AGRICULTURE WATER SERVICES FOR AGRIBUSINESS

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AKADEMI SAINS MALAYSIA

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Foreword

As a thought leader in science, technology and innovation, the Academy of Sciences Malaysia (ASM) strives to provide the best scientific advice that is independent, credible and timely to address matters of national and international importance. One such aspect is water resources management. Since 2008, water sector studies have been undertaken by ASM to provide strategic and relevant input to the government towards ensuring integrated water resources management in the context of sustainable development.

The Water-Energy-Food nexus is pivotal to sustainable development. One of the biggest challenges is the increasing demand for all three. Global population expansion, rapid urbanization, shifting food requirements and economic growth are among the factors driving water demand. According to the United Nations, agriculture is the largest consumer of the world's freshwater resources, up to 70% of a country's water resources. In addition, more than 25% of the energy used globally is attributed to food production and supply. The interconnected nature of the water-energy-food domains call for an integrated approach to ensuring water and food security.

For Malaysia, the water consumption for agriculture is currently around 64% of total demand and is targeted to be reduced to 50% by 2050. This is quite a formidable target to achieve. As such, integrated and sustainable agriculture water management is vital to ensure optimal agriculture production with minimal water consumption towards achieving "more crop per drop".

I would like to congratulate the ASM Water Committee and the members of the ASM Water and Agriculture Task Force for their expert contribution, effort and dedication in producing this Advisory Report. I hope the findings and recommendations of this report would serve as a useful reference for strategic input towards sustainable water resources management in relation to agriculture water for agribusiness in Malaysia.

Professor Datuk Dr Asma Ismail FASc
President

Preface

which calls for the balanced development and management of “water as a resource” and “water for livelihood”. Implementation of the IWRM agenda involves the integration of both natural and human systems set within an overall frameworks that provides the enabling environment with effective institutional arrangements and supported by necessary management instruments. Implementation of IWRM across all sub-sectors and levels of hierarchy are guided by the internationally endorsed 1992 ICWE Dublin Principles.

The Dublin Principles on Water (ICWF 1992)

Principle No. 1 – Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment

Principle No. 2 – Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels

Principle No. 3 – Women play a central part in the provision management and safeguarding of water

Principle No. 4 – Water has an economic value in all its competing uses and should be recognized as an economic good

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

One of the studies undertaken by the Academy is this study on **Agriculture Water Services for Agribusiness.**

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List of Abrreviations

3R	*Reduce, Reuse, Recycle*
ADB	*Asian Development Bank*
AIZ	*Aquaculture Industrial Zone*
ARI	*Average Return Interval*
ASM	*Academy of Sciences Malaysia*
AWS	*Agriculture Water Services*
BOs	*Business Opportunities*
BOD	*Biochemical Oxygen Demand*
BOT	*Build Operate and Transfer*
BPSP	*Bahagian Pengairan dan Saliran Pertanian (Irrigation and Agriculture Drainage Division, MOA)*
CAWMA	*Comprehensive Assessment of Water Management in Agriculture*
COD	*Chemical Oxygen Demand*
CoE	*Centre of Excellence*
DID	*Department of Irrigation and Drainage*
DOA	*Department of Agriculture*
DOF	*Department of Fisheries Malaysia*
DVS	*Department of Veterinary Services, Malaysia*
EBN	*Edible-Nest Swiftlet*
EIA	*Environmental Impact Assessment*
EPPs	*Entry Point Projects*
EPU	*Economic Planning Unit*
ETP	*Economic Transformation Programme*
EC	*European Commission*
EIP	*European Innovation Partnership*
FAMA	*Federal Agricultural Marketing Authority*
FAO	*Food and Agriculture Organization*
FELDA	*Federal Land Development Authority*
FFB	*Fresh Fruit Bunches*
GDP	*Gross Domestic Product*
GHG	*Green House Gases*

GNI	*Gross National Income*
GOM	*Government of Malaysia*
HDO	*Herbal Development Office*
IADA	*Integrated Agricultural Development Areas*
IADP	*International Agriculture Development Project*
IAT	*Industri Asas Tani*
IPB	*Bahagian Industri Padi dan Beras*
ICID	*International Commission on Irrigation and Drainage*
ICT	*Information and Communications Technology*
IIMI	*International Irrigation Water Management Institute*
IPP	*Independent Power Producer*
ITTP	*Industri Tanaman, Ternakan dan Perikanan*
IWMI	*International Water Management Institute*
IWRM	*Integrated Water Resources Management*
IZAQ	*Integrated Zone for Aquaculture*
JICA	*Japan International Cooperation Agency*
JKR	*Jabatan Kerja Raya*
JPS	*Jabatan Pengairan dan Saliran*
JV	*Joint Venture*
KAA	*Key Action Areas*
KADA	*Kemubu Agriculture Development Authority*
KETARA	*Kawasan Pembangunan Pertanian Bersepadu Terengganu Utara (IADA)*
KeTTHA	*Ministry of Energy, Green Technology and Water*
KKR	*Kementerian Kerja Raya*
KPA	*Kumpulan Pengguna Air*
LPP	*Lembaga Pertubuhan Peladang*
LRT	*Light Rapid Transit*
MADA	*Muda Agricultural Development Authority*
MARDI	*Malaysian Agricultural Research and Development Institute*
MASSCOTE	*Modernization of Management, Operation, and Maintenance of Irrigation Systems*

MNC	*Multinational Corporation*
MOA	*Ministry of Agriculture and Agro-based Industry, Malaysia*
MOMA	*Kementerian Pemodenan Pertanian Sarawak*
MOSTI	*Ministry of Science, Technology and Innovation, Malaysia*
MPIC	*Ministry of Plantation Industry and Commodities, Malaysia*
MPOB	*Malaysian Palm Oil Board*
MRB	*Malaysian Rubber Board*
MRT	*Mass Rapid Transit*
NAHRIM	*National Hydraulic Research Institute of Malaysia*
NAP	*National Agro-Food Policy*
NBOS	*National Blue Ocean Strategy*
NCER	*Northern Corridor Economic Region*
NGO	*Non-Governmental Organization*
NKEA	*National Key Economic Areas*
NPP	*National Physical Plan*
NPV	*Net Present Value*
NRE	*Ministry of Natural Resources and Environment, Malaysia*
NWMTC	*National Water Management Training Centre*
NWRP	*National Water Resources Policy*
NWRS	*National Water Resource Strategy*
NWRVI	*National Water Resources Vulnerability Index*
OER	*Oil Extraction Rate*
PAKAR	*Pasar Komuniti and Karavan*
PEMANDU	*Performance Management and Delivery Unit*
PPP	*Public-Private Partnership*
RAS	*Recirculating Aquaculture System*
RM	*Ringgit Malaysia*
RMK -	*Rancangan Malaysia Ke-*
RMK11	*Rancangan Malaysia Ke-11 (Malaysia 5-year Development Plan No-11)*
RNWRS	*Review of National Water Resources Study*
RRI	*Rubber Research Institute*

