering of water table not just in the vicinity of the drainage channels but extending over vast adjacent areas. This then would induce or require water replenishment from upstream areas that also have to meet water demands for those respective areas and water sectors.

Up to about the 1960s and early 70s, the drainage systems were regulated by the Drainage Works Act

1954 (Act 354) and for areas declared (gazetted) as Drainage Areas. This Act is now not enforced.

i) WDM for Horticulture, Livestock and Aquaculture

Horticulture includes non-paddy crops such as fruit trees and vegetables. Whilst knowledge and technology is adequate for the planning and design of irrigation systems for these crops, not much is known in terms of water demands and water quality management from the water resources perspective. There are two main reasons for this. One is that the irrigated areas are relatively small and intersperse with other rain-fed crops to impose significant demands on the water resources. The other is that since it is an informal system (unregulated), there is no authority or a dedicated institution or department to monitor and collect relevant data and information on water demands and drainage water quality for these crops. However as illustrated, when irrigated farming becomes intensive over a large contiguous area in the Cameron Highlands, the water demands become significant and without any effective regulation and authority, the impact can be severe on water demands affecting other sectors as well (hydropower, water supply and the ecosystem). Further planning and development for improving the situation is impeded by the lack of comprehensive data and information.

The situation for livestock is also the same as above in that WDM issues will be significant when the industry intensifies over a large contiguous area. The industry's water quality discharge issues have become prominent but these are being addressed by the DOE under the Environment Act.

Table 4.17: Positive Yield Response to Irrigation

Experiment details	Results reported	Reference
Drip or furrow irrigation of oil palms (Non-effluent)	30% yield increase from irrigation and mulching	<i>Chan K.W. et al. (1985)</i>
Flatbed irrigation on oil palm (Non-effluent)	11% yield increase with irrigation	<i>Lee C.T. et al. (2011)</i>
Furrow application of rubber effluent on oil palm	4-40% yield increase with irrigation	<i>Mohd Nazeeb et al. (1983)</i>

Similarly for aquaculture and although a non-consumptive sector, the intensification of the Arowana fish farms along and adjacent to a section of the main canal of the Kerian granary irrigation system has begun to impose higher WDM stresses on the system operations and maintenance. Abstraction of water from the main canal into the fish ponds has resulted in increased releases from the Bukit Merah reservoir. From time to time, there are reports of incidences of fish fatalities due to river water pollution. Again, these are more often treated on a case-by-case basis without any comprehensive plans for long-term water quality management.

ii) WDM for Rubber and Oil Palm

Both rubber (planted area 1,057,271 ha in 2013) and oil palm (planted area 5,229,729 ha in 2013) are categorised as industrial rain-fed crops.

Of the two, the concern on the need for water is more for the oil palm industry than that for rubber. Oil palm crop is water sensitive in that yield is responsive to water availability. Dry periods can cause significant drops in yields. At present the national average yields of oil palm is around 20 tons/ha/yr FFB. Results of experiments in Malaysia have indicated the potentials of irrigation to increase this to between 32 to 60 tons/ha/yr FFB (refer to Table

4.18). In India, with a national average of 8 tons/ha/yr FFB yields, irrigation could increase the yields

Table 4.18: FFB yield in Malaysia

Situation	FFB Yield (t/ha/yr)
Malaysian National Yield (1975-2010)	18.94
MPOB (DG's plot)	32
FELDA (irrigated)	46
FELDA (lysimetric with maximum inputs of fertilizers and water)	60
India (irrigated)	32
India (non-irrigated)	8

Source: Basiron, 2014

tremendously to 32 tons/ha/yr FFB.

Given those tremendous potentials, interests in irrigated oil palm production are increasing. Under the circumstance and in line with policies to increase oil palm yields and subsequently export earnings, efforts on water management should be focused to a systematic development of irrigation for oil palm with sectorial and inter-sector WDM considerations.

For oil palm areas along the coastal belt, irrigation would be more based on water table management of the drainage systems. In the relatively flat alluvial plains, are many paddy irrigation schemes that have been converted into oil palms under the Crop Diversification Policy. Many of these schemes

Table 4.19: Parameter Limit for Discharge into Water Course

Parameter	Limits according to period of discharge					
	1.7.1978 to 30.6.1979	1.7.1979 to 30.6.1980	1.7.1980 to 30.6.1981	1.7.1981 to 30.6.1982	1.7.1982 to 31.12.1983	1.1.1984 and thereafter
Biochemical Oxygen Demand (BOD) 3-day, 30°C, mg/l	5,000	2,000	1,000	500	250	100

have with relatively stable water supply designed for paddy irrigation. However, at the on-set of the diversification, the irrigation systems were either abandoned by the system operators or even demolished to plant the oil palm. Under present circumstances and with climate change impact, it would be worth to relook at the irrigation systems for such areas and reactivate them for increased oil palm yields. A new system will have to be developed for the hilly areas and even with consideration of small reservoir developments.

Water quality discharge from oil palm mills is also an issue of the industry affecting the WDM of other sectors downstream of the discharge point. Efforts have increased to reduce this and now the regulatory limit for POME discharge is set at not more than 100 mg/l BOD (3 day; 30deg). There are other methods being promoted to further improve discharge management and this includes the applications of "zero discharges" from the plantation and mills.

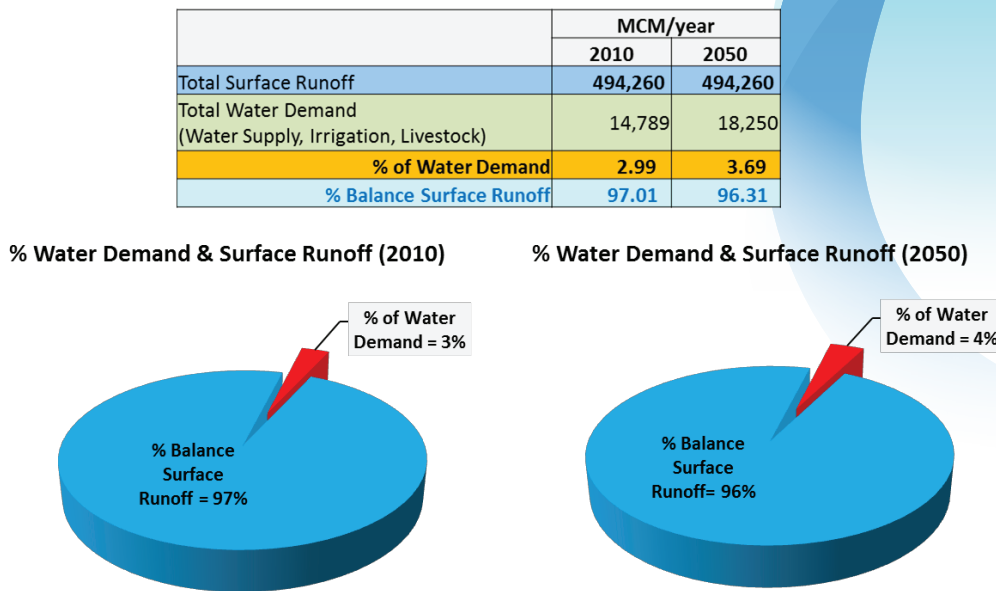
4.4 Ecosystems WDM (Environmental Needs)

4.4.1 Overview

The environment is a passive user of water and not directly related to human activity needs. The type and mix of the vast number of flora and fauna that makes up the environment as a whole are results

of responses to the local geography of which available water is one of the main elements. Thus, from the perspective of water needs for the existing environment, the amount of water not used and not diverted for human needs is its water requirement. From this perspective, accounting for environmental needs in the total water resources management would indicate that the environment is the biggest user of water. For Malaysia, this would be 494,260 mcm, or 97% of the total water resources yields (Figure 4.7).

At the same time, the projections are that the water demand for human use is projected to increase to 18,250 mcm by 2050. Concurrently the remaining volume for environment will therefore decrease to 14,789 mcm or 2.99% of the total water resources yields. Technically, this reduction is a "forced" WDM on the ecosystems WDM sector to satisfy human activity needs. The environment would response to adapt to the reduced available water and to the returned water quality too. The consequence of this on human lives and well-being can be disastrous in the long-term. Thus, a special WDM for the Ecosystem is now necessary to ensure sustainable water and water resources management.



Source: NWRS 2012

Figure 4.7: Total Water Demand and Surface Runoff

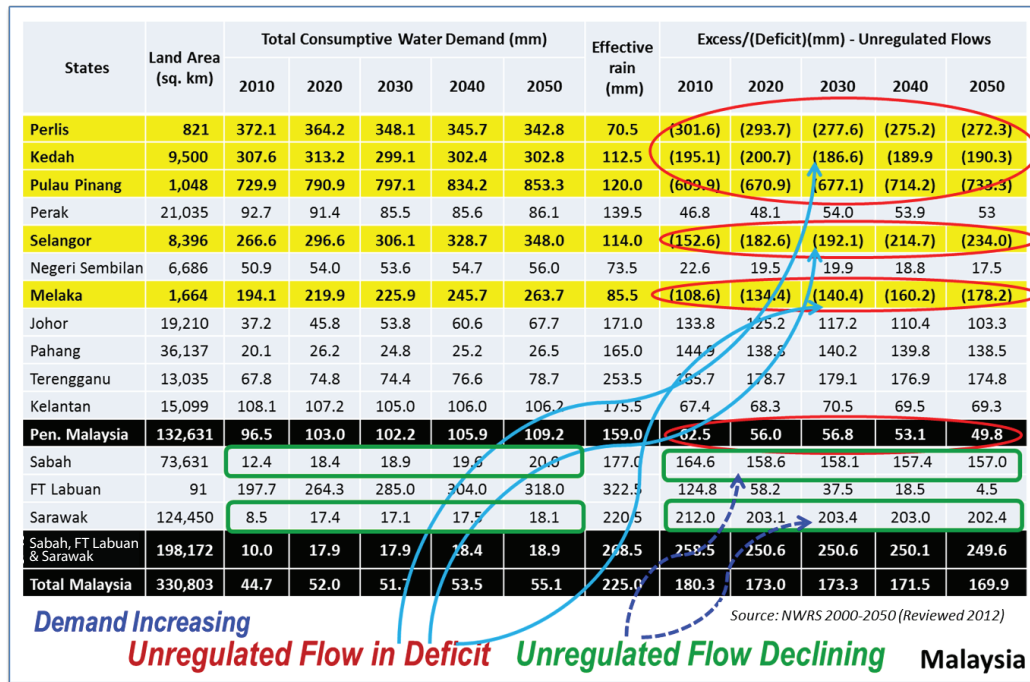
4.4.2 Present Status

Presently, there is no single authority dedicated to be responsible for ecosystems WDM services. The water accounting and management approach presently is directed towards more for human needs (human-centric). The phrase "water is abundant" to describe the country's water resources yields more often than not connotes that water is plentiful for human use. Often overlooked is that for the abundance of water, there is a wealth of biodiversity and the environment. Also overlooked is that any abstraction from the natural freshwater flow and returned water for human activity is also an abstraction from the available water for the existing environment.

Since ecosystems WDM is related to water resources management, involving land management, it becomes a state matter under the Federal Constitution. Overall, at Federal level, the responsibility lies with the NRE. The NWRS 2012

Policy Principles stress on a strong Federal-State alliance and commitment for sound management of river basins nationally. The DOE Malaysia is, however, responsible for regulating the quality of water, especially returned water to the system after human use under Environment Quality Act 1974. Water quality is also monitored by the respective sectorial water managers mainly for maintaining compliance with regulations or for the respective sectorial water quality needs.

The review of the NWRS 2012 projected a declining trend in available unregulated flows in all States in Malaysia. Five of the States are already in deficit and the situation is projected to worsen (Figure 4.8). This situation is not only of concern to sectorial water managers but it is also indicative of the potential severe stress on the ecosystems that needs immediate attention.



Source: NWRS 2012

Figure 4.8: Consumptive Water Demand and Available Unregulated Flows

In addition to the above, the NWRS 2012 also provided a measure of the vulnerability of the water resources in relation to the integrity of the ecosystems WDM. This is in the form of National Water Resources Index (NWRVI). Figure 4.9 shows the NWRVI for the States in Malaysia. As can be seen only two states, Sabah and Sarawak, are in the low vulnerability

category and only just. All the rest of the states in Peninsular Malaysia are below this category with four States, Perlis (almost), Pulau Pinang, Selangor and Melaka already in the vulnerable category. This state of the environment should not be left unchecked especially if the environmental deterioration accelerates and the situation irreversible.

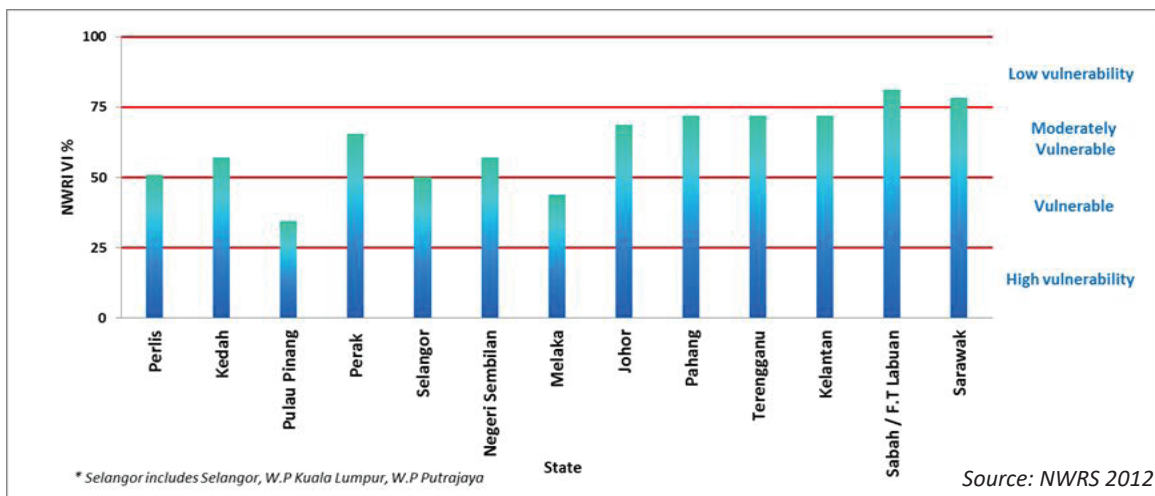


Figure 4.9: National Water Resources Vulnerability Index by States

Among the strategies adopted for enhancing ecosystems WDM include:

- Adopt WDM in Policy Decisions
- Need for central regulation for environmental management; and
- Develop an operational WDM action plan.

4.4.3 Adopt WDM in Policy Decisions

Develop Criteria to determine water resources use priority Thrust 6 : Strategy 16.

The NWRP recommends priority for water resources use, particularly in times of crisis or threat.

It also emphasises on:

PTS 33 : Identify key users and uses; and

PTS 34 : Identify key water resources use areas.

NWRP may need to be reviewed with the need to identify the need for conservation of water resources, catchments and bodies to sustain water resources for ecosystems WDM for water needs.

The National Policy on Biological Diversity (2016–2025) provides the direction and framework for the nation to conserve our diversity and is relevant to enhancing ecosystems WDM. Among the principles of the National Policy on the Environment (October 2002) is to conserve natural ecosystems to ensure integrity of biodiversity and life support systems.

4.4.4 Need for central regulation for ecosystems services WDM

Water for the ecosystem services is mainly defined in terms of environmental flow “releases from dams which are intended to achieve environmental benefit as opposed to releases which are intended for consumptive purposes” (Zulkifli 2012). Expanding this, environmental flows are “the quality, quantity and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems that provide goods and services to people” (Zelina 2012; Zulkifli 2012).

Another concept introduced and promoted by several organisations and interest groups is the Total Maximum Daily Load (TMDL). TMDL is to define the “maximum amount of pollutant that a water body can take but still meeting the designated use and water quality standards” (Zulkifli 2012).

At present, the only significant water management for the ecosystems is the Environmental Flow releases by dam owners in their daily operations. This is based mostly on values determined by rule of thumb based on simple indices or desk top hydrological statistical methods without any extensive study on the environmental needs itself. As a rule of thumb about 10% of the Average Annual Flow (AAF) is normally applied for dam planning purposes (Lim & Mohamed Roseli, 2010). In many cases, these figures were determined at the planning and design stages without any further review during the operations of the dams and changes development and land use downstream. In certain cases, the values for the release are also for specific requirements and not the environment as a whole. For example, the release of water for managing salt water intrusions to sustain firefly in Kuala Selangor. These habitats are becoming

very scarce in man-made river structure when water allocated for its demand is not sustainable. The practices of releasing environment flow at the operational dams like Hulu Terengganu Hydro-electric project located upstream of Kenyir Dam is 1.5 cumecs.

For ease of operations, the value of these releases are also mostly constant without further consideration of the needs of the numerous flora and fauna in terms of timing, quantity and quality.

While there are concepts for environmental water demand management and studies on environmental water needs, the present issue is that without a dedicated authority specifically for ecosystems WDM, water management, and the physical implementation to ensure effective and sustainable environmental management is simply ineffective and even totally neglected in many river basins. The ecosystems sector needs to establish institutional and legal framework for sustainable water management.

The best arrangement is to establish this body at central level, under the NRE. The ministry could conduct state-level dialogue and workshop in environment WDM with participation of IRBM.

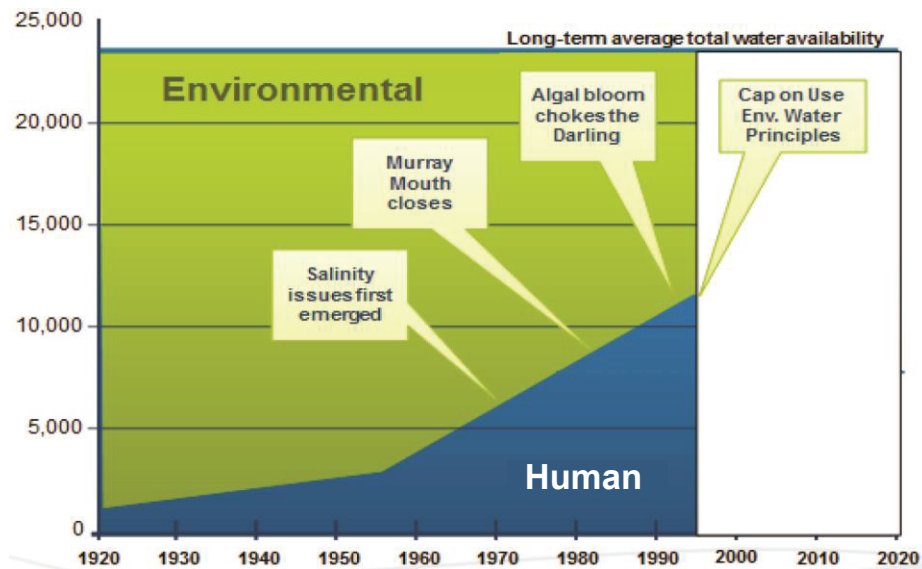
4.4.5 Developing an Operational WDM Action Plan

Admittedly, the understanding and knowledge of water management for the environment in Malaysia is still lagging. Whilst there are tools applied for determining environmental flows (Zulkifli 2012; Lim and Rosli 2012) and studies on specific locations e.g. Sg. Seget (Zulkifli 2012) and Sg. Langat (Lim & Rosli 2012) there is no operational approach developed for water management for the environment for the country. The NWRS 2012 provides the state of the environment and areas of concern including priority areas for environmental management. It also forwards a series of recommendations for sustainable water and the environment management. The urgent need now is to develop strategies and action plans to operationalize those recommendations.

Principles For The Provision of Water for Ecosystems

Principle 1	River regulation and/or consumptive use should be recognised as potentially impacting on ecological values.
Principle 2	Provision of water for ecosystems should be on the basis of the best scientific information available on the water regimes necessary to sustain.
Principle 3	Environmental water provisions should be legally recognized.
Principle 4	In systems where there are existing users, provision of water for ecosystems should go as far as possible to meet the water regime necessary to sustain the ecological values of aquatic ecosystems whilst recognising the existing rights of other water users.
Principle 5	Where environmental water requirements cannot be met due to existing uses, action (including reallocation) should be taken to meet environmental needs.
Principle 6	Further allocation of water for any use should only be on the basis that natural ecological processes and biodiversity are sustained (i.e. ecological values are sustained).
Principle 7	Accountabilities in all aspects of management of environmental water provisions should be transparent and clearly defined.
Principle 8	Environmental water provisions should be responsive to monitoring and improvements in understanding of environmental water requirements.
Principle 9	All water uses should be managed in a manner which recognises ecological values.
Principle 10	Appropriate demand management and water pricing strategies should be used to assist in sustaining ecological values of water resources.
Principle 11	Strategic and applied research to improve understanding of environmental water requirements is essential.
Principle 12	All relevant environmental, social and economic stakeholders will be involved in water allocation planning and decision-making on environmental water provisions.

Source: ARMCANZ and ANZECC, 1996



Source: Carr and Jones, (2012), eWater CRC

Figure 4.10: Increasing Human Water Use over Time

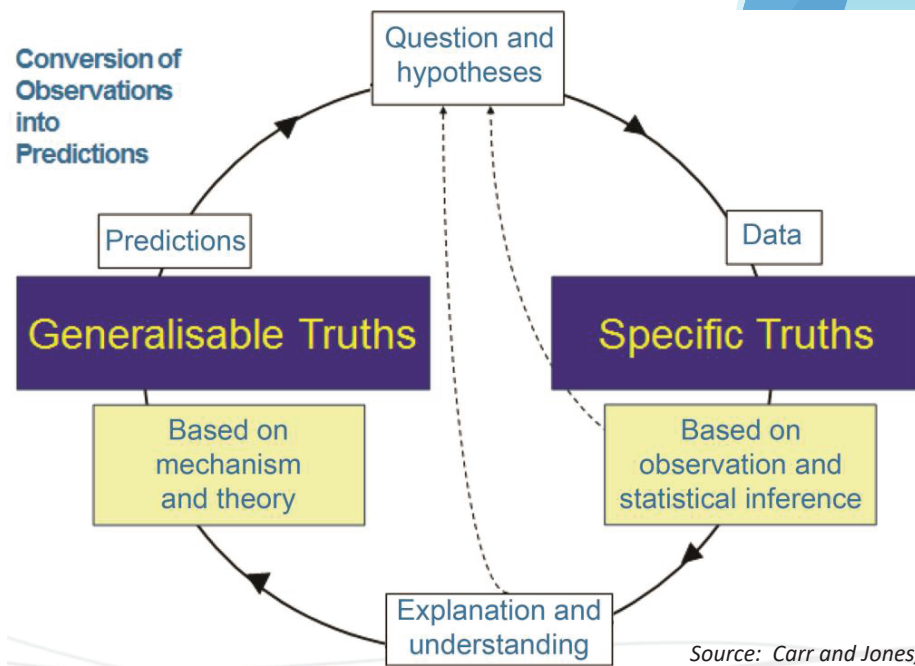
Understanding fully the environmental water needs is a complex and time consuming exercise. Thus an approach that is pragmatic and could be developed and implemented in a relatively short time is needed. One such model that could be considered is that applied by the Australian Government (similar to Malaysia). Australia is a Federation of States, known as the Commonwealth and water is under the purview of the respective states). In fact, reforms in the Australian water management were induced by widespread public outcry on the environmental deterioration of the Murray-Darling River basin due to over abstraction of water for human use. This was following the well-publicised toxic algae blooms in the Darling River in 1991. The water management reform introduced the 12 principles on Environmental Water. This included the need to provide ecological water on scientific basis and also stakeholder's participation. By mid-1990, a cap was defined to limit the use of water for

human activities so as to ensure adequate amount is protected for environmental water (Figure 4.10).

4.4.6 The Process of Defining Environmental Water Requirements

Ultimately, a full understanding of the environment is necessary to enable precise water management practices. However, as this is time consuming, a more pragmatic approach and implementable relatively fast is therefore necessary (Carr 2012) whilst research and studies continue.

One of the first steps would be to identify and select iconic environmental sites or key environmental assets (Carr 2012) and key areas of special interests that need to be protected and managed particularly in river basis. Some examples are the firefly area in Selangor, terrapins of Sg. Perak, Kuala Gula Bird Sanctuary in Perak and certain stretches of the



Source: Carr and Jones, (2012), eWater CRC

Figure 4.11: Conversion of Observations into Predictions

mangrove swamps along the coastal belt. The NWRS 2012 also provides information on environmental areas of interests. In addition, the National Physical Plan No 2 (NPP2) also indicates environmentally sensitive areas, forests and coastal zones in Peninsular Malaysia that requires special attention.

Again, since detailed scientific information may not be available and research results takes time, working out the water management needs can be based on "Generalisable Truths" i.e. acceptable information from experts and observations of experience people that can be used to estimate water needs and environmental responses of the identified areas of interests. This will have to be followed by a process to determine the "Specific Truths" (Figure 4.11) and for refinement of the water management for the environment.

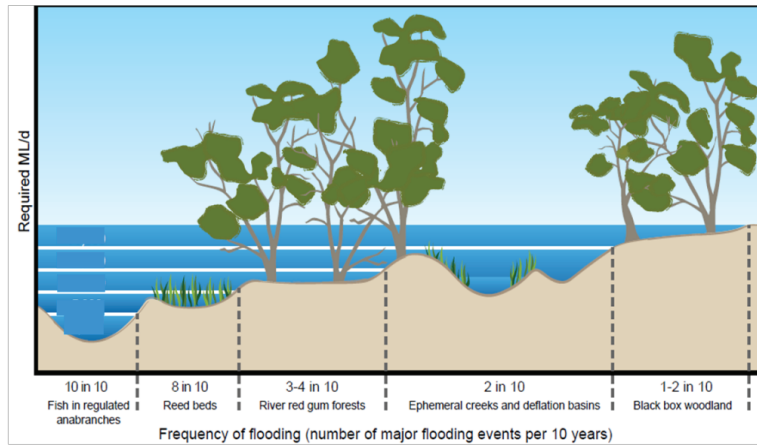
The main drivers of River Health & Ecological Condition?

1. *Biota*
 - *Biodiversity, endangered species, pests.*
2. *Water Quality*
 - *Nutrients, toxicants, temperature.*
3. *Habitat*
 - *Physical, hydraulic.*
4. *Flow regime*
 - *Ecologically important hydrology.*

The primary objective is to develop a model on how the environment responds to flow. The framework can be built up from a general inventory of the existing area of interest and the adjacent river flow regimes (Figure 4.12). This would require an understanding of the main drivers of river health and ecological conditions. Subsequent refinement would

Need to Define an Outcomes framework

Summarising results against different parts of the ecosystem



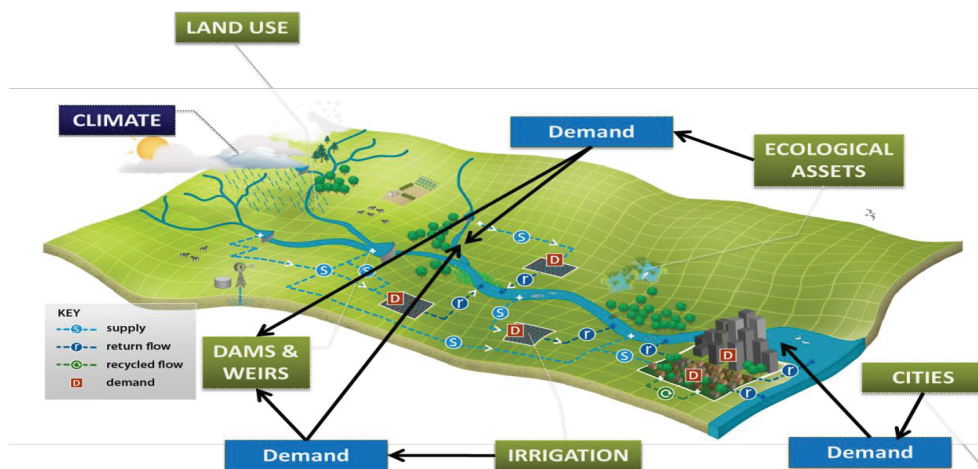
Source: Carr and Jones, (2012), eWater CRC

Figure 4.12: Results against Different Parts of the Ecosystem

then allow for a predictive model for the desired operational flow regime that could induce or sustain a desired environment or even recover a damaged environment. From this, an environmental flow demand model can be developed for operational use by the water managers and interested stakeholders (Figure 4.13).

Operationally, the dam operators in the respective river basin would be one of the key stakeholders that

are in control of water stored in the dams. For the environmental sector, the number of key stakeholders can be as varied as the elements of the environmental icons or environmental areas of interest. The locations of these sites could also be located far from the dams and therefore the dam operators may not be aware of any disastrous situations and to take time actions.



Source: Carr and Jones, (2012), eWater CRC

Figure 4.13: Environmental Flow Demand Model

WDM for Non-consumptive Sectors

4.5 Hydropower (Energy) WDM

In Malaysia, there are 13 numbers of hydropower dams with a total storage capacity of more than 79,000 mcm of good quality freshwater over a surface area of 1,600 km² (RPM Engineers, 2014). More hydropower dams are planned as part of the strategy to increase renewable energy sources. This storage offers significant potential and possibilities for within and inter-sector WDM management strategies for various states of water resources availability.