SOA	*Service-Oriented Architecture*
SOM	*Service-Oriented Management*
SPAN	*Suruhanjaya Perkhidmatan Air Negara (National Water Services Commission)*
SRI	*Sustainable Resource Initiative*
SSL	*Self-Sufficiency Level*
STI	*Science, Technology and Innovations*
TNB	*Tenaga Nasional Berhad*
UASB	*Up-Flow Anaerobic Sludge Blanket*
UNDP	*United Nations Development Programme*
UN	*United Nations*
UN-ESCAP	*United Nations - Economic and Social Commission for Asia and the Pacific*
UNESCO	*United Nations Educational, Scientific and Cultural Organization*
UNESCO-IHE	*Institute for Water Education*
UNU-INWEH	*United Nations University- Institute of Water, Environment and Health*
UN WWDR	*United Nations World Water Development Report*
UNWWP	*United Nations World Water Programme*
UPEN	*Unit Perancang Ekonomi Negeri*
WDM	*Water Demand Management*
WEF	*Water-Energy-Food*
WQI	*Water Quality Index*
WRG	*Water Resources Group*
WSIA	*Water Services Industry Act*
WUA	*Water User Association*
WUG	*Water User Group*

List of Units and Measurement

°C	*Degree Celsius*
bil.	*billion*
CO_2	*Carbon Dioxide*
cu.m	*cubic metre*
eq/yr	*equivalent per year*
Ha	*hectare*
Km	*Kilometre*
m/ha	*metre per hectare*
m^3/yr	*metre cubic per year*
MCM	*Million Cubic Metre*
MLD	*Million Litres Per Day*
Mm	*millimetre*
tons/ha	*tonnes per hectare*

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Executive Summary

Executive Summary

1. Overview

Up to 2004, the Agriculture Sector, through the Ministry of Agriculture and Agro Industry (MOA), had the privilege of direct access to the full spectrum of Agriculture Water Services (AWS) (often referred to as Irrigation and Drainage for traditional reasons). The spectrum covers agricultural land reclamation, agriculture drainage, irrigation, water resources development, river management, coastal protection works and flood management. Completing the spectrum of AWS are operations and maintenance of the systems, hydrological data and information services, applied research and capacity building for system managers and farmers.

This privilege was withdrawn when the Department of Irrigation and Drainage (DID) was transferred from the MOA to the Ministry of Natural Resources and Environment (NRE). With the move, the AWS human resource capacity at the Federal level was reduced from nearly 1,000 to just about 60 personnel based in the Irrigation and Agricultural Drainage Division (BPSP) of the MOA. The move also saw the withdrawal of major institutional facilities from the MOA such as applied research National Hydraulic Research Institute of Malaysia (NAHRIM), the water management training centre for farmers and system managers and hydrological services. Similar restructuring was also undertaken at the State levels and in most cases, AWS is now supported by just a unit of the State Jabatan Pengairan dan Saliran (JPS) offices. The exception is the AWS in Muda Agricultural Development Authority (MADA) and Kemubu Agriculture Developement Authority (KADA) Granaries that remain within their respective institutions.

It is prudent to recall that the systematic approach to AWS in this country beginning in 1932 was in response to policies to address poverty alleviation and increasing food supply then. The strategy was to form a dedicated department, the DID, to focus on AWS. This recognised the dependency and sensitivity of Agriculture, and the jobs related to it, to water resources and water related issues such as floods and droughts.

Over the past more than 80 years from 1932, the role of AWS has been one of the key success factors for the admirable achievements by Agriculture sector. Poverty in the rural areas has largely been resolved. The National food Self-Sufficiency Level (SSL) is generally at comfortable and consistent levels. AWS in paddy irrigation for example, has ensured SSL targets for paddy production (now at 70%) are consistently met every year for over the past 30 years. Aquaculture and livestock industries have expanded.

AWS is not just for food production but also for plantation and commodity crops. AWS in drainage areas has supported the oil palm sector to transform into a premier agriculture industry and as a major export earner at RM 80.41 billion in 2011 (Vijaya Subramanian, 2013).

The country is now on the verge of being a high income, developed-status nation and achieving this is driven by the Economic Transformation Programme (ETP) (PEMANDU, 2010

The emphasis on “inclusivity” in the ETP is an important point for agriculture sector development in that it should not be straggling economically compared to other sectors. Agriculture development should now be transformed from the general notion that “agriculture is a poor man’s occupation” to one that is “an attractive and rewarding occupation and an industry comparable to all other sectors” in a developed nation. Responding to this, the theme for agriculture as promoted by the MOA is that “*Agriculture is Business*” and the ETP is supporting this with the theme of “*Transiting from Agriculture to Agribusiness*”.

The projected average annual growth rate for Agriculture between 2016 and 2020 is 3.5% and the ETP recognises Agriculture (categorised into eight sub-sectors with high growth potential) as one of the twelve National Economic Areas (NKEAs). The 16 Entry Point Project (EPPs) and 11 Business Opportunities (BO) under this Agriculture NKEA is expected to deliver an incremental Gross National Income (GNI) impact of RM 28.9 billion and 74,600 additional jobs by 2020. Oil palm, an important sector of Agriculture, is also recognised as an NKEA and its 8 EPPs and 3 BOs is expected to provide an incremental GNI impact of RM 125.3 billion and generating additional 41,600 jobs by 2020.

Interestingly, for these agricultural development aspirations and, unlike the Water Supply and Energy (Hydroelectric) sectors, there is no affirmative policy and strategy for AWS in the key national development policies and plans. The National Agro-Food Policy 2010-2020 is silent on AWS. The Eleventh Malaysia Development Plan has no distinctive plan for AWS and the ETP does not recognise water development and services as an NKEA. The National Water Resources Policy was introduced in 2012 but this is not specifically addressed to the sectorial needs of agriculture.

Without definitive AWS policies and strategies, and with the severely reduced AWS institutional capacity, achieving those ambitions and sustaining them could face formidable challenges. The “2014 Great Flood” and the 2015 and 2016 prolonged water stress situations that are expected to be more severe and frequent due to climate change impacts are indicative of such challenges. Added to these, the increasing water demands by the Water Supply and Energy Sectors and the need for flood management in expanding urban areas are gradually breaching the once “exclusive” water resources and water management facilities for Agriculture.

The National, State, regional, local and even global issue now is thus Water Security and managing this as the Water-Energy-Food Nexus (WEF) approach.

Under the circumstances, a strong and distinctive AWS is therefore all the more necessary not only to defend the needs of the sector, but also to harmonise the total water management approach for the Nation.

2. The Role of AWS

In essence, AWS is “*managing large volumes of water for the provision of agriculture water supply and drainage facilities in agricultural schemes and subsequently to operate, maintain and manage the systems for all types crops, livestock and aquaculture produced by individuals and business entities to ensure reliable and sustainable water management for the upstream production side in the overall agricultural production chain and in harmony with other water sectors*”.

The AWS policy has always been for the Government to provide for infrastructure and services that were beyond the capacity of the farmers and business entities or in situations that require intervention for a balanced and harmonious water management at local and regional levels.

Farmers continue to be responsible for their own on-farm water management with the support of agriculture extension and services provided by the Government through a large number of institutions such as the Department of Agriculture (DOA), Department of Veterinary Services (DVS); and Department of Fisheries (DOF) under the MOA; and agencies under the MPIC such as Malaysian Palm Oil Board (MPOB), Malaysian Rubber Board (MRB) and the Rubber Research Institute (RRI). The larger private sector entities in the plantation sector also provide similar services to their respective holdings.

The role of AWS is not just about increasing yields and production consistency. The long-term AWS provision is also for sustainability and consistency of the role of the Agriculture sector in tandem with National social and economic aspirations as the country develops. AWS was for increasing food supply and poverty alleviation when the economy was primarily agriculture. Then, as the economy diversifies, AWS was for food security and income generation. For now and in the future, AWS will be for higher levels of food security and for wealth creation (Figure E1).