For within sector WDM for hydropower, control of reservoir surface evaporation would be one of the strategies to be developed. This is because evaporation is the major source of "loss" or the "consumptive" aspect of the hydropower dam storage (also for other sectorial dams). Based on a simplistic estimate of total potential evaporation at 1.25 mcm/km²/year or 3.42 mld/sq km², the total losses from hydropower dam surfaces in Malaysia has been worked out to be 2,000 mcm/year or 3,872 mld. Actual losses are dependent on the variation of surface area relative to reservoir releases for generation and other uses. The Intergovernmental Panel on Climate Change (2012) released a special report on renewable energy in 2012 that gave a range of water consumption estimates in hydropower facilities from 0.04 m³/MWh to 209 m³/MWh (Bakken et al. 2013). These figures are now being reviewed as the estimates obtained are dependent on the methodologies and definitions of consumptive use. Technologies for evaporation loss management are already available and applied in some countries. In Malaysia, it appears that their applications have yet to be economically justified.

Based on operational data obtained from the

hydropower stations in Peninsular Malaysia, the actual annual nett unit of electricity (kWh) generated from year 2006 till 2015 at combination of various dams currently in operation namely Temengor, Bersia, Kenering, Chenderoh dams of Sg. Perak, Kenyir dam of Sg. Terengganu and Pergau dam of Sg. Kelantan are shown in Figure 4.14.

Generally, the amount of water used to generate electricity at these dams follows approximately similar trend to the actual yearly nett unit of electricity produced. It is worth to highlight that unlike water consumed for irrigation, water supply and flood mitigation purposes, the amount of water utilised for hydropower generation at these dams are returned significantly to the respective rivers.

Based on current operational activities, Kenyir Dam of Terengganu Hydroelectric Project located at the downstream of Hulu Terengganu Hydroelectric Project, releases environmental flow for flood mitigation, recreational and water supply purposes. Water is also being release to flush salt water intrusion into the nearby river. On the other hand, besides hydropower, Bersia Dam also releases water for water supply. The water utilised to generate hydropower at both Chenderoh and Temengor dams are also being released for recreational and flood mitigation purposes.

Inter-sector WDM in hydropower generation could also be from operational strategic combination of sources of energy. In times of increased water demands from other sectors, power generation from non-water based energy sources could be increased thereby hydropower generation reduced. This is especially for higher water demands by other sectors during the dry seasons. Further advancement of solar energy and energy storage technologies would

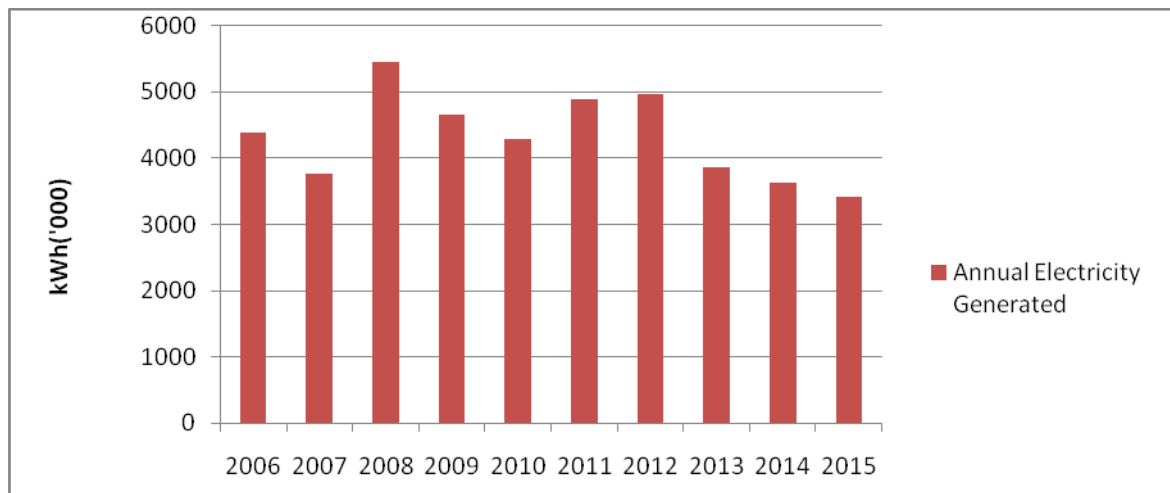


Figure 4.14: Actual annual nett unit of electricity (kWh) generated from combination of Temengor, Bersia, Kenering, Chenderoh, Kenyir and Pergau dam from year 2006 till 2015

facilitate the development and application of this strategy.

4.6 Navigation WDM

Sarawak is about the only State in Malaysia with significant use of the rivers for navigation. These are regulated by the Sarawak Rivers Ordinance 1993 and enforced by the Sarawak River Board. Traffic and water quality are two of the major aspects of the regulations. A number of states such as Perlis, Perak, Selangor and Melaka, in Peninsular Malaysia, have indicated interests to revitalise river navigation along their major rivers especially for tourism and, if possible, for goods as well as alternative to land transportation.

In most cases, the WDM for navigation is primarily dependent on Sectors owning and operating dams on the upstream stretches that have induced changes in the river regime. This has resulted in severe siltation that in turn caused loss of draught for river boats and ships during the dry seasons such as that in

Sg. Perak.

Revitalising river transport would require specific WDM strategies by the dam owners to release water to facilitate safe and smooth navigation. Planning of new dams would also now have to include navigation needs for the future.

4.7 Recreational WDM

Water-based (e.g. water sports and recreation) and water dependent tourism (e.g. water fronting and water-based access to tourism facilities) is a relatively new aspect to consider in WDM. An example of water-based tourism that is restrictive to dam operations is the tourism site within the Bukit Merah reservoir for the Kerian granary. For year-round tourism here, the reservoir operational levels have to be limited to a minimum of +7.0 m for boat access. This requirement restricts the operations of the reservoir for other sectors (irrigation, aquaculture, water supply and flood management).

An option for WDM for this component of the

tourism sector is to develop seasonal rather than year round activities in tandem with the water needs and availability for other sectors. This would require a firm commitment on specific service levels by the water sectors in control and regulating water sources.

Water quality management is also important aspect particularly for water-body contact activities. This is dependent on the WDM by all sectors.

4.8 Inter-sector Water Demand Management

4.8.1 Overview

The sectorial approach to water resources management in this country is well embedded following years of such development approach. This approach was inevitable as each sector was formed in the early days of government administration to address specific issues of that time. JPS was formed in 1932 to address the issues of rice shortages as well as rural poverty. The Water Supply Department for stable supply of safe drinking water and the power supply organisations for electricity. Over the years when floods became an issue, the JPS also develop flood management dams and flood diversion systems. These are key sectors and players in terms of having the authority and control over their respective water management facilities that influence the available water for use for other uses and users.

The need to coordinate these major water sectors was not an issue for many years as available water was abundant relative to demands. A milestone in the need for inter-sector coordination was the proposal by the first National Water Resources Study in 1981 to form a high-level body for the country's water resources management. It was not until 17 years later in 1998 that the National Water Resources Council

(NWRC) was formed as an administrative platform to address water resources and water management issues.

As the country develops and with population growth, the water demands by each sector increases. This invariably increases the pressure on the water resources of the country and the need for a coordinated management. Responding to this, the National Water Resources Policy (NWRP) was introduced in 2012 and a Draft National Water Resources Act has prepared subsequent to this policy and is still under consideration.

4.8.2 The Sectorial Connectivity

The conceptual sectorial connectivity of the WDM structure is represented in Figure 4.15. The water sectors can be categorised as a combination of active (in control; developer and manager) or passive (not in control) and consumptive (abstract water for human activity off the water system) or non-consumptive (returns water to the system at the point of use without any significant change in water quality). The water supply and the irrigation (for Paddy) are the two major active and consumptive users of water. The hydropower sector (Energy) and flood management sector (Environment) is also active but non-consumptive water managers. The returned water from the water supply sector is managed by the sewerage sector. All other sectors such as environment, fisheries and livestock, transport and tourism can be considered as non-consumptive passive water users.

At present, WDM is practiced by the respective

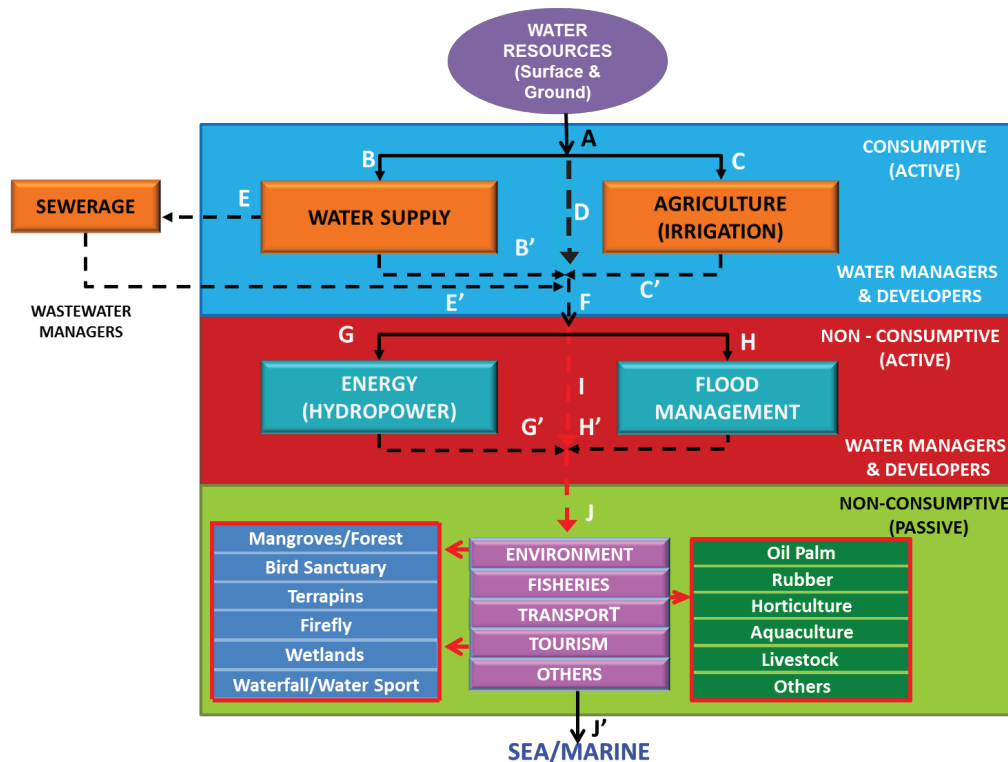


Figure 4.15: Sectorial Connectivity of WDM (Regulated Sources)

sectors (within sector WDM) only and principally by the Water Supply and Irrigation Sectors only. Inter-sector WDM is effectively Water Resources Demand Management. Currently, there is no official government department responsible for water resources in the country. Until one is appointed, JPS under the NRE is generally accepted as the responsible department for water resources management at the national level. Similar situation prevails at the state level. Here and as with the federal level, the state JPS assumes responsibility for the respective state water resources management. The exception is the water resources authorities formed in certain states such as in Selangor, Kedah and Sabah. These organisations however have yet to have any definite programmes for inter-sector WDM.

4.8.3 The Need for Inter-sector WDM

Overall, the need for Inter-sector WDM is to manage a finite resource, water resources, sustainably. Sectorial water demands are increasing particularly the water supply sector. The demands of other sectors that were previously passive and non-consumptive water are increasing. Freshwater aquaculture, non-paddy irrigation (especially for high value crops), livestock and tourism are emerging sectors with increasing water demands. Even oil palm sector that are traditionally rain-fed have indicated the need for irrigation for stable high yield production. Furthermore, to meet increasing energy demands and using renewable energy, more hydropower dams are planned that would impact on the increasing water demands downstream of these facilities.

At the same time, projections of available unregulated flows are declining with five States in the Peninsular already in deficit. This availability estimate are based on quantity and with declining water quality, the actual availability could be far less.

Plans for new dams are already in place (Table 4.20) to address this. However, timely implementation may not be achievable due to the time consuming and effort needed consider local and international social, economic and environmental impacts.

Table 4.20: Potential Future Dams in Malaysia by State

No.	State	Purposes						Total
		Water Supply	Hydropower	Irrigation	Flood Mitigation	Environment	Recreation	
1	Perlis	0	0	0	0	0	0	0
2	Kedah	0	0	6	0	0	0	6
3	Pulau Pinang	0	0	0	0	0	0	0
4	Perak	5	0	0	0	0	0	5
5	Wilayah Persekutuan	0	0	0	0	0	0	0
6	Selangor	0	0	0	0	0	0	0
7	Negeri Sembilan	0	0	0	0	0	0	0
8	Melaka	3	0	0	2	0	0	5
9	Johor	10	0	0	1	0	0	11
10	Kelantan	0	3	1	2	0	0	6
11	Terengganu	2	1	0	2	0	0	5
12	Pahang	10	4	0	0	0	0	14
Total Peninsular Malaysia		30	8	7	7	0	0	52
13	Sabah	7	0	1	0	0	0	8
14	Sarawak	3	10	0	0	0	0	13
15	Labuan	0	0	0	0	0	0	0
Total Sabah, Sarawak and Labuan		11	10	1	0	0	0	21
Total Malaysia		40	18	8	7	0	0	73

Reliefs on available water for various sectors especially the water supply are expected from the projected reduction of irrigation water demands (NWRS 2012). However, these are based on the assumptions that irrigation efficiencies could be increased considerably in time. Else the pressures to develop more sources will increase. Also, with the review of the self-sufficiency levels for rice production to be above 70% (National Agro Policy), four new granaries have been added to the existing eight and these would impact on the respective regional water demands.

The signs of inter-sector and even inter-state water demand pressures are becoming obvious. The MADA granary irrigation system that is basically designed for irrigation have now to be operated for multi functional purposes to satisfy the needs for other sectors namely water supply and flood management (Figure 4.16). The Bukit Merah reservoir that was exclusively developed for the IADA Kerian Granary has now to serve the needs of the regional water supply, aquaculture, flood management and tourism. This dam has been raised twice (in 1960s and 1980s) to enhance its capacity but further development is impeded by the requirements of the tourism and transport (railway) sectors. The 2014 drought events particularly in Selangor has reactivated pressure for groundwater resources to be developed for conjunctive use with surface water resources.

The need for inter-sector WDM is therefore to maximise the use of existing sectorial and common resources and facilities and to avoid, delay or be prepared for delays of new water resources developments by reducing sectorial needs and wastages especially of freshwater.

From the perspective of future dam development, the total estimated storage of 2,672 mcm from the future dams has been identified for the water supply sector (40 dams; 2,108 mcm) and agriculture (Irrigation) sector (8 dams; 564 mcm) (Table 4.21). The potential saving from WDM is 12,371 mld (Table 1.0 - Executive Summary) which is substantial and could allow for possible delays or deferment in the implementation of those dams.