Achieving both food security and wealth within the Agriculture sector in a rapidly expanding diversified economy is challenging. Although its absolute value is expected to increase at an average annual growth rate of 3.5% between 2016 and 2020, the projected contribution to Gross Domestic Product (GDP) is only 8% by 2020 (Economic Planning Unit (EPU), 2015) and declining to 4.0% in 2050 (Government of Malaysia (GoM) (e), 2012). In some ways, this is a reflection of the relatively low level of attractiveness of investments, therefore Agribusiness, compared to other sectors.

However, the consistent and long-term significant "presence" of AWS in the past has gained the confidence of farmers and retained them to continue planting and invest in on-farm infrastructure in an economic environment that is inducing new investments away from Agriculture for the relatively more attractive opportunities outside. The AWS contributing significantly to managing water related risks have allowed farming to steadily progress towards establishing it as industry. Farmers do not now have to "toil the soil" but have become production managers on their lands instead. This is because the long-term AWS has been able to encourage the development of business opportunities related to the industry in the form of agriculture service providers.

The long-term and consistent AWS has allowed for Agriculture to be in a position for change in tandem with the economic landscape. First it was in a position to change from for poverty alleviation to income generation by the 1970s. From the 1980s onwards, AWS has supported Agriculture to be in a position to continuously consolidate and defend itself by appropriate responses to address issues in an expanding diversified economy. Agriculture is now in the position to transform into Agribusiness for wealth creation as well as for food security.

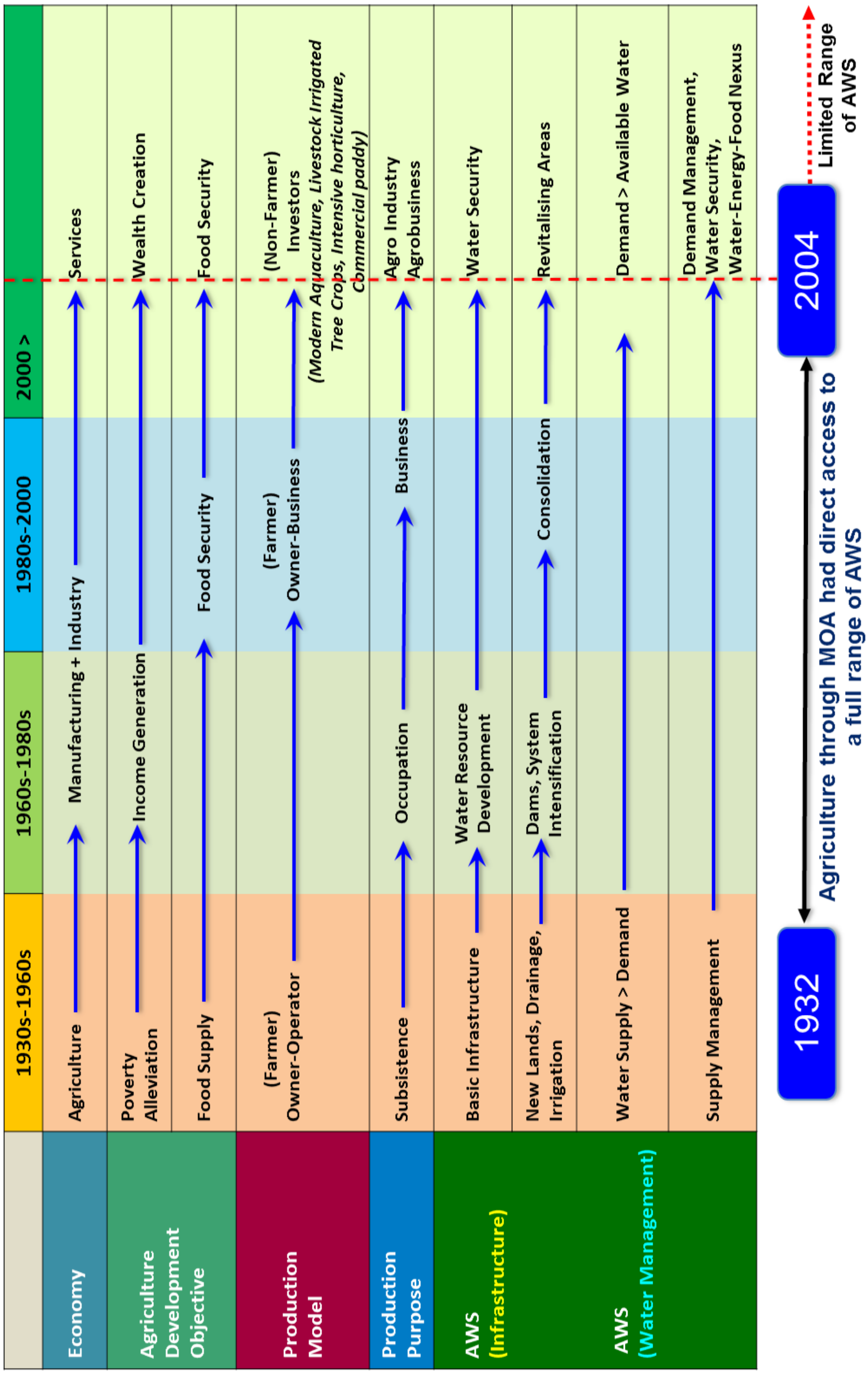


Figure E1: Agriculture through MOA (1932-2004)

3. AWS for Agribusiness and Food Security

As a business, the objective is for returns on investment more than for individual income. Encouraging the investments and ensuring their returns are dependent on the levels of associated risks and the confidence that these are acceptable and manageable. Water hazard (floods and droughts) is the main component of agriculture investment risk and a high level of AWS to manage this together with exposure and vulnerability is a prerequisite.

Agribusiness investors would expect a high AWS performance service levels but this would have to be a shared risk between them and the Government. As a business, the investor should appreciate that there are associated costs for the service and therefore be prepared to remunerate.

The AWS, however, should not confine its responsibility to the agribusiness alone; instead, the AWS will need to be responsible for local, regional and national water security and managing this in the WEF Nexus for food security.

In line with this, the proposed Key Action Areas (KAA) for AWS are:

- KAA1 : Developing water accounting and auditing system
- KAA2 : Risk Management
- KAA3 : AWS for Food Security and Wealth Creation
- KAA4 : Investments and Financing for AWS
- KAA5 : Managing the WEF Nexus
- KAA6 : Public Participation and Capacity Building

KAA 1: Water Accounting and Auditing

The present national water resources accounting framework is now too simplistic for effective water resources management in a developed nation. It is still based on freshwater availability. Agriculture water demands and use estimates now are based simplified assumptions. The need is for a more refined water accounting system that considers both water quantity and quantity parameters. The system should be harmonised will all water sectors and acceptable by Federal and State Governments. This would lead to establishing a systematic water auditing system as part of the water Governance process.

The need for more refined water accounting framework and establishing a water auditing system is to address some of the major concerns as follows:

Agriculture Water Demands and impacts could be higher than projected

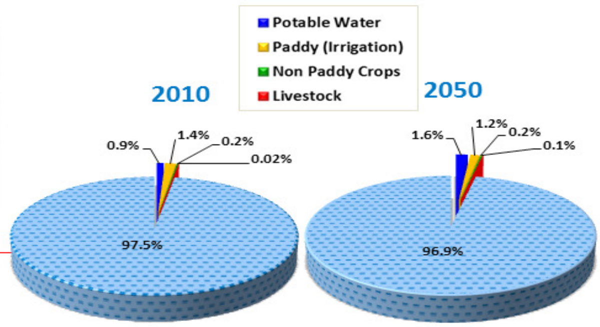
From the total yield of 973 billion cu.m estimated by the Review of National Water Resources Study (RNWRS) 2012, the estimated renewable water resource for the country is estimated to be 580 billion MCM annually (FAO Aquatrans).

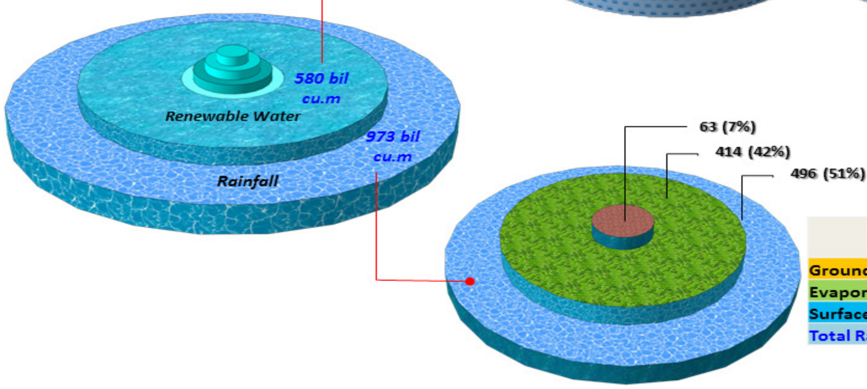
The total water demand based on consumptive use by Agriculture and the Water Supply sectors is projected to increase from 14,789 MCM in 2010 and projected to 18,250 MCM by 2050. Of this, Agriculture is the biggest user of at 9,511 MCM in 2010 (64.3% of the total water demand). Within the Agriculture sector, the biggest water user is by the Paddy Irrigation sub-sector at 8,266 MCM in 2010 forming 55.9% of the total water demand and 64.3% of the total agriculture water demand.

However, the Agriculture sector is projected to decrease its demand to 8,959 MCM by 2050. The water demands for the non-paddy crops is projected to increase from 1,117 MCM in 2010 to 1,176 MCM (5% increase) in 2050. Over the same period, the Livestock sub-sector is also projected to increase from 129 MCM to 578 MCM (348% increase). Water demands for Fisheries, considered as non-consumptive water user under the RNWRS 2012, is also projected to increase from 1,287 MCM in 2010 to 2,898 MCM by 2050 (125% increase).

	Water Demand	MCM/year		%	
		2010	2050	2010	2050
A	Potable Water	5,277	9,291	0.91%	1.60%
B	Agriculture (a+b+c)	9,512	8,959	1.64%	1.54%
	a. Paddy	8,266	7,205	1.43%	1.24%
	b. Non Paddy Crops	1,117	1,176	0.19%	0.20%
	c. Livestock	129	578	0.02%	0.10%
	Total Water Demand (A+B)	*14,789*	*18,250*	*2.55%*	*3.15%*
	d. Fisheries*	1,287	2,898		
C	Total Renewable Water Resources	*580,000*	*580,000*		

* Considered as Non – Consumptive





Water	Billion cu m per year
Groundwater Recharge	63
Evaporation	414
Surface Runoff	496
Total Rainfall	973

(Source: GoM (e), 2012)

Figure E2: Water Resources and Water Demands

Overall, the total water demand (Water Supply and Agriculture) is projected to increase from 2.55% in 2010 to 3.15% of the total renewable water resource in 2050 (Figure E2). Over the years, the Water Supply Sector (Potable Water) demand will surpass Agriculture's by 2035 as Agriculture Sector demand is projected to decrease from 1.64% in 2010 to 1.54% of the total renewable water resource by 2050.

The projected reduction of 1,061 MCM from 2010 and 2050 in water demands by the Irrigation sub-sector is based on the assumptions then that the paddy production areas will be restructured, the eight (8) matured Granaries will remain as the main production areas and that irrigation efficiencies will increase to 75%. Those assumptions may not be entirely valid now.

In 2013, four (4) new Granaries were added to the existing eight (8) matured Granaries thus increasing the total Granary area to 230,275 ha. At the same time, there are considerations to add to the eight (8) matured Granaries about 17,500 ha of active non-Granary irrigation schemes at their respective fringes. These additions would inevitably increase the water demands of the Irrigation sub-sector.

Improving their efficiencies could contribute significantly to water savings. The estimated potential savings is 1,067 MCM (or equivalent to 2,927 MLD) (ASM, 2015). However, improving irrigation efficiencies is not really a definitive measure of water savings in irrigation since wastages could occur at the farm levels too. The objective would instead be to aim for higher agricultural water productivity. Under this concept, the water accounting approach for irrigation would need to be revised to account for not only for freshwater demands and efficiency of use, but also to incorporate quantity and quality of the used water returned to the system.

Declining available unregulated flow

The RNWRS also projected that five States in the Peninsular are already in deficit of available unregulated flows and projected to decline further towards 2050. Four of these States, Perlis, Kedah, Pulau Pinang and Selangor are hosts to three of the eight (8) matured Granaries namely MADA, Integrated Agricultural Devlopment Areas (IADA) Pulau Pinang and IADA Barat Laut Selangor.

This decline could also affect future development of non-paddy crops, livestock and fisheries. Their impact on local water demands could be significant especially when their developments are concentrated in a contiguous area as in the Cameron Highlands. It could also limit realising the potential of non-paddy agriculture yield increases through irrigation such as that for oil palm. Irrigated oil palm has the potential of increasing yields from about 19 tons/ha to between 32 to 62 tons/ha (Yusof Basiron, 2014). For livestock, modern production systems requires reliable water supply for production (Kamarudin M.I et al., 2015). For Fisheries, the traditional production that was non-consumptive has now changed to include consumptive production systems. This is estimated to require up to 46,800 cu.m/year/ha pond area (Marzuki Hashim and Yeo Moi Eim, 2015).

The deficit situation and increased demands could also result in lower water table situations for tree crops (especially rubber and oil palm) in the low-lying coastal drainage schemes that would affect yields.

This declining state of available unregulated flow however refers mainly to freshwater resources. For the future, the water accounting system would have to be more sophisticated with considerations of wastewater as a resource too with applications of the Water Footprint approach for freshwater management (Haslawati Baharuddin, 2013; Zainura Zainon, 2015).

Declining Water Resources Vulnerability Index

The National Water Resources Vulnerability Index (NWRVI) is indicating a decline in water quality status. All States in the Peninsular are already in the Moderately Vulnerable Category with four (4) States, Perlis, Pulau Pinang, Selangor and Melaka in the Vulnerable category. Only Sabah and Sarawak are in the Low Vulnerability Category but only just.

The present regulations and enforcement on water quality are more for point-source pollution management. Agriculture has always been one of the prime suspects for non-point source of pollution that at times affected the performance of Water Treatment Plants and all other agricultural activities especially aquaculture. Fertiliser and pesticide use over long-term and impact on surface water quality as well as groundwater resources and the expected increase for higher yields are of concern. Water quality issues and impact assessments on the ecosystem and groundwater reservoirs have yet to be extensively studied and monitored. These are critical parameters necessary in developing water resources accounting and auditing systems for future water management.