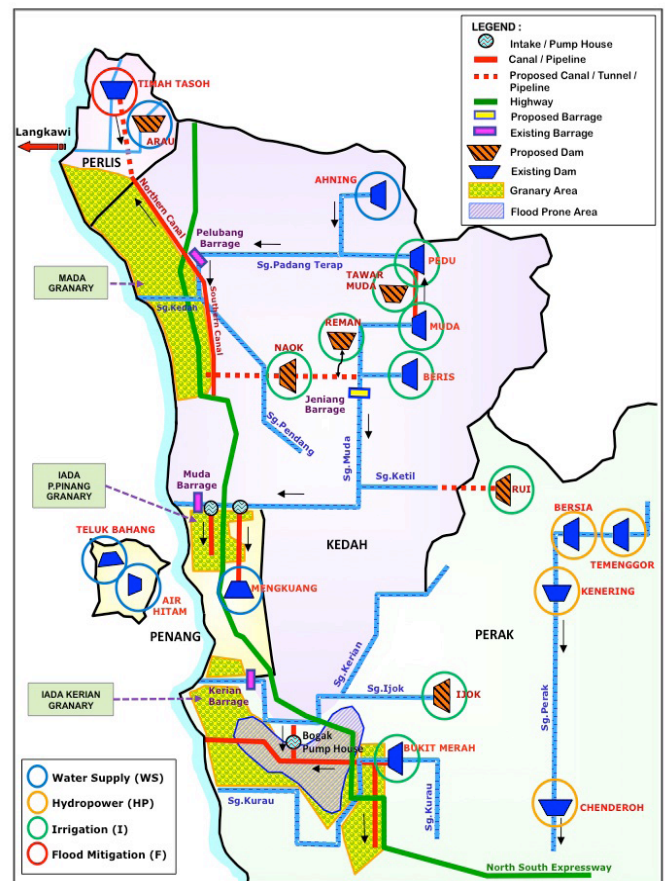


Figure 4.16: Northern Region and Water Resources Network

Table 4.21: Storage Capacity of Potential Future Dams

No.	State	Purposes												TOTAL	
		Water Supply		Hydropower		Irrigation		Flood Mitigation		Environment		Recreation			
		No's	Capacity (mcm)	No's	Capacity (mcm)	No's	Capacity (mcm)	No's	Capacity (mcm)	No's	Capacity (mcm)	No's	Capacity (mcm)	No's	Capacity (mcm)
1	Perlis													0	0
2	Kedah					6	464							6	464
3	Pulau Pinang													0	0
4	Perak	5	184											5	184
5	Wilayah Persekutuan													0	0
6	Selangor													0	0
7	Negeri Sembilan													0	0
8	Melaka	3	32					2	21					5	53
9	Johor	10	1,029					1						11	1,029
10	Kelantan			3		1		2	3,460					6	3,460
11	Terengganu	2	297	1	885			2	54					5	1,236
12	Pahang	10	299	4										14	299
Total Peninsular Malaysia		30	1,841	8	885	7	464	7	3,535	0	0	0	0	52	6,725
13	Sabah	7	267			1	100							8	367
14	Sarawak	3		10										13	0
15	Labuan													0	0
Total Sabah, Sarawak and Labuan		10	267	10	0	1	100	0	0	0	0	0	0	21	367
Total Malaysia		40	2,108	18	885	8	564	7	3,535	0	0	0	0	73	7,092

Notes:

Information based on available data only. More hydropower dams planned in Sabah and Sarawak.

4.8.4 Strategies to Implement Inter-sector WDM

i) Accounting

The present water accounting system as presented in the NWRS 2012 should be reviewed to account for all forms of water resources (surface and groundwater) not just for freshwater resources but to include water returned to the system and in terms of both quality and quantity. Return water and wastewater should now be considered as a water resource too not only for within sector reuse or recycling but for other

sectors as well. Limits on water resources for human use should be established to ensure adequate water for the present, and desired future environment. At present there is no capping on the amount of water abstracted from the system for human use that now accounts for 2.99% of the total resource and projected to increase to 3.69% by 2050. The impact on the environment for this seemingly could be detrimental and need to be established.

The accounting system would also be needed to establish sectorial water allocations in normal and

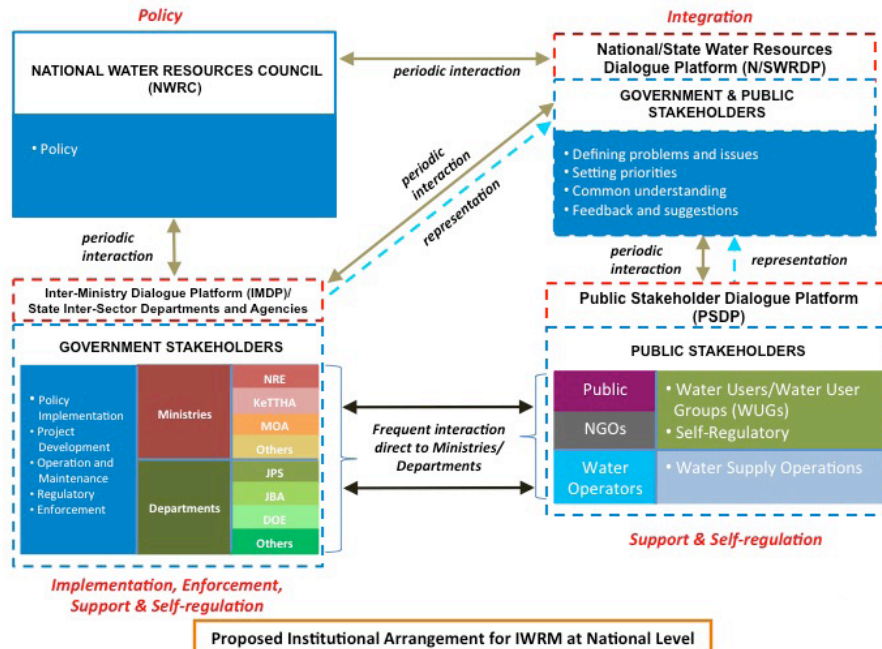


Figure 4.17: Stakeholder Participation

drought situations. These allocations would also have to consider within sector water and inter-sector water reuse and recycling capacities and potentials.

ii) Stakeholders Participation

The success of inter-sector WDM ultimately is subject to the response of the sectorial managers and their respective end users. Sectorial managers have several formal and informal government platforms for coordinating inter-sector WDM. Whilst the water supply and irrigation sectors have formal platforms for their end users, others especially the passive water users do not. For the future, an inclusive stakeholder's platform needs to be established at the local, river basin and State level that leads on the national level NWRC (Figure 4.17).

iii) Governance and Institution

The governance and institution for inter-sector

WDM are necessary to ensure water resources and environment sustainability in the future. The signs of water management stress are becoming significant and disaster could be impending if nothing is done now. There is a need to establish an authority for the nation's water resources management now and subsequently manage the inter-sector WDM based on agreed allocations for water and the protocols needed for disaster situations.

iv) Integrated Resource Development and Management

Inter-sector WDM requires integrated use of resources. The present facilities have all been developed and managed separately by each sector. As seen from the experience of the MADA Granary irrigation system and the Bukit Merah reservoir, the trend of resource sharing is inevitable. In fact, resource sharing is a necessity in inter-sector WDM. It is also in line with the National Blue Ocean Strategy (NBOS).

Major Dams in Malaysia

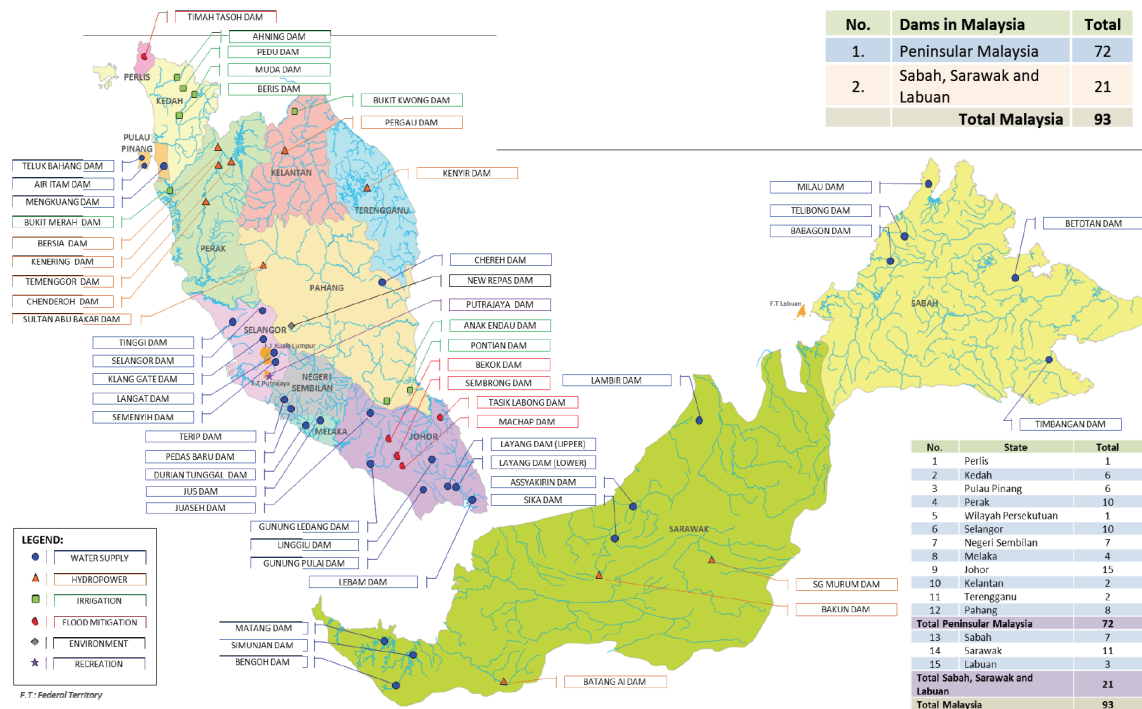


Figure 4.18: Major Dams in Malaysia

Figure 4.18 shows the location and distribution of major dams in Malaysia and Table 4.22 shows the estimated number of dams and storage capacities by sector in Malaysia. The energy (hydropower) sector is the largest freshwater “banker” in the country with 79,142 mcm of storage. This is followed by the water supply sector (2,326 mcm), irrigation sector (1,997 mcm) and the flood mitigation sector (130 mcm). With increasing inter-sector demands, these sectors will need to be prepared for sharing of the water resources that is now almost exclusive for the sector use.

There may also be a need to consider changes in priority of use in terms of water quality use. Priority of freshwater will more be for the increasing demands of the Water Supply, Environment, Aquaculture and Tourism sectors and others will need to depend more on lower quality water.

The potential of the sewerage sector to increase available water resources should be realised soonest. This can be a substantial amount in urban areas and thus relieve urban water supply needs.

The present sectorial approach to data and information collection need also to be integrated. These data and information collected are mostly common and useful for all sectors such as rainfall, flow, water levels and water quality. These can all be integrated and for use by all sectors. Subsequently, these can also be used to develop a common forecasting and warning system for use by all sectors. In meeting all these future demands, the impact on available water for the environment should not be side-lined.

Table 4.22: Number of Dams and Storage Capacities by Sector In Malaysia

	Water Supply		Hydropower		Irrigation		Flood Mitigation		Environment		Recreation		Total		Per Capita	
	No.	MCM	No.	MCM	No.	MCM	No.	MCM	No.	MCM	No.	MCM	No.	MCM	Population 2010 (mil.)	Cu.m/ Capita
LARGE DAM (LD)																
Peninsular Malaysia	29	1,989	10	20,229	10	1,997	5	130	2	0	1	27	57	24,372	23	1,060
Sabah, Sarawak and Labuan	13	331	3	58,913	-	-	-	-	-	-	-	-	16	59,244	6	9,874
Total Malaysia	42	2,320	13	79,142	10	1,997	5	130	2	0	1	27	73	83,617	29	2,883
SMALL DAM (SD)																
Peninsular Malaysia	10	3	-	-	1	0	-	-	2	0	2	0	15	3		
Sabah, Sarawak and Labuan	5	3	-	-	-	-	-	-	-	-	-	-	5	3		
Total Malaysia	15	6	-	-	1	0	-	-	2	0	2	0	20	6		
Overall Malaysia	57	2,326	13	79,142	11	1,997	5	130	4	0	3	27	93	83,623	29	2,884

Note: LD: Large Dams (LD)>15m (ICOLD Definition); SD: Small Dams

4.9 The WDM Strategies and Masterplan

The outputs of the Strategic Action Plan Framework are as shown in Tables 4.23 for each sector as well as for inter-sector. These were built-up based on the feedback and discussions during the strategic consultation series as well as personal communications with the relevant experts in water management. The final output is a synthesis of those feedbacks with considerations of the inherent characteristics and the anticipated characteristics of the water sector in a developed nation.

The proposals here are no means comprehensive and indications of priorities are not provided. This would require a comprehensive study by the respective sectors and water resources and environment managers. However, it does provide a good initial outline of areas of focus that are inter-related and necessary to implement WDM. This effectively is the outline of the WDM masterplan.

As can be seen from the tables, many of the strategies proposed are basically enablers necessary to ensure the effective implementation of WDM for the country as a whole. Saving from water supply

in 2020 is 9,966 mld (refer to Table 4.1) and when compared to total water supply demand of 18,618 mld (NWRS 2012), this represents a total savings of 50%. From the Agriculture Sector, specifically from the eight matured Granaries, the potential savings is 2,405 mld (877 mcm) for water use efficiency at 75%. Therefore, the total potential water savings in the overall use by water supply and agriculture sector (eight matured Granaries) is 12,371 mld in 2020 compared to the total demand of 46,648 mld (NWRS 2012). This represents a total saving of 26% out of total water demand of the country in 2020.

As water is a state matter, these strategies could be implemented by the respective state as well. However, since water has now emerged as of national importance, a concerted federal-state approach would be preferred and highly recommended. This would also be necessary to ensure consistency of implementation and sustainability of the WDM efforts particularly with respect to nationwide acceptance of the end users, the population.

The full list of strategies for effective WDM is summarised in Table 4.23:

Table 4.23: WDM Strategies

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
B	Policy	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
D	Institution	Strategy 4	Form a dedicated Department for 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
		Strategy 5	Form a dedicated WDM Unit in all water management related departments and Institutions
		Strategy 6	Form a dedicated Water Management R&D and Capacity Development Institution for Agriculture Water Management

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
		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
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 of 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

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
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 sector - 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
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 programmes 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. Capping domestic water consumption to 180 l/c/d for Peninsular Malaysia by 2020
		Strategy 17	Implement efficiency improvement and returned water quality control programmes 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 programmes for non-paddy sectors of agriculture to include horticulture, livestock, aquaculture and plantation and commodity crops

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
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 Programmes by all sectors for staff 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 Planning for heavy water industrial users to recycle or reuse at least 30% of their water consumption
		Strategy 23	Adopt applications of the National Blue Ocean Strategy in WDM - Planning for future WDM should consider sectorial and inter-sectorial 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

NO.	MANAGEMENT CATEGORY	STRATEGY	DESCRIPTION
O	R&D	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-Food-Energy Nexus	Strategy 27	Develop inter sector framework for water, food and energy

WATER DEMAND MANAGEMENT

Table 4.24: Strategic Action Plan Framework

NO.	SECTOR	ACCOUNTING	BARGAINING	CODIFICATION
		Quantified Quality and Quantity of Water	Stakeholder's Participation and Decision Making Process	Laws, Rules And Regulations
1 (a)	WATER SUPPLY	– Develop accounting parameters, processes and procedures for Potable and non-potable water demands for industries – Develop accounting parameters, processes and procedures for Potable and non-potable water needs for domestic users – Structuring Regulatory Water Accounting (RWA) framework for the purpose of tariff setting – Monitoring and evaluating the water services operator's financial performance more effectively – Setting platform (RWA) benchmarking costs based on market prices and formulates efficiency-based targets in the review and calculation of water tariff	– Formalise and strengthen the Water Forum – Establishing WUG platform in major operation areas – Water Forum accommodates demand side of consumers when dealing with regulator – Consider involvement of more private-sector, NGOs with proven PR capability in dealing with resilient public	– Establish rules and regulations for the management of the Water Forums – Outcome of the bargaining process to be formulated as operational policies, rules, regulations and procedures – Establish some quantitative elements of the service levels at sectoral interface where specific rules and decision variables will still be necessary
1 (b)	SEWERAGE	– Develop accounting processes and parameters and procedures for discharge of wastewater to receiving waters – Develop accounting processes and parameters and procedures for recycling of wastewater for non-potable purposes – Structural Regulatory Water Accounting framework for tariff setting based on actual cost of wastewater treatment – Develop joint billing system with water supply services based on water usage	– Formalise and strengthen the Water Forum – Establishing WUG platform in major operation areas – Water Forum accommodates demand side of consumers when dealing with regulator – Consider involvement of more private-sector, NGOs with proven PR capability in dealing with resilient public	– Establish rules and regulations for the management of the Water Forums – Outcome of the bargaining process to be formulated as operational policies, rules, regulations and procedures – Establish some quantitative elements of the service levels at sectoral interface where specific rules and decision variables will still be necessary

DELEGATION	ENGINEERING	FEEDBACK & EVALUATION
Institutional Responsibilities	Physical Infrastructure and Science, Technology and Innovations	Performance Audit
- Form public and system manager stakeholders' platform - Establishing a dedicated organisation for regulating water services undertaken by water operators on state or regional basis. - Setting up "Centre of Excellence" for capacity building programmes in major parts of the country. - Creation of a central "Water Hub" that is dedicated to STI development in WDM - Establishing National Stakeholder Platform to involve more private sector participation in the water industry - Establishing "Visitors Centre" and a "Water Museum" in major parts of the country to get the public to be knowledgeable in water and what they pay for better and efficient service	- Develop programmes for STI for 3Rs (Reduce, Reuse, Recycle) - Reviewing systems and methodologies used for water savings and 3Rs - Providing and monitoring the provision of the agreed levels of service - Promoting groundwater as conjunctive use consonant with WDM approach - Making more freshwater available by reduction in raw water pollution - Development of advance water measurement instruments and control structures and systems in line with STI - Promoting technology and incentives to achieve more efficient use of water	- Develop reporting system on performance and auditing system - Periodic (Annual Report) on: - Physical Performance - Financial Performance - Licencing, Enforcement and Tariff - Environment, Health and Quality Standards - Consumer Affairs on Resolution of Complaints and Development of Consumer Standards - Feedback from Stakeholders' Participation and Decision made
- Form public and system managers stakeholders platform - Establishing a dedicated organisation for regulating water services undertaken by water operators on state or regional basis - Setting up "Centre of Excellence" for capacity building programmes in major parts of the country - Creation of a central "Water Hub" that is dedicated to STI development in WDM - Establishing National Stakeholder Platform to involve more private sector participation in the water industry - Establishing "Visitors Centre" and a "Water Museum" in major parts of the country to get the public to be knowledgeable in water and what they pay for better and efficient service	- Develop programmes for STI for potable and non-potable water returns - Providing and monitoring the provision of the agreed levels of service - Making more freshwater available by reduction in raw water pollution - Development of advance water measurement instruments and control structures and systems in line with STI - Promoting technology and incentives to achieve more efficient use of water	- Develop reporting system on performance and auditing - Periodic (Annual Report) on: - Physical Performance - Financial Performance - Licencing, Enforcement and Tariff - Environment, Health and Quality Standards - Consumer Affairs on Resolution of Complaints and Development of Consumer Standards - Feedback from Stakeholders' Participation and Decision made

NO.	SECTOR	ACCOUNTING	BARGAINING	CODIFICATION
		Quantified Quality and Quantity of Water	Stakeholder's Participation and Decision Making Process	Laws, Rules And Regulations
2 (a)	AGRICULTURE (Paddy Irrigation)	– Development of water accounting parameters and methodology – Development of water auditing parameters and methodology – Establishing the price of agriculture water – Establishing irrigation capital and asset cost – Establishing operations and maintenance costing	– Revitalising the WUGs in all Granaries with a view for Farmers' Exit Plans and to transform these into Commercial Farm Entities (EPP10 and EPP11) – Establish WUG Platforms	– Review of the Irrigation Areas Act 1953 to include WDM and Water Quality Management and 3Rs – Establishing WUG Rules and Regulations
2 (b)	AGRICULTURE (Non-Paddy)	– Development of water accounting parameters and methodology – Development of water auditing parameters and methodology – Establishing the price of agriculture water – Establishing irrigation capital and asset cost – Establishing operations and maintenance costing	– Introduce WUGs in all the designated/ consolidated farming areas (e.g. Cameron Highlands) – Establish WUG Platforms	– Review or introduce new Irrigation Areas Act 1953 for non-paddy crops to include WDM and Water Quality Management and 3Rs – Establishing WUG Rules and Regulations

DELEGATION	ENGINEERING	FEEDBACK & EVALUATION
Institutional Responsibilities	Physical Infrastructure and Science, Technology and Innovations	Performance Audit
– Establish a dedicated organisation for Irrigation and Drainage (Department) – Gazette all Granary Irrigation Areas – Establish a Centre of Excellence (CoE) for Irrigation Management Modernisation that includes being responsible for WUG and Irrigation Manager Capacity Building Programmes as well as Systems Performance and Evaluation. Also for the development of new and advance technologies in irrigation and drainage for 3Rs (Reduce, Reuse and Recycling) – Establish National Stakeholders Platform	– Review of systems design for water savings and 3Rs – System efficiency increment programmes towards 75% – Development of new 3Rs Technologies for WDM – Development of Systems Water Management including Flood and Draught Forecasting System – Development of less water demanding rice varieties. – Development of advance water measurement and control structures and systems	– Periodic (Seasonal and Annual) report on irrigation water use and water savings including dam management – Periodic (Annual or Biannual) reporting of irrigation cost/price of water – Periodic Systems Performance and Evaluation (MASCOTTE 2) (Every 3 years)
– Establish a dedicated organisation for Irrigation and Drainage (Department) – Gazette all non-paddy irrigated areas – Establish a Centre of Excellence (CoE) for Non-paddy crop Irrigation Management Modernisation that includes being responsible for WUG and Irrigation Manager Capacity Building Programmes as well as Systems Performance and Evaluation. Also for the development of new and advance technologies in irrigation and drainage for 3Rs (Reduce, Reuse and Recycling) – Establish National Stakeholders Platform	– Review of systems design for water savings and 3Rs – System efficiency increment programmes towards 75% – Development of new 3Rs Technologies for WDM – Development of Systems Water Management including Flood and Draught Forecasting System – Development of less water demanding varieties – Development of advance water measurement and control structures and systems	– Periodic (Seasonal and Annual) report on irrigation water use and water savings including dam management – Periodic (Annual or Biannual) reporting of irrigation cost/price of water – Periodic Systems Performance and Evaluation (MASCOTTE 2) (Every 3 years)

NO.	SECTOR	ACCOUNTING	BARGAINING	CODIFICATION
		Quantified Quality and Quantity of Water	Stakeholder's Participation and Decision Making Process	Laws, Rules And Regulations
2 (c)	AGRICULTURE (Oil Palm and Tree Crops)	– Development of water accounting parameters and methodology – Development of water auditing parameters and methodology – Establishing the price of agriculture water – Establishing irrigation and drainage system capital and asset cost – Establishing operations and maintenance costing	– Introduce WUGs in all the designated/ consolidated farming areas (oil palm estates) – Establish WUG Platforms	– Review or introduce new Agriculture Water Use Act for oil palm and tree crops to include WDM and Water Quality Management and 3Rs – Establishing WUG Rules and Regulations
2 (d)	LIVESTOCK AND FISHERIES (AQUACULTURE)	– Development of water accounting parameters and methodology – Development of water auditing parameters and methodology – Establishing the price of agriculture water – Establishing irrigation capital and asset cost – Establishing operations and maintenance costing	– Introduce WUGs in all the designated/ consolidated farming areas (e.g. Arowana industry within the Kerian granary, coastal belt) – Establish WUG Platforms	– Review or introduce new Agriculture Water Use Act for livestock and aquaculture to include WDM and Water Quality Management and 3Rs – Establishing WUG Rules and Regulations
3	ENVIRONMENT	– Development of water accounting parameters, methodology and tools – Development of water auditing parameters, methodology and tools – Establishing the price/value of water for the environment – Establishing capital and asset cost – Establishing operations and maintenance costing	– Form Environmental Expert and Specialist Group – Establish WUG Platforms	– Establish Laws for Environmental Water Services – Establishing WUG Rules and Regulations

DELEGATION	ENGINEERING	FEEDBACK & EVALUATION
Institutional Responsibilities	Physical Infrastructure and Science, Technology and Innovations	Performance Audit
- Establish a dedicated organisation for Irrigation and Drainage (Department) - Gazette all oil palm and tree crop areas - Establish a Centre of Excellence (CoE) for Agriculture Water Management Modernisation that includes being responsible for WUG and System Manager Capacity Building Programmes as well as Systems Performance and Evaluation. Also for the development of new and advance technologies in irrigation and drainage for 3Rs (Reduce, Reuse and Recycling) - Establish National Stakeholders Platform	- Review of systems design for water savings and 3Rs - System efficiency increment programmes towards 75% - Development of new 3Rs Technologies for WDM that include water quality management systems - Development of Systems Water Management including (Flood and Drought Forecasting System) - Development of less water demanding varieties - Development of advance water measurement and control structures and systems	- Periodic (Seasonal and Annual) report on irrigation water use and water savings - Periodic (Annual or Biannual) reporting of irrigation cost/price of water - Periodic Systems Performance and Evaluation (MASCOTTE 2) (Every 3 years)
- Establish a dedicated organisation for Irrigation and Drainage (Department) - Gazette all livestock and aquaculture industrial areas - Establish a Centre of Excellence (CoE) for Agriculture Water Management Modernisation that includes being responsible for WUG and System Manager Capacity Building Programmes as well as Systems Performance and Evaluation. Also for the development of new and advance technologies in irrigation and drainage for 3Rs (Reduce, Reuse and Recycling) - Establish National Stakeholders Platform	- Review of systems design for water savings and 3Rs - System efficiency increment programmes towards 75% - Development of new 3Rs Technologies for WDM that include water quality management systems - Development of Systems Water Management including (Flood and Drought Forecasting System) - Development of less water demanding varieties - Development of advance water measurement and control structures and systems	- Periodic (Seasonal and Annual) report on agriculture water use and water savings including dam management - Periodic (Annual or Biannual) reporting of agriculture cost/price of water - Periodic Systems Performance and Evaluation (MASCOTTE 2) (Every 3 years)
- Establish a dedicated organisation for Environmental Water - Gazette all Protected Environmental Areas - Establish a Centre of Excellence (CoE) for Environmental Water - Establish National Stakeholders Platform	- Review of systems design for environmental water - Development of new 3Rs Technologies for WDM - Development of Systems Water Management including Flood and Drought Forecasting System - Development of advance water measurement and control structures and systems	- Periodic (Seasonal and Annual) report on Environmental Water use - Periodic (Annual or Biannual) reporting of environmental water cost/price/value - Periodic Systems Performance and Evaluation (Every 3 years)

NO.	SECTOR	ACCOUNTING	BARGAINING	CODIFICATION
		Quantified Quality and Quantity of Water	Stakeholder's Participation and Decision Making Process	Laws, Rules And Regulations
4	ENERGY (HYDROPOWER)	– Development of water accounting parameters, methodology and tools – Development of water auditing parameters, methodology and tools – Establishing the price/value of water for the environment – Establishing capital and asset cost – Establishing operations and maintenance costing – Development of water accounting parameters, methodology and tools – Development of water auditing parameters, methodology and tools – Establishing the price/value of water – Establishing capital and asset cost – Establishing operations and maintenance cost	– Establish WUG Platforms	– Establish Laws for Hydropower Water Use and inter-sector water management – Establishing WUG Rules and Regulations
5	INTER-SECTOR	– Development of inter-sector water accounting parameters and methodology and priorities for freshwater use as well and environmental water allocation – Development of inter-sector water auditing parameters and methodology – Establish inter-sector water allocation and sectorial water quality management as well as commitment on potable and non-potable return water – Establishing the price of sectorial and inter-sector water – Establishing the water resources system capital and asset cost – Establishing operation and maintenance costing – Establish ground water resource accounting and auditing system	– Establish inter-sector platform involving all sectorial water users – Rationalising of the water industry particularly the private sector	– Establishing water industry codes of practices – Establishing Inter-Sector Water Management Rules and Regulations for normal and stress situations – Establish Ground water use rules and regulation – Reinforce WDM in all water Related Policies

DELEGATION	ENGINEERING	FEEDBACK & EVALUATION
Institutional Responsibilities	Physical Infrastructure and Science, Technology and Innovations	Performance Audit
– Establish a Centre of Excellence (CoE) for Hydropower Water Use – Establish National Stakeholders Platform	– Review of systems design hydropower water management – Development of new 3Rs Technologies for WDM – Development of Systems Water Management including Flood and Drought Forecasting System. – Development of advance water measurement and control structures and systems for inter-sector water sharing	– Periodic (Seasonal and Annual) report on Hydropower Water use – Periodic (Annual or Biannual) reporting of hydropower water cost/price/value – Periodic Systems Performance and Evaluation (Every 3 years)
– Establish a dedicated organisation for Water Industry Development – Establish a Centre of Excellence (CoE) or as special institution for Water Industry Management Modernisation that includes being responsible for Capacity Building Programmes as well as Systems Performance and Evaluation. Also for the development of new and advance technologies in irrigation and drainage for 3Rs (Reduce, Reuse, and Recycling) – Establish National Stakeholder Platforms	– Review of existing dam and reservoir performance and capacities including safety – Study and plan for inter-sector resource sharing and linkages – Review on systems design for water saving and 3Rs – System efficiency increment programmes towards 75% – Development of new 3Rs Technologies for WDM that include water quality management systems – Development of National Systems Water Management including Flood and Drought Forecasting System – Development of advance water measurement and control structures and systems – Develop Groundwater development and technology for utilisation and monitoring system	– Periodic (Seasonal and Annual) report on the national water resources security and safety status – Periodic (Annual or Biannual) reporting of eater cost/price of water – Periodic System Performance and Evaluation (every 3 years)

CHAPTER 5
OPPORTUNITIES IN
SCIENCE, TECHNOLOGY
AND INNOVATION (STI)
AND RESEARCH NEEDS
IN WATER DEMAND
MANAGEMENT

CHAPTER 5: OPPORTUNITIES IN SCIENCE, TECHNOLOGY AND INNOVATIONS (STI) AND RESEARCH NEEDS IN WATER DEMAND MANAGEMENT

5.1 Introduction

The development and applications of STI to support and encourage wealth creation is becoming a necessity as the country develops. Equally important is that STI is needed for higher precision and capability in managing limited resources to satisfy the increasing needs of a more affluent society and complex economy.