Urbanisation

Urbanisation is expanding rapidly and by 2020 it is projected that 75% of the population would be living in urban areas and increasing to 80% by 2030 (GoM, 2015). The impact on agriculture is that the agricultural drainage systems have now to cater for urban drainage and flood flows. These conflicting urban-agriculture water management requirements are not easily managed and will need adjustments to the agriculture drainage management systems to ensure consistent farm output.

KAA 2: Evolving Risk Management Strategies

A good understanding and appreciation of risk in Agribusiness are important for system planners, managers and investors in Agribusiness.

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

Agribusiness needs to understand the limitations of the water management systems also and take on the responsibility for risk sharing and management with the system managers. The Agribusiness will need to accept and able to manage higher risk levels in relation to the limits of Government investment. In other words, the agribusiness would also need to invest in water infrastructure, participate in water management activities, plan for resilience and recovery such insurances and, in the long-term consider payment for higher agriculture water service levels for improved risk management.

Managing hazards, exposure and vulnerabilities

Agriculture is highly exposed to the vagaries of weather and vulnerable to water hazards. The risks involved are not only on the success of planting the crops but also on the production system as a whole. Managing water hazard is therefore one of the most important strategies in the risk management for agribusiness.

Transiting to Agribusiness will now necessitate the review of present design criteria to match the acceptable risk levels of the agribusiness.

With paddy production migrating to commercial farming and to attain an average 8 tons/ha yields, then the risk management approach may have to consider higher levels of protection, higher farm road performance as well as more intensive on-farm investments in land-levelling and field-channels. Higher value food crops would need higher protection levels such as 1:50 years Average Return Interval (ARI) for irrigating vegetables. Similar review will be needed for both water supply and drainage systems for tree crops, livestock and aquaculture too. Oil Palm as an NKEA should now be considered as a high value crop. So too are certain ornamental fishes for export such as Arowana.

A potential area for improved risk management would be the non-Granary irrigation schemes identified for diversification to other agricultural activities particularly for oil palm and aquaculture. Many of these schemes were abandoned not for lack of water but for economic reasons. The Study on Crop Diversification in 1988 has identified the schemes and a review of these should be with the objective of assessing the possibility of reactivating the irrigation and drainage systems.

Floods in agricultural area continue to be one of the major hazards and flood events in the MADA Granary for example shows that this appears to be at an increasing frequency.

Developing non-structural measures for risk management

Risk management is not only by structural measures but non-structural measures too. Systems vulnerability and exposure is managed by AWS through operations and maintenance activities, flood and drought warning systems, planting schedules and standard operating procedures for disaster management and recovery. Even capacity building programs are considered as part of the non-structural measures. In addition, there are also, on a case-by-case basis, cash compensation for relief and recovery from severe incidences leading to income losses.

An example of cash relief provided for flood damages is for affected farmers in the MADA Granary. The records show that flood occurrence, at a frequency of about one a year, were awarded cash relief by the Government averaging RM 1,009/ha/event and totalling RM 100.89 million over 27 years. This relief support could be the basis for developing a resilience building and recovery plan (e.g. insurances) as part of the non-structural risk management by the Government and agribusiness.

Service-Oriented Management (SOM) in AWS

Apart from reduced facilities, an emerging concern is the gradual deterioration of skills and knowledge acquisition in AWS. Under the circumstance the concern is if the Agriculture sector now has the capacity to meet the demands of Agribusiness investors for higher AWS levels. The present AWS provided by the Government would need to be reviewed and restructured to match those expectations similar to the Water Supply and Energy Sectors. For Agribusiness and total National water management for the future, the AWS should now be based on the SOM approach.

Investments in AWS can be either by the Government or the private sector or both (Public-Private Partnership (PPP)). Remuneration for AWS remains a contentious issue and may not be implemented within the near future. However, now there should at least be a system of measurement, value assessment and information flow between the user and the AWS provider. The agribusiness in the long-term, as in any other businesses, would have to appreciate the need to pay for services and AWS is one of them. The Agribusiness should be prepared to be ready to remunerate for AWS in the future.

Replicating the Granary Model

The Granary policy for paddy production evolved in response to wide scale abandonment of paddy areas in the 1980s and 90s that threatened national food security. The large contiguous irrigated schemes proved resilient by economies of scale and these then were deemed the National Granaries. This policy has proven to be advantageous from many aspects.

Apart from economies of scale, the nationwide spread is also a risk-spreading strategy in case of inevitable disasters affecting scheme performance. In the long-term it has allowed for the farm activities to evolve into an industry. The economic influence extends beyond the Granary boundaries. The paddy areas at the fringes continue to develop to be in a position to be considered for incorporation into the nearby Granary. Also, it allows for a focused long-term AWS development for water security management.

There are other sub-sectors of Agriculture that has developed to be similar models informally and driven by private sector initiatives or induced by special regulations. One example is the pig farming industry. The vegetable industry in Cameron Highlands is another. The oil palm industry is commercially driven but its regional sustenance is indirectly encouraged by oil palm mills acting as the nucleus "binding" the surrounding farms.

Developing agribusiness that is supported by an efficient AWS will need to consider replicating the Granary model for non-paddy agriculture. The Agriculture EPPs could be the nuclei and catalysts for expanding into an economically viable local business and industry. The Aquculture Industrial Zone (AIZ) sites of the Aquaculture sub-sector is already in place and these too could be formalised agribusiness zones similar to the Granary model.

Another possibility for focused area production with distinct AWS support is the non-Granary irrigation schemes identified for diversification.

Improving Agriculture Water Security

Improving agricultural water management is deemed critical "because of its larger share in the overall water management landscape".

Paddy irrigation sub-sector with reservoir facilities would have higher levels of water security. Other schemes and agriculture sub-sectors without are therefore vulnerable to unregulated flows.

At present, there are 11 dams for paddy irrigation with total storage of 1,997 MCM (2% of National total reservoir storages). Eight dams, all for paddy, are planned for the future with a potential increased storage of 564 MCM.

Planning for new dam projects for agriculture is possibility but implementing them would be faced by several social, environmental and financial constraints. The way forward is for agriculture to implement the Integrated Water Resources Management (IWRM) approach. This would open the possibility of sharing of existing water resources in control by other sectors especially that by the Energy Sector that has an estimated total storage of 79,142 MCM (95% of National total) with potential future increases of more than 885 MCM.

There is also an option to develop small reservoirs for Agriculture. An inventory of potential sites for these was prepared in 1995 and could be reviewed for agribusiness objectives.

KAA 3: AWS for Food Security and Wealth Creation

The impact of long-term and consistent AWS is the increased level of confidence for farmers to continue and invest in agriculture, allowed for time and opportunities to develop capacities for income generation and on the whole, allowed for opportunities for wealth creation through the development of new business opportunities and industries. This is an important factor especially when food security objectives, particularly paddy, are more of a national agenda (Government's) than that of farmers. Agribusiness investors instead have returns on investments and maximising profits at the top of their agenda. Higher value crops would be more attractive or even, for agriculture landowners, converting the lands to non-agriculture investments.

For paddy, a food security crop, the conflicting agenda issue is addressed by the ETP through EPP10 and EPP11 with the exit plan for farmers. These efforts should include transforming AWS with a possibility for the tertiary systems to be operated and maintained by the commercial enterprises or by private AWS providers.