One of the main characteristics of a developed country is ownership of advance technology. This should be the spirit and the approach in developing STI and research in WDM for the benefit of stakeholders. Scientific research that is credible, relevant and grounded in regular engagement with stakeholders is more likely to produce outputs that can be translated into outcomes (Volta).

The present and future development direction around the world is for green growth. One aspect of green growth is to manage water as a natural capital that for higher levels of economic and ecological quality and growth in tandem with human capital development for higher skills and knowledge (Chung 2015).

This chapter sets out an overview of the water business potential for WDM followed by opportunities and strategies for enhancing water industry R&D in Malaysia. International examples are examined, including reference to one of the

exemplars for water industry research institutions as found in the UK.

5.2 Overview of The Water Business Potential for WDM

The world water industry (market) is projected to grow from USD535 billion from 2012 to USD865 billion by 2025 (Kim 2015 from *Environmental Business Journal* 2014, *Snapshot survey* 2014). The annual growth rate of this industry is estimated to grow at 5% annually after 2015. From Table 5.1, the advance country regions of United States, Western Europe and Japan have market sizes of more than USD100 billion in 2013 with an average annual growth rate of more than 2%. For the rest of Asia, the estimated size is USD91 billion in 2013 and with a high average annual growth rate of 9.1%. The same journal ranked the water industry at fifth place at about USD550 to USD600 billion after petroleum, automobile, electricity and Information Technology (IT). By global growth prospect of the water industry, the rest of Asia (excluding China, India and Japan), is ranked seventh amongst all the countries and regions in the world.

From the environmental market perspective (environmentally acceptable friendly products and services), the total market size in Asia Pacific have shown steady growth and achieving USD229 billion in 2014 with Malaysia at an estimated USD3.5 billion in 2014 (Table 5.2). The water industry is part of

this environmental market and globally, the water treatment works component alone is at USD121.9 billion in 2014 (Table 5.3).

In the United States, the projections from 2014 to 2023 are that the operating and capital expenditures of the Water Industry is projected to be USD52 billion. This in turn will contribute to some USD524 billion to the national economy over the 10 years and creating approximately 289,000 permanent jobs. In general, it is estimated that for every USD1 million spending by this utility sector, it will support 16 jobs throughout all sectors of the economy.

In the United Kingdom, the water sector provided an economic impact of British Pounds 15.2 billion in 2012/2013 and supports 127,000 jobs directly and indirectly.

Such comprehensive data on the water sector in Malaysia are not readily available but the figures provided do show that this is an industry with growth potential and therefore could provide ample opportunities for STI and research for WDM as part of the environmental market sector. Furthermore, the need for new technology to support WDM could still be considered as at its infancy stage in Malaysia and therefore the opportunity to develop and own new technologies in this field is immense. SPAN estimates that the water supply industry in Malaysia is already at USD1.3 billion.

Table 5.1: Water and Economic Effect (USD billion)

Region	2009	2010	2011	2012	2013	AAGR
United States	287.5	289.7	305.7	320.3	328.0	3.4%
Western Europe	244.8	254.4	259.0	261.2	265.7	2.1%
Japan	100.1	104.0	103.3	106.9	109.1	2.2%
Rest of Asia	64.3	71.8	78.0	84.1	91.0	9.1%
Mexico	11.70	12.39	12.96	13.48	14.05	4.7%
Rest of Latin America	24.8	27.0	28.5	29.8	31.6	6.3%
Canada	19.6	20.2	21.0	21.6	22.5	3.5%
Australia/New Zealand	12.9	13.3	13.6	14.2	14.7	3.3%
Central & E.Europe	12.8	13.2	13.7	14.1	14.7	3.5%
Middle East	13.9	16.0	17.5	18.9	20.3	3.5%
Africa	8.3	9.5	10.3	11.1	12.0	10.0%
Total	801	832	864	896	924	9.7%

Source: Jeong-In Kim (2015) from Environmental Business Journal 2014 Snapshot survey 2014

Table 5.2: Environment Market in Asia Pacific 1999–2014 (USD billion)

Country	2007	2008	2009	2010	2011	2012	2013	2014
Japan	101.26	100.54	95.82	97.64	99.56	101.58	103.40	105.27
Australia	10.56	10.76	10.95	11.33	11.78	12.25	12.72	13.20
New Zealand	1.90	1.92	1.92	2.01	2.10	2.20	2.29	2.39
Hongkong	2.53	2.63	2.62	2.80	2.98	3.16	3.36	3.57
Singapore	2.24	2.31	2.31	2.49	2.67	2.83	2.99	3.16
South Korea	9.08	9.47	9.67	10.30	11.03	11.60	12.13	12.68
Taiwan	5.73	5.95	5.98	6.41	6.85	7.29	7.76	8.24
Indonesia	2.28	2.47	2.63	2.84	3.07	3.33	3.62	3.99
Malaysia	2.31	2.46	2.48	2.65	2.84	3.05	3.28	3.52
Philippines	1.06	1.14	1.20	1.29	1.39	1.51	1.63	1.72
Thailand	2.52	2.69	2.73	2.99	3.28	3.58	3.92	4.20
China	19.17	22.53	25.18	29.22	32.99	37.20	41.92	47.21
India	8.35	9.39	10.20	11.40	12.70	14.10	15.67	17.41
Rest of Asia	1.71	1.88	2.05	2.23	2.32	2.41	2.51	2.61
Total	170.68	176.15	175.74	185.59	195.56	206.11	217.19	229.18

Source: Jeong-In Kim (2015) from Environmental Business Journal 2014, Snapshot survey 2014

Table 5.3: Global Environmental Market by Segment 2004–2014 (USD billion)

Equipment	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Water Equipment and Chemicals	56.2	58.5	61.1	64.3	67.7	65.0	69.0	69.6	72.4	75.3	78.3
Air Pollution Control	46.5	48.6	50.6	52.1	52.4	47.7	50.0	50.2	51.5	52.8	54.2
Instruments and Info Systems	7.7	8.2	8.6	9.0	9.3	8.6	9.1	9.3	9.8	10.3	10.8
Waste Mgmt Equipment	33.8	34.4	35.5	36.6	37.1	34.1	33.3	35.8	36.9	38.0	39.2
Process and Prevention Tech	3.6	3.8	4.0	4.1	4.4	4.0	4.0	4.2	4.3	4.4	4.5
SERVICES											
Solid Waste Management	131.0	134.6	138.0	141.0	141.0	140.3	139.1	144.1	145.9	147.8	149.8
Haz Waste Management	21.4	21.8	22.2	22.6	22.9	21.8	22.4	21.8	22.0	22.2	22.4
Consulting and Engineering	41.7	44.2	46.9	50.1	52.5	52.0	53.2	55.1	56.8	58.5	60.2
Remediation/Ind'l Services	34.2	36.2	38.1	40.0	41.3	40.1	39.4	40.9	41.3	41.7	42.1
Analytical Services	4.6	4.8	4.9	5.0	5.2	5.2	5.3	5.4	5.5	5.6	5.7
Water Treatment Works	95.9	98.8	101.6	104.6	109.6	111.8	118.9	116.2	118.1	120.0	121.9
RESOURCES											
Water Utilities	109.2	112.8	116.3	119.7	124.9	126.9	136.5	132.3	135.0	137.7	140.4
Resources Recovery	42.2	42.3	52.0	61.8	51.1	42.4	46.2	59.4	70.0	75.4	81.8
Clean Energy Systems and Power	29.8	36.1	52.0	67.5	91.7	100.8	105.2	119.2	126.3	133.9	141.9
Total	657.8	685.1	731.7	778.6	811.2	800.7	831.5	863.5	895.7	923.6	953.2

Source: Environmental Business International, Inc., San Diego, Calif. Units \$bil ©EBI Inc.

5.3 Opportunities for STI in WDM

Implementing the strategies for WDM requires significant STI input and products and services. These are:

1. Developing water accounting and auditing system for a water sectors and inter-sector WDM.
2. Developing tools for managing water for the environment.
3. Developing water sources quality monitoring and evaluation systems.
4. Developing an integrated data and information collection related to WDM management.
5. Developing flood and drought and water use forecasting and warning systems.
6. Irrigation system efficiency improvements.
7. Developing NRW management tools.
8. Developing water saving devices in the water supply and irrigation sectors.
9. Developing WDM monitoring and evaluation systems.
10. Developing river basin, inter-basin, regional and national water management plans.

5.4 Strategies for Enhancing STI and Research in WDM

- (1) Structure the water industry as a distinct business sector so as to provide special focus on future development and to derive the maximum potential business growth in the local as well as in the international market.
- (2) Subsequently develop the water industry (Market) as an NKEA.

- (3) Establish a distinct Water Institution specially designed to for STI in WDM and the green growth market. All advanced countries have such very prominent water institutions that develop and market advanced and leading edge STI in water management solutions. Some examples are K-Water in Korea (1967), eWater of Australia (1995), Delft in the Netherlands (1940) and UK Water Industry Research (UKWIR) (1993). These institutions were set-up with Government support and given opportunities to grow and expand as a business entity. Their approaches include strong and established ties with the private sectors. Their products and services are internationally accepted and used in many of the major projects around the world. Founded in 1993, UKWIR was set up by the UK water industry to provide a framework for the procurement of a common research programmes for UK water operators on 'one voice' issues.

UKWIR's members comprise 21 water and sewerage undertakers in England and Wales, Scotland and Northern Ireland. UKWIR has since become an exemplar case of a research institution specifically developed to support the water sector R&D which, in turn has enhanced the industry as a whole. Focusing on demand driven-industry relevant research as opposed to highly academic studies, the UK's water operators fund R&D projects through an annual fee. Over the last 15 years, UKWIR subscribers have contributed some £50 million with a further £30 million of research coming from UKWIR collaborators, resulting in over 750 reports delivered to members. The majority of work is put out to open tender to a wide range of companies, academic institutions and other organisations in the UK and overseas. Project management is undertaken

by both the water industry's R&D departments and by individuals employed by UKWIR. The research programmes is currently divided into the following topic areas: drinking water quality and health; toxicology; water resources; climate change; wastewater treatment and sewerage; sewage sludge; water mains and services; sewerage; leakage and metering; as well as customer and regulatory issues.

- (4) The average spending for most high income developed nations per GDP is between two to three per cent whereas in Malaysia the R&D per GDP has been hovering around one per cent. There are initiatives to increase this to at least two per cent by 2020 as spelt out in the Third National Science, Technology and Innovation Policy.
- (5) Implement large-scale projects (similar to Entry Point Projects in the ETP that are challenging yet inspiring for STI and research based on tropical climate conditions in water management that allows for the development and ownership of new and even leading edge technology. Some potential are in the field of environmental water management; water "reduce, reuse and recycling" in irrigation, sewerage, water supply and river management; national integration of water-based data collection (e.g. hydrology, river flows, river water quality, reservoir levels) and nationwide and inter-sector flood and drought forecasting. Projects such as the Greater KL River of Life could be one such project.
- (6) The establishment of a permanent science-based committee as part of the overall decision-making process and procedure to address short-term and long-term water safety and security. The Danube River (in Europe) formed a permanent Science

Committee to provide scientific evidence to support the policy and political decision-making processes. The water management reform in Australia was based on detailed scientific study and research to develop the appropriate laws, rules, regulations and administration for harmonised water management system adopted by all the States.

5.5 Research Need in WDM

Developing advance technologies for national ownership requires advance and leading edge research support. These will have to cover the full spectrum of the water sectors especially water supply, agriculture, sewerage, energy, environment and floods. The underlying objective would be to reduce over dependence on freshwater – the need of almost every country in the world.

Many of the technologies developed were based on data and information of temperate countries and modified for use in non-temperate conditions. This is where Malaysia could capitalise in the R&D works for technology development based on equatorial conditions.

Establish a "Water Industry Promotion Centre" or "Water Hub"

A strategic move for Malaysia would be to establish a "Water Industry Promotion Centre" or "Water Hub" for WDM and WSM research to provide Institutional support to help businesses achieved sustainable growth. This "centre" would be the focal point for advance technological innovation with specific direction for technology ownership with collaborative network with manufacturers.

It is vital, therefore, for the “centre” to be well-supported by the businesses which need research support and, preferably, located within and form a part of the industrial “water city” itself. Such favourable locations could be at any of the regional economic centres established by the Government.

Priority Areas for Research

The potential research areas and subjects are many but the strategic areas of research on WDM that could have the higher chances of success are as follows:

(1) Demand-driven and Multi-disciplinary Research Strategy

To achieve a sustainable and robust national water industry by 2020, it is recommended to undertake a comprehensive nation wide R&D strategy to support evidence based policy making. Considerable uncertainty remains over various aspects related to the current and future sustainability of the industry which could be addressed via new knowledge creation. Examples of the challenges that face the industry include:

- i) An investigation into how the water supply and sewerage services sectors can contribute more effectively to national GDP. This involves identifying the drivers and barriers to raising the tradability of Malaysia’s water services (i.e. technology and R&D services).

At the same time, to identify and account for the quantum of sustainable water use by all sectors through production claims as part of contribution to national GDP.

- (ii) An investigation to estimate and map National Water Footprint from both a production and consumption perspective. In carrying out the study, estimate international virtual water flows related to industrial commodities and trade in agriculture.

The water footprint is defined as the total volume of freshwater used to make a product, or consumed by a person, community or country. A product’s water footprint is an indicator both of direct and indirect water use. It is thus a measure of how a consumer or producer relates to the use of freshwater systems. The concept can, for instance, be used to quantify and map the water use in consumption and guide reduction in water use to a sustainable level.