Similar efforts for other agricultural schemes are also necessary. The AWS for the Cameron Highlands vegetable and flower industry for example, could be the strategy to rationalise the agriculture water management for its development sustainability.

AWS for food security and wealth creation for rural prosperity should not be bounded by specific categories of agriculture. Instead it should integrate the needs of the local population and economies for growth and wellbeing. The breaches of paddy irrigation exclusivity to service the needs of multi-subsectors of agriculture and of other sectors should be taken as positive changes and as added responsibility of the AWS in supporting a developed nation.

Whilst AWS is to support food security and wealth creation, AWS by itself could be considered as an industry and should be structured as such. The AWS consolidated with the other water sectors such as Water Supply, Environment and Energy (Hydroelectric) to form a distinct Water Industry could evolve as a significant economic sector and even qualify as an NKEA. The global development direction is for Green Growth and in this case is to manage water as a natural capital for higher levels of economic and ecological quality in tandem with human capital development for higher skills and knowledge (Raekowon Ching, 2015).

AWS as an industry would also provide for a systematic and market approach to advanced Science, Technology and Science (STI) development and national ownership of technology, one of the main characteristics of a developed nation. The potential is tremendous covering software and hardware for production, climate change mitigation and adaptation as well as for environmental enhancement.

STI will be needed to increase oil palm yields from 19.2 tons/ha to 26.2 tons/ha, worker productivity from 1.5 to 2.8 tonnes/worker/day and Oil Extraction Rate (OER) from 20.5% to 23% by 2020 (Vijaya Subramaniam, 2013). Green Growth technologies would be expected for methane gas capture (Green House Gases (GHG) savings of 16.3 million tCO2eq/yr) for electricity production (Electricity displacement of 5.8 million tCO2eq/yr). A number of STIs are already being practised such as zero burning techniques by recycling of biomass and environmentally friendly pest management techniques (Tang Meng Kon, 2014). New ones are also emerging such as zero waste-zero discharge techniques (Sardar Ali, 2014). The Rubber industry has already begun research on wastewater recycling that has the potential to produce 60 million litres of potable water per day from processing 300 cu.m of wastewater daily (Preetiba and Christine Lee, 2015). The STI for aquaculture would be towards intensive aquaculture system (Mazuki Hashim and Yeo Moi Eim, 2015). In the Livestock sub-sector, mixed farming (integration of livestock and feed crops) for a better agro-environment ecosystem is encouraged for higher water productivity (Kamarudin et al., 2015).

Wastewater recycling and biogas for energy production are also emerging technologies applicable for large-scale farming.

Malaysia Agriculture Research and Development (MARDI) has also begun research on water savings STI (Chan et al., 2015). This includes cultural practices for water savings and development of water-saving aerobic rice variety. Future agriculture water management would also need STIs for data and information management for system managers and farmers (Elizabeth Malangkig, 2015).

For aquaculture, oil palm and selected agriculture process, researches in Agriculture Sector Water Footprint has also begun (Haslawati Baharuddin, 2013; Zainura Zainon Noor, 2015) and would be useful for refining future policies, strategies and action plans for agriculture water management.

At present, the tendency is for applications of advanced technologies imported from elsewhere. There is a need to shift this approach so as to vigorously encourage local STI development.

KAA 4: Investment and Financing for AWS

One of the key expected outcomes of the ETP through the EPPs is job generation especially those of high value. The EPPs under Agriculture alone is expected to generate 109,335 jobs. The expectation is that these EPPs would be able to be replicated and expanded to provide for more opportunities. Agriculture is a highly water-dependent industry and therefore the jobs too. Therefore, investments in AWS with water productivity objectives are crucial for job opportunities and sustenance within the sector and beyond.

Apart from the traditional financing approach for water infrastructure and services, agriculture now would need to consider other financing models for investment and services The AWS could be based on the Federal Road and Federal Building maintenance model implemented by the Ministry of Works (KKR). This is a long-term performance-based contract and has shown advantages in improved services as well as strengthening the private sector capacities in this sector. Financing models for AWS such as those in the Water Supply and Energy sectors should be seriously considered for a developed status nation.

The PPP approach for Agriculture and models with the participation of end-users WUG as shareholders in the venture have long been implemented in France and are now being introduced in developing countries in Africa.

In the above approaches it is not only advantageous in terms of higher levels of service enjoyed by the end-users but also in terms of capacity development of the service providers from increased knowledge and skills and, attracting as well as retaining talents in the respective specialisation. New investment funding structures should also now be considered as promoted by the National Blue Ocean Strategies (NBOS).

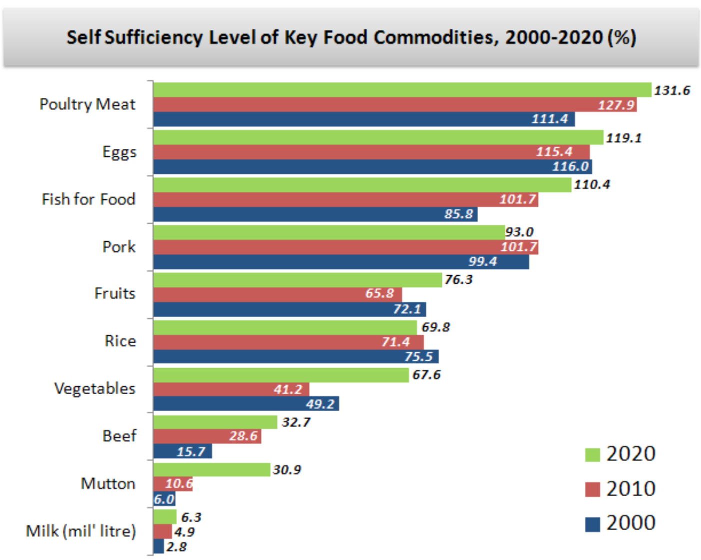
Conversion of single-purpose systems to multi-use systems is a Blue Ocean strategy since it maximises the use of existing resources and facilities. Extending this concept is the possibility of cross-sector financing such as Water Supply Sector investments in Agriculture Sector to increase water savings in paddy irrigation that in turn would relieve water resources for the Water Supply Sector. This could defer the need for the Water Supply sector to develop new dams for example. Another possibility is for the Agriculture and Water Supply Sectors (and even for flood management) to jointly and proportionately invest in the "investment attractive" Energy

Sector development of new dams for renewable energy but for multi-purpose use. The possibility of raising the height of existing sectorial dams for increased storages and for multi-function could be another strategy for water security improvements through cross-financing.

Another possibility of a financing model is for selected agricultural areas to be designed to temporarily store floodwaters as part of the flood management system. This could reduce the need for heavy investments in flood management infrastructure to protect both urban and rural settlements. The case of cash compensation by the Government for flood damage crops in the MADA Granary could be a model for developing this approach in flood management. The compensation could perhaps be developed to be an arrangement for fixed land rental of the flood susceptible paddy lands. As an initial assessment, from the average compensation of RM1,000/ha for flood damage over 4,000 ha, the average total compensation is RM 4 million/year in the MADA Granary. Over 10 years this works out to be RM 40 million or RM25 million Next Present Valve (NPV) at say, 10% discount rate. This amount is far less that physical flood management infrastructure project that could be as much as RM200 million (as say RM 50,000/ha including land acquisition) to protect 4,000 ha at 1:20 year ARI. This could be a very attractive approach to flood management financing.