Virtual water is also the amount of water used to generate a product and, therefore, incorporated in the product. This concept which emerged in 1990s is used to illustrate how much water a region or country imports or exports. In this way, regional or global water efficiency can be optimised through trade. It takes about 30 litres per day to satisfy the biological needs of a human being and about 1000 times as much to produce food. In other words, a country that imports 1 million tonne of wheat is importing and, therefore, enlarging its water resources by 1 billion m³ of water.

- iii) An investigation to determine the key research priorities for the water sector in order to support a national “Demand driven and multi-disciplinary research strategy”. Such a strategy will identify where R&D resources need to be directed to achieve the local (i.e. community and operator) and national goals of the sector.

- iv) An investigation on the preparedness of the industry to face climate change (i.e. extended dry spells, more intense rainfall during wet periods).

A targeted national level R&D strategy would help to generate knowledge to address these concerns.

In order to identify the key R&D issues of concern, a comprehensive stakeholder engagement exercise is required. Following successful attempts at undertaking stakeholder engagement exercise (see Leeds University 'Water@Leeds' project, UTM's tropical peatland stakeholder initiative and University Nottingham Malaysia Campus conservation and biodiversity initiative), it is recommended to engage with a wide group of water industry stakeholders (operators, government agencies, regulator, consumer groups, non-governmental agencies) to identify the priority issues for research. Such an exercise will help determine and identify the key R&D issues for specific stakeholders, which in turn can form the basis of a 'demand-driven and multi-disciplinary research strategy'. Such an initiative will also evaluate the methods to fund the R&D activities via consultation with industry, government and potential external sponsor.

(2) Addressing high water consumption in Malaysia

Currently, Malaysia consumes approximately 210 litre per person per day which is significantly higher than Singapore (130 l/p/d) and other ASEAN countries. Research is required to better understand why consumption is so high and what practical measures can be taken to reduce it. This involves a detailed multi-disciplinary study

focusing on wide spectrum of disciplines such as social science, policy studies, engineering, architecture, and economics. UTM is undertaking a study aiming to understand the drivers for municipal food waste generation and thus similar methods could be employed for water consumption (work in progress).

(3) Integrating wastewater, greywater and stormwater management

If wastewater, greywater and stormwater managements are integrated at an early stage (planning), with urban planning process, benefits and synergies can be obtained, making additional costs relatively small. Considering stormwater as a valuable resource, not as a waste problem or a threat, during the planning process can reduce the cost of climate adaptation.

Stormwater drainage systems have to be very large to handle extreme weather events like cloud bursts and thunderstorms: often larger than the sewerage systems currently in place. The most cost effective solution is often to integrate large structures like canals, lakes and storage basins into the stormwater system. The PUB study in Singapore, mentioned at section 4.1: stormwater offers a good example for a similar study in Malaysia.

A special study is needed to look into this feasibility as additional water security to meet Water Demand requirement in the country.

(4) Structural Policy Reforms: A Meta-Analysis

The current phase of water supply reforms was enacted in 2006 and has involved the creation of

a regulatory body (SPAN) and the implementation of an 'asset light' model through the PAAB financing mechanism. Questions remain over the effectiveness of this policy for Peninsular Malaysia (i.e. only five state operators have, so far, migrated to the policy regime) and therefore detailed policy analysis to explore areas for policy strengthening and governance reform is required. This could also involve examining options for the potential integration of Sabah and Sarawak into the current water policy regime.

(5) Detailed WDM Masterplan Study

A special study is required to develop a detailed Masterplan study with higher emphasis on WDM programmes. The progressive outcomes of this study could be incorporated and subsequently implemented under the National Water Blueprint initiated by the government early this year in March 2015.

CHAPTER 6
WATER DEMAND
MANAGEMENT OUTLINE
MASTERPLAN

CHAPTER 6: WATER DEMAND MANAGEMENT OUTLINE MASTERPLAN

6.1 Introduction

With present efforts towards achieving a developed and high income nation status by 2020, the WDM Masterplan should also be designed concurrently and towards the same objectives. However, to develop a detailed Masterplan would require a special study and this could delay the implementation of programmes for higher emphasis of WDM programmes. Instead an outline Masterplan is proposed in this study that could be considered for immediate implementation.

The strategic plans for inter-sector and sectors are shown in Table 4.23 (Chapter 4). These are mainly enablers that are necessary to ensure nationwide support and sustainability of the WDM efforts. The others potential and on-going WDM projects of the various sectors and for inter-sector that could be up-scaled in line with the ETP objectives.

It may be too optimistic to target the detailed WDM Masterplan study could be completed by 2020 especially those that involve Inter-Ministry, Federal-State, Inter-State, Government-private sector-public discussions and negotiations. These are especially those which are concern to laws, rules, regulations and policies as well as financial implications. However, considering the present situation of national water management risks on socio-economic growth, the process should start soonest. The recommendation is to incorporate this in the upcoming Rancangan Malaysia ke 11 (RMK11) 2016-2020.

As the outline masterplan is implemented, the progressive outcomes could be incorporated and subsequently implemented under the National Water Blueprint recently (2015) initiated by the Government. This process would allow for the topic on the need for higher emphasis on WDM to be continuous and kept alive. The idea is that by 2020 all sectors at the Federal and State levels are not only aware but advocate and implement certain aspects of WDM.

6.2 The Outline Masterplan

The overall objective of the Masterplan could be: ***“To enable the full and sustainable implementation of higher levels of WDM as an integral component of the National Water Management for water safety, security and economic growth”.***

The proposed components of the Outline Masterplan are:

1. Inter-sector harmonisation of water management approaches at the Federal level.
2. Federal-State water management approach harmonisation
3. Water Industry structuring as an economic growth sector
4. Government-Public Participation platform; and
5. Sectorial and Inter-Sector WDM improvements.

The outline Masterplan is shown in Table 6.1.
A brief of this outline Masterplan is as follows:

1. Inter-Sector WDM Harmonisation for National Water Management

The objective of this plan is to develop a set of principles and code of practices that is acceptable by all sectors for WDM of the future. This would also include development of the water accounting, auditing and reporting principles as well as for water pricing.

Some of the major areas of focus (refer to the Strategic Action plans at Chapter 4) are:

- (1) Formation of a dedicated Federal institution for National Water Resources Management.
- (2) Developing sectorial and inter-sector water accounting procedures and tools including a framework for water pricing for all sectors.
- (3) Establishing a dedicated institution or a team within an existing institution (e.g. JPS) for managing water for the environment.
- (4) Incorporate WDM in the proposed Water Resources Act and other water related laws [e.g. Irrigation Areas Act (1953)].

2. Federal-state WDM Harmonisation

The objective of this plan is to develop a harmonised set of principles and code of practices acceptable by the Federal and State level water managers for WDM.

The plan could include:

- (1) Developing common principles for WDM
- (2) Review of Federal and State laws for possible harmonisation
- (3) Development of a National WDM Code of Practice; and
- (4) Development of water pricing principles.

3. Water Sector Industry Structuring for Economic Growth

The objective of this plan is for the water industry at national and State level to be recognised as one of the NKRA that contributes to the targeted GNI and employment opportunities. Some of the major areas of focus (refer to the Strategic Action plans at Chapter 4) are:

- (1) Structuring of the Water Industry as an NKEA.
- (2) Establishment of a water hub or a water institute (possibly My1Water) with the clear mandate to undertake STI and for national ownership of technologies.

Table 6.1: Outline Masterplan for WDM

No.	Components	Lead	Members	RMK11 2016-2020					Output
				2016	2017	2018	2019	2020	
1	Inter-Sector Harmonization for National WDM	NRE/KeTTHA	- Water Supply - Sewerage - Agriculture - Water Resources - Flood Managers - Environmental Managers	- Form a Secretariat - Form at Task Force - Develop Terms of Reference - Form a Water Resources Department - Undertake Studies	Development of Principles and Code of Practices, Accounting and Auditing Water Pricing Principles				- Sectorial and Inter-sector Principles of WDM - Sectorial and Inter-sector WDM Code - Proposals for policies, new laws, and amendments
				2 million	1 million	1 million	1 million	1 million	
2	Federal-State WDM Harmonization	EPU	Total Budget: RM6 million - Federal Ministries - State Government	- Form a Secretariat - Form at Task Force - Develop Terms of Reference - Undertake Studies	Development of Principles and Code of Practices, Accounting and Auditing Water Pricing Principles				- National Principles of WDM - National WDM Code
				2 million	1 million	1 million	1 million	1 million	
3	Water Industry Structuring for Economic Growth	Ministry of Trade and Industry	Total Budget: RM6 million - NRE - KeTTHA - Trade Organizations - NGOs (eg: MWA, MyWP, MANCID) - Research Institutions (eg: NAHRIM, MARDI)	- Form a Task Force - Develop Terms of Reference - Undertake a Study	Implementation				- Define Water Industry Structure - NKEA justification - Identification of EPPs - Development of 3R technologies - Research on WDM
				2 million	1 million	1 million	1 million	1 million	
4	Government and Public Participation	NWRC Secretariat	Budget RM37 million Total Budget RM43 million Public-Private Sector	2 million 4 million - Form a Task Force - Develop Terms of Reference - Undertake Studies	10 million 11 million	10 million 11 million	10 million 11 million	5 million 6 million	- Codes for WUG formation - Formation of WUGs - Rules and Regulations - Capacity Building Programme
				Implementation					
5	Sectorial and Inter-Sector WDM Improvements	Respective Sectors	Total Budget RM6 million Respective Sectors	2 million	1 million	1 million	1 million	1 million	Sectorial and Inter-sector WDM Improvement Projects
				Project Identification and Implementation					
By Respective Sectors									
Budget									

- (3) Developing Water for the Environment tools.
- (4) Integrating water data and information (quantity and quality) monitoring system.
- (5) Developing an integrated national and regional drought and flood management system.

4. Water Managers and Public Stakeholder Platforms

The objective of this plan is to establish water managers and public stakeholder platform towards the common aim of WDM for managing water as a finite resource, appreciate that water has value and manage water as a natural capital resource.

Some of the major areas of focus (refer to the strategic action plans at Chapter 4) are:

- (1) Establishing sectorial water user groups (Water supply, sewerage, agriculture, environment)
- (2) Establishing water manager stakeholder platform (Government Institutions)
- (3) Establishing public stakeholder platform.
Estimated to be about 141 regional and sectorial representations (Table 6.2).
- (4) Establishing a National Water Manager and Public Stakeholder Platform that is linked to the National Water Resources Council.

5. Sectorial and Inter-Sector WDM Improvements

The objective of this plan is to continue present efforts for WDM but with higher emphasis than before and with higher levels of inter-sector coordination and developing future planning strategies and action plans.

Table 6.2: Possible Representation for Stakeholder Platform
(NGOs and Interest Groups)

No.	Sector	Number of Organisations	Notes
1	Water Supply	14	All States
2	Sewerage	14	All States
3	Water Resources	14	All States
4	Environment/ Biodiversity/ Wildlife	26	NGOs
5	Agriculture (Paddy)	12	All Granaries
6	Agriculture (Non Paddy)	5	NGOs
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	NGOs
12	Resident Associations	5	Growth Regions
13	Humanitarian Relief	10	Interest Groups
	TOTAL	141	

Some of the major areas of focus (refer to the Strategic Action plans at Chapter 4) are:

- (1) Detailed study of groundwater resources and installation of monitoring systems.
- (2) Integrating all sectorial water data and information collection system.
- (3) Development of a national water management forecasting and management system.

- (4) Forward planning for a water grid for the Peninsular Malaysia.
- (5) Water use efficiency improvements in paddy irrigation.

6.3 Indicative Budgetary Requirements

The indicative budgetary requirements are also shown in Table 6.1. These are mainly for related studies necessary in the process of implementing the outline Masterplan. The estimates are based on past experience of similar studies (e.g. NWRS 2012: RM2 million, about 1 year duration). For the National Water Hub or institution, the set-up cost is based on similar projects (e.g. NAHRIM) that include land and buildings and start-up laboratories and equipment. Based on this, the process of initiating enabling environment for higher emphasis on WDM and towards its role in economic growth is RM60 million.

For the sectorial and inter-sector WDM improvements, these would be based on the annual sectorial budget allocation (Ministries and Departments). For the granaries, the estimated development cost at RM1.7 billion (Table 6.3). This cost is not only for delivery efficiency improvement works but for modernisation works needed in the Granaries based on the feasibility studies of selected Granaries in 1998 (Government of Malaysia and JICA (1998)). For water use efficiency improvements aspects, the advice is for systems performance evaluation be performed first to determine the actual levels of infrastructure improvement requirements.

In addition, there may be special or critical projects that may need to be implemented quickly in anticipation of potential disaster situations such as

Improving Resource Use Efficiency

In broad terms, agriculture has two options to increase water use efficiency: reduce water losses and increase water productivity.

The first option seeks to increase the efficiency of water use by reducing water losses in the process of production. Technically, "water use efficiency" is a dimensionless ratio that can be calculated at any scale, from irrigation system to the point of consumption in the field. It is generally applied to any management approach that reduces the non-beneficial use of water (i.e. reducing leakage or evaporative losses in water conveyance and application). The second option focuses on increasing crop productivity. This involves producing more crop or value per volume of water applied.

Clearly, there is scope for managing the demand for water in agriculture in time and in space. However, excessive emphasis is often placed on the first option, with efforts aimed at reducing water "losses" within irrigation distribution systems. Two factors limit the scope for and impact of water loss reduction. First, only part of the water "lost" (defined as water that is diverted for purposes that have clear and tangible benefits, such as for household purposes, irrigation, industrial processing and cooling), while withdrawn for beneficial use, can be recovered effectively at a reasonable cost. Second, part of the water "lost" between the source and final users return aquifers or as return flow into river systems. The share of water lost through non-beneficial consumption, either through evaporation or through drainage into flow quality water bodies or to the sea, varies according to local conditions. A clear understanding of the real potential for reducing water losses is needed to avoid designing costly and ineffective demand management strategies (2030 WRG 2013).

In the most cases, the single most important avenue for managing water demand in agriculture is through increasing agricultural productivity. Increased crop yields are made possible through a combination of improved water control, improved land management and agronomic practices. The latter include the choice of genetic material, and improved soil fertility management and plant protection. It is important to note that plant breeding and biotechnology can help by increasing that harvestable part of the biomass, reducing biomass losses through increased resistance to pests and diseases, reducing soil evaporation through vigorous early growth for fast ground cover and reduced susceptibility to drought. Therefore, managing overall demand through a focus on water productivity rather than concentrating on the technical efficiency of water use alone is an important consideration.

Source: WWAP (United Nations World Water Assessment Programmes, 2015)

severe drought in major cities or regions (e.g. Klang Valley, Langat Valley, Linggi Valley, the economic development corridors and the granaries). Such projects could include detailed groundwater assessment and development, water reuse and recycling plants, dam raise, flood and drought forecasting and warning systems and Government-public stakeholder platforms especially to prepare for any emergencies. Certain components of these projects should provide for the development of STI for national ownership of technologies.