KAA 5: The Water-Energy-Food Nexus Approach

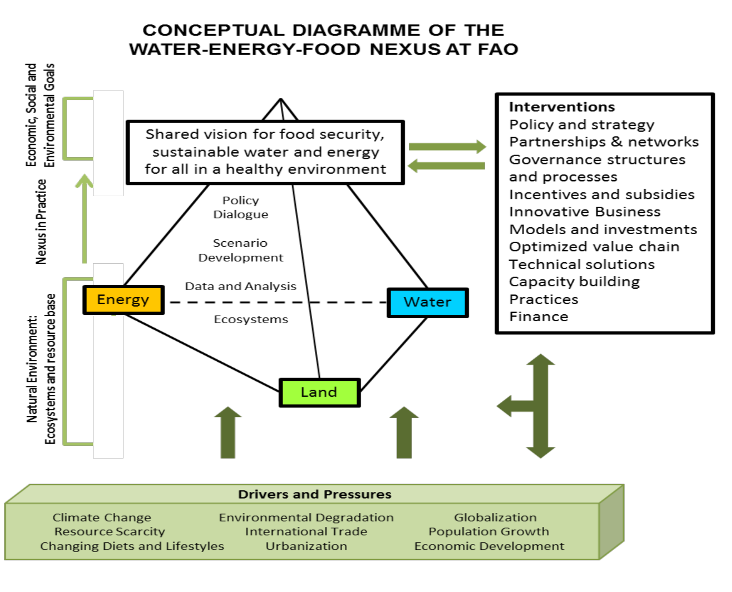
That Malaysia has achieved a comfortable food SSL (Figure E3) is indeed commendable. However, SSL is by no means a representative indicator for food security levels. There are several approaches to analysing these three key inter-related elements, Water, Energy and Food, of security for sustainable development (Hezri, 2015).



(Source: Zalilah Selamat, 2013)

Figure E3: Self-Sufficiency Levels for Key Food Commodities

The Food and Agriculture Organization (FAO) concept for the WEF Nexus management (Figure E4) is based on fundamental drivers and pressures that influence the impact on the WEF elements and consequential responses. An example (International Trade) is the food price crisis in 2007/2008.



(Source: Thierry Facon and Marisha Wojciechowska, 2015)

Figure E4: FAO Conceptual Diagram of the WEF Nexus

The impact on Malaysia was a rice supply shortage incidence in 2008. Although for only a short period (less than a month) and localised (in central Peninsular), the policy response was significant. The SSL for paddy was revised to be more than 70%, four new Granaries were added to the existing eight matured Granaries (although the National Agrofood Policy (NAP) specifically indicated that there were to be no new Granaries) and investments in paddy irrigation were increased and included for active non-Granary irrigation schemes with considerations that these be consolidated with the adjacent Granary.

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

The conceptual model for AWS in relation to managing the WEF Security Nexus and Water Resources security is shown in Figure E5. The interactions between the respective sector services and Governance should be the basis for IWRM and ultimately for achieving the desired levels of Water, Energy, Food and Water Resources security.

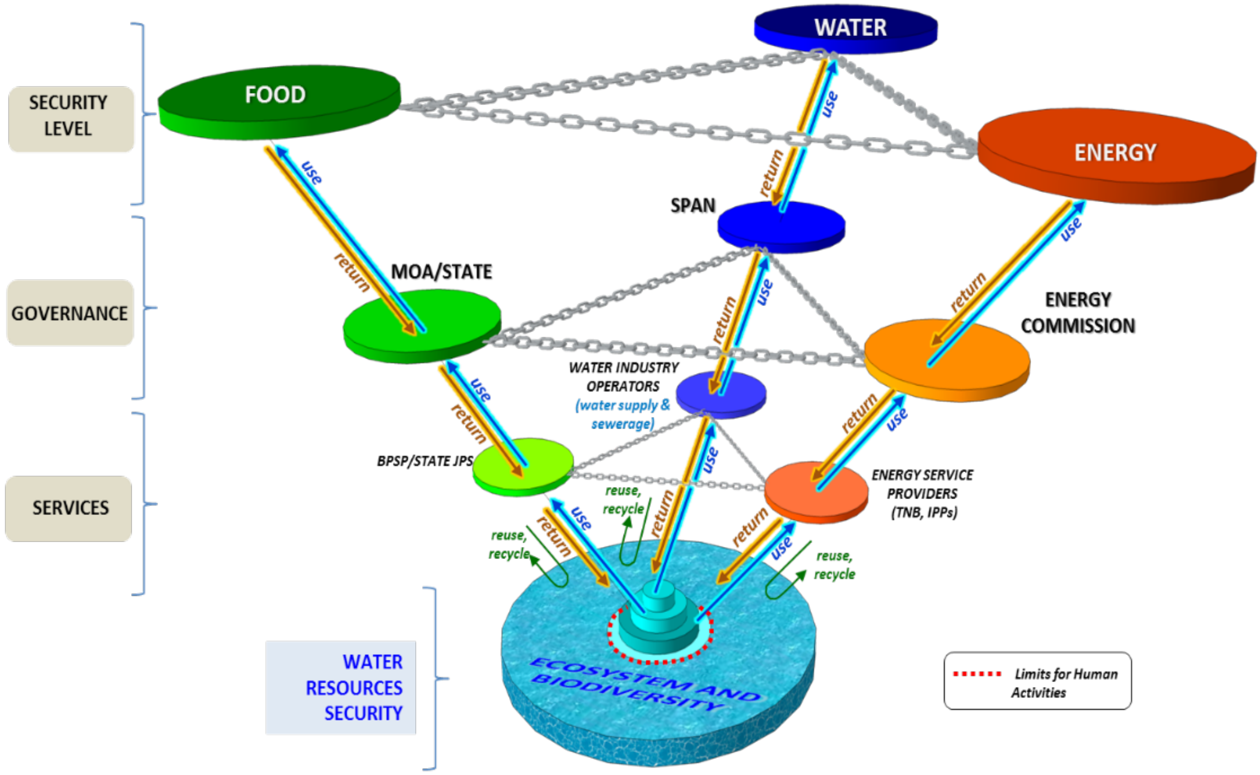
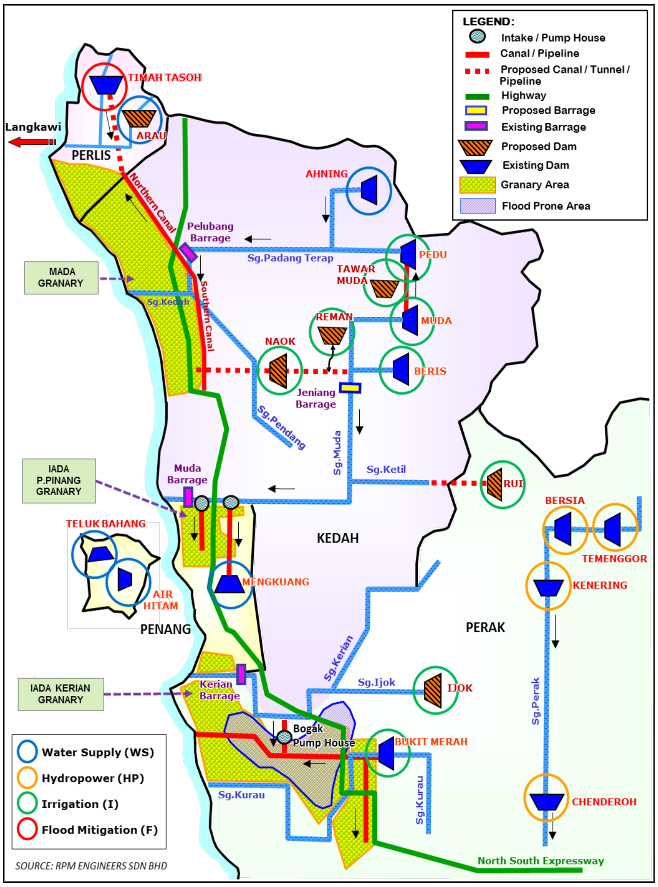


Figure E5: Concept of WEF Security Nexus driven by Water Resources Security



(Source: Mohd Adnan, Liam, and Shiamala, 2014)

Figure E6: Water Resources and Distribution Network in the Northern Corridor Economic Region (NCER)

There are already examples of significant issues of the Nexus at regional and local levels that require urgent attention.

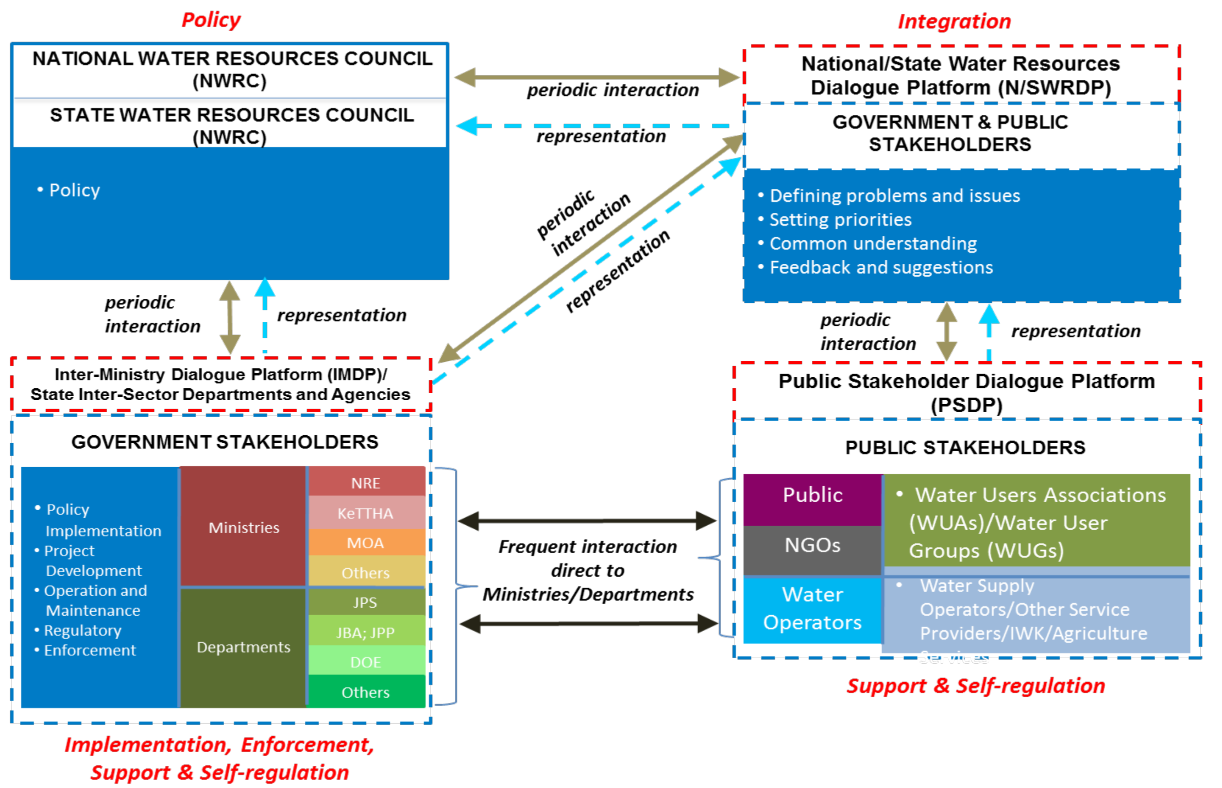
One is the Northern Corridor Economic Region (NCER) (Figure E6) covering the States of Perlis, Kedah, Pulau Pinang and the northern region of Perak, the hosts to three of the 12 Granaries namely MADA Granary, IADA Pulau Pinang Granary and IADA Kerian Granary. The irrigation facilities for these are increasingly under pressure to service the Water Supply and the Energy Sector (an Independent Power Producer (IPP) in Kedah). Another is the Perak River basin where the Energy Sector (hydropower) is under pressure to release more of its waters for agriculture (including the IADA Seberang Perak Granary) and water supply needs downstream. The vegetable and flower industry in the Cameron Highlands is indicating severe impacts on the Water Supply and Energy (hydropower) Sectors.

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

The way forward is to implement the IWRM approach. This IWRM approach is in fact in line with the NBOS.

Implementing the IWRM approach as one of the key strategies for the Nexus management. IWRM in Nexus management is also for transboundary water management (as in the NCER and transboundary rivers (e.g. Muda, Kerian, Bernam, Linggi, Muar rivers)) that involves State Governments.

An enabling environment that could be a basis for structuring the IWRM and Nexus management protocol is a common and universally agreed water accounting and audit system for water governance.



Source: RPM Engineers SB

Proposed Institutional Linkages for Public Participation and Communication

(Source: ASM, 2015)

Figure E7: Proposed Institutional Linkages for Public Participation and Communication

KAA 6: Public Participation and Capacity Building

One of the characteristics of a developed nation is a high-level of public participation in local, regional and national water management.

In the 1980s, Water User Groups were formed in irrigation schemes for improved on-farm water management. The Drainage Works Act (1954) has provision for the formation of a Drainage Board comprising government representatives as well as from the private sector.

The need is now to formalise the Water User Group (WUGs) for all Agriculture sub-sectors and form linkages with the Government water management institutions. Advanced countries such as France and Spain have already incorporated laws on the formation of WUGs (Water User Associations (WUAs)). The USA too has WUAs for all sectors of water uses including for lake management.

A proposed formal public participation institutional linkage is shown in Figure E7.

Managing a meaningful and effective public participation requires special capacity building program for the WUGs as well as the system managers. Another area of interest in developing capacity building programs is on the subject of integrity and transparency in AWS.

4. Strategies for AWS

The Approach

Developing strategies for water and agriculture for a developed nation requires an appreciation of models that have been practised successfully, anticipation of problems and issues of the future, a vision for social and economic growth and incorporating opportunities for wealth creation and sustainability even beyond the boundary of agriculture.

The approach here is to review the following:

- Lessons learned and experience gained from the history of irrigation (paddy) and drainage schemes (for non-paddy) development and management (AWS);
- Emerging issues; and
- Vision for the future of water and agriculture.

4.1 Lessons from History of Irrigation and Drainage (AWS)

The systematic approach to Irrigation and Drainage, the traditional term for AWS, began in 1932 with the formation of a dedicated Department, the DID. Over the years until 2004 when the DID was moved to the NRE, the DID consistently provided the AWS necessary to develop and sustain the Agriculture Sector in tandem with National growth aspirations and the meeting challenges along the development phases. The lessons learned in the form of attributes of the AWS over the years from 1932 to 2004 are shown in Table E1. These needs