- (4) The nature of project has a high local content with high chances of success in developing local technologies (hardware and software designs).
- (5) Can be implemented quickly, functional segmental delivery of service (on-line by segments) and fully completed within five years.

6.4 A Recommended Project

A recommended project for immediate implementation is the **“National Water Data and Information Integrated Monitoring System and Drought and Flood Forecasting and Water System”** for the following reasons:

- (1) The project would induce the participation of all water sectors from both the government and the private sectors.
- (2) It would also involve other economic sectors such as communication, IT and construction.
- (3) Developing this would require the development of the common water management basic principles and uniform national codes for water accounting, auditing and performance feedback system.

Table 6.3: WDM Development Cost for the Granaries

No.	Efficiency Improvement	Unit	RM/Unit	Quantity	Total cost (RM million)	Notes
1	Infrastructure Improvement Works	ha	5,000	205,508	1,028	Matured Granaries only (MADA, P.Pinang, Kerian - Sg Manik, Seberang Perak, Barat Laut Selangor, KADA, Kemasin-Semarak, KETARA)
2	On Farm Efficiency Improvement (Land Levelling, Field Structure)	ha	500	205,508	103	Matured Granaries only (MADA, P.Pinang, Kerian - Sg Manik, Seberang Perak, Barat Laut Selangor, KADA, Kemasin-Semarak, KETARA)
3	Water Management System (Forecasting, Telemetric System)	ha	2,000	205,508	411	Matured Granaries only (MADA, P.Pinang, Kerian - Sg Manik, Seberang Perak, Barat Laut Selangor, KADA, Kemasin-Semarak, KETARA)
4	WUG Capacity Building	No	50,000	1,150	58	All 12 Granaries (MADA, P.Pinang, Kerian - Sg Manik, Seberang Perak, Barat Laut Selangor, KADA, Kemasin-Semarak, KETARA, Pekan, Rompin, Kota Belud and Batang Lupar.
5	Centre of Excellence (CoE) for Irrigation Management Modernisation	No		1	30	Set-up cost only Operating cost is RM10 million per year
6	Water Accounting and Auditing System Development	Sum			20	Matured Granaries only (MADA, P.Pinang, Kerian - Sg Manik, Seberang Perak, Barat Laut Selangor, KADA, Kemasin-Semarak, KETARA)
7	Water Quality Management System Development	Sum			20	
8	Water Reuse and Recycling Studies and Systems Design Review	Sum			20	
Total Cost					1,689	

Source: Figures for items No. 2, 3 and 4 derived and adjusted from Government of Malaysia (JPS) and JICA (1998), The Study of Modernization of Irrigation Water Management System in the Granary Areas of Peninsular Malaysia.

Notes:

1. The 4 new granaries are assumed to be implemented under respective development budget allocation. (Item 1, 2, 3)
2. WUG Capacity Building Programmes involves WUGs for all 12 Granaries. (Item 4)
3. For Item 1, System Performance evaluation should be carried out at first.

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Appendix A

National Colloquium on Water Demand Management 2009

Summary: Aspects of water demand and recommendations for Stakeholder

Water Demand Aspect/Theme	Stakeholders	Recommendations
Technical: Agriculture	DOA (MOA)	- Promote reduction of water consumption programmes - Promote and conduct capacity building programmes - Conduct programmes to educate farmers on water conservation
	JPS/ River Basin authority/ IWRM Manager	- Determine measures to complement Rice Irrigation Management Information System(RIIS) within IWRM - Establish water recycling systems to make better use of rainfall during dry season - Set up Virtual Rainfall Station (VRS) - Establish programmes for continuous monitoring - Improve the building of infrastructures to maximize water supply, such as the lining of water supply and the design of canals - Establish systems to improve water efficiency
	JPS / IWRM Authority	Look into the possibility of one Ministry to monitor water authorities and appointment of water resource managers to plan equitable water resources allocation in order to ensure that all schemes have a good water measurement and database system
	MARDI Research Institutes/ Universities	- Identify plant/rice varieties that are less water demanding, drought tolerant, with a short maturity period - Conduct more research on crops that require less water with more plants per acre - Conduct research on improving farming techniques - Identify appropriate options for experts in water demand management to assist farmers - Conduct studies on agronomic practices

Water Demand Aspect/Theme	Stakeholders	Recommendations
	Water operators	Establish systems to continuously monitor demand and supply of water to ensure equitable distribution
	Granary Area Authorities	• Establish systems for continuous monitoring • Identify rice varieties that are less water demanding, drought tolerant and with a short maturity period • Building infrastructures to maximise water supply - lining and design of canals • Establish systems to check for leakages
	BPSP	• Establish systems to monitor water demand and supply to ensure equitable distribution to granary schemes • Determine areas with lower competition for water in terms of population size • Determine means to shift towards water demand management instead of just water supply concept • Building infrastructures to maximise water supply - lining and design of canals • Establish systems to check for leakages
	KADA	• Ensure that water groups are better organized • Consider the "estatiation" water users rather than ask the farmer to manage their farm individually (e.g. Bumbung Lima, Pulau Pinang DOA station)
	MARDI	• Identify plant/rice varieties that are less water demanding, drought tolerant, with short maturity periods • Conduct more research on low water demand crops with more plants per acre • Conduct research on improving farming techniques • Identify appropriate options for experts in water demand management to assist farmers

Water Demand Aspect/Theme	Stakeholders	Recommendations
Technical: Potable	Research Institutes / Universities	Conduct R&D on water demand management looking at domestic and industrial demands
	Water operators	• Conduct R&D on water demand management looking at domestic and industrial demands • Provide incentives to non-domestic consumers to encourage water saving effort • Provide training on development and implementation of water efficiency plan • Review water tariff • Conduct R&D on waste water recycling • Establish collaboration with NGOs - both local and international, private sectors and governmental agencies to help raise awareness and educate users about WDM • Establish mechanisms for joint consultation on decision making in matters concerning the implementation of WDM
	KPKT	Provide incentives for rainwater harvesting
	SPAN	• Conduct R&D on water demand management looking at domestic and industrial demand • Establish KPIs for Water Demand Management for water operators • Conduct awareness campaign programmes for all levels of society focused on water conservancy and the benefits of using water efficient appliances. Consumer groups/respected parties or personnel should be involved • Establish measures or mechanism to provide incentives, or rebates for voluntary use of water efficient appliances • Develop regulatory provisions for mandatory use of water efficient appliances • Make provisions to enforce the use of dual flush cistern (when it is made mandatory in 2010) and other fixtures
	IWK	• Determine the suitable platform for cross coordination between relevant agencies (NAHRIM, SPAN, Water operators) on R&D for water efficiency • Encourage participation of consumer groups in water efficiency labelling • Introduce labelling for water efficient devices • Provide incentives to non-domestic consumers to encourage water saving • Provide training on development and implementation of water efficiency plan • Review water tariff for institution • Conduct further R&D on waste water recycling • Conduct further R&D on waste water recycling

Water Demand Aspect/Theme	Stakeholders	Recommendations
Governance: Agriculture	DOA (MOA)	- Amend law/include water rights (Irrigation Ordinance) - Reintroduce enforcement initiatives - Devise incentive and disincentive schemes together with education programmes
	KeTTHA	Consider serving as joint secretariat for National Water Council
	National Water Council NRE-JPS (as Secretariat)/ MOA	- Introduce fixed agenda to include all water issues such as agriculture water use - Increase frequency of meetings - Consider membership of MENO - Consider making technical committee to be formed under the JPS (MOA) a full-fledged department and not just a division - Prepare rules and provide schemes for incentives (recognition to the contractor and developer; rebates for consumer etc.) to encourage usage of water efficient devices
	Prime Minister's Department	Consider making WDM objectives as part of the KPI for NRE, MOA and KeTTHA
Governance: Potable	KeTTHA	- Prepare rules and give incentives (recognition to the contractor and developer; rebates for consumers etc.) to encourage usage of water efficient devices - Establish collaboration with NGO-led community as watchdog of the government - Link WDM with green technology themes

Water Demand Aspect/Theme	Stakeholders	Recommendations
	SPAN	• Establish mechanism for collaborative discussion with relevant agencies prior to decision making • Determine measures to ensure that WDM is implemented top-down and bottom-up concurrently • Prepare rules and give incentives (recognition to the contractor and developer; rebates for consumers etc.) to encourage usage of water efficient devices • Identify suitable targets/ KPIs for WDM to be implemented by water operators • Establish platforms for collaboration with NGOs and private sectors • Establish mechanism for the involvement and consultation of government agencies • Enlist help and establish collaboration with international NGOs (e.g. Water Aid) • Establish collaboration with NGO-led community as watchdog of the government • Link WDM with green technology themes • Develop rules to implement WDM
	Public/NGOs	• Seek and identify incentives schemes that can help promote and encourage usage of water efficient devices • Spearhead collaboration to promote water demand management's educational and awareness programmes/campaign among the public • Identify opportunities to establish joint consultation in decision making • Act as a watchdog for the government and public
	Local Authority	• Establish mechanisms for discussion with relevant agencies prior to decision making on matters concerning WDM • Collaborate with SPAN to develop rules to implement WDM

Water Demand Aspect/Theme	Stakeholders	Recommendations
Water Demand Economics:	Ministry of Agriculture and Agro-based Industries	Commission a detailed study on the economics of water demand for agriculture
	National Water Resources Council KeTTHA/NRE (Water resources/ Potable water) MOA (Agriculture)	• Commission studies to determine the true economic value of water and determine true economic value of water / full economic price of water demand management for agriculture • Commission studies on economic feasibility of water supply for different categories of use (e.g. treated water for consumption only, and recycled for non-consumptive use) • Develop clear policy directions for tariffs on treatment and distribution • Commission studies on the feasibility of pricing towards efficiency and payment for environmental services • Conduct awareness programmes related to the full economic value of water, relating it to scarcity/availability • Provide mechanisms to allow for reflection of true economic value of water in tariffs with rebates to poorer income groups to fulfil basic needs. • Conduct nationwide water tariff reviews • Commission studies to revise existing models for tariff settings for sewerage treatment and identify appropriate economic model that encompasses services for treated water and sewerage treatment; award grants to contractors as a form of an incentive (see the Dutch model) • Identify policy options to facilitate greater use of recycled sludge e.g. for public works • Commission in-depth studies to identify convergence point – interests and stakeholding with respect to water tariffs setting • Commission in-depth studies to determine new economic model that covers water demand for potable water and irrigation

Water Demand Aspect/Theme	Stakeholder	Recommendation
Operational: Agriculture	JPS/Irrigation Authorities	Enhance drought forecasting capability
	Irrigation Authority/ MADA	• Conduct studies to increase dam capacity • Enhance WDM to reduce water demand • Groundwater, recycling and cloud seeding • Consultation with farmers to rearrange crops schedule • Optimise other available water sources • Enhance drought forecasting capability • Document and review standard operating procedure • Conduct trainings • Institute procedures for disciplinary action to be taken for Incompetence and negative human-operation staff • Award recognition for good performance of the staff • Recruit new staff to strengthen capacity • Enhance technologies by obtaining additional funding for R&D and to acquire new technologies/instruments • Establish of water user association • Conduct road shows or workshops • Organise team building sessions amongst farmers • Look into State and Federal funding to address the problem of inadequate funding for operational purposes • Charge farmers for water usage • Study options for flow measurement (structure or equipment) • Install telemetric stations • Carry out RAP once every 3-5 years • Carry out benchmarking every year
	State and Federal Government Authorities	• Look into available funds for operation
	Dam Operator(s)	• Identify options for experts to review the procedures on dam safety • Conduct studies to increase the capacity of dams • Modify dam structure to suit requirement on water - more flexibility of water release from dams • Provide maintenance manual and checklist

Water Demand Aspect/Theme	Stakeholder	Recommendation
	Farmers	• Identify measures to enhance WDM • Conduct studies on groundwater, water recycling, cloud seeding • Institute consultations to rearrange crop schedule • Identify options to optimise other available water sources
	Water User Association	• Establish and strengthen of water user association • Conduct road shows, workshops • Organise team building sessions amongst the farmers
Operational: Potable	Water operators	• Establish database on water wastage due to quality • Schedule maintenance of distribution system as KPI of relevant bodies • Improve piping systems • Develop a leakage detection programmes • Establish call centres • Study options for incentives for feedback • Identify and develop programmes for quick and quality repair • Develop an asset management system • Establish a one stop centre for coordinating approvals for construction works involving public utilities • Institute measures to ensure operators draw up proper business plan • Establish KPI for maintenance • Conduct inspection and verification at least once a year to ensure accuracy of metering • Determine measures to institute replacements for parts etc. every 8 year cycle

Water Demand Aspect/Theme	Stakeholder	Recommendation
	SPAN	• Establish database on water wastage due to quality • Schedule maintenance of distribution system as KPI of relevant bodies • Improve piping systems • Put into place metered supply to operator squatters and illegal factories • Enforce stricter regulatory control on plumber • 'Outsource' enforcement to water operators • Develop KPI for NRW • Publish standards and guidelines • Conduct inspection and verification at least once a year to ensure accuracy of metering • Determine measures to institute replacements for parts etc. every 8 year cycle
	Local Authority	Set up a one-stop centre
	Developer, Contractors, Consultant, Plumbers	Publish standards and guidelines
Capacity Building, Research	Research Institutes / Universities	• Intensify research on WDM • Establish systems for sharing of data and information and coordination of research activities/priorities; setting up a central data bank and facilitate regular checking, forecasting and actual demand • Develop a framework, to address the uncertainty • Conduct more seminars, workshops and focused group meetings –establish a special body to translate research outputs used by practitioners • Identify needs for water resource managers should be addressed by professional institutions/ universities by providing a proper career path through structured training • Organise seminars, workshops with CPD points • Centralise in-house training and adoption of Best Management Practices • Develop benchmarking system • Source information from international organisations for international funding

Water Demand Aspect/Theme	Stakeholder	Recommendation
	NAHRIM	Provide incentive to the private sectors, i.e. tax reduction, awards etc. to tap fund from the private sectors
	MOE	Review the education system to change the mindset of educators and parents on WD
	MOHE	• Should establish more RCEs (under UNESCO) • Review educational system at the tertiary level to change the mindset of educators on WD
	NRE/ MOSTI / Meteorological Department	Identify research options and capacity building for adaptation to climate change
	JPA	Provide a proper career path through structured training
	EPU	Provide incentive to the private sectors, e.g. tax reduction, awards
	MOF	Provide incentive to the private sectors, e.g. tax reduction, awards
	National Water Resources Council	Provide incentive to the private sectors, e.g. tax reduction, awards
	MYWP	Source information from international organisation
	Water Regulators (SPAN)	Identify and develop certification scheme for water labelling
	Mass Media	• Intensify sharing of data and information • Promote research activities/priorities

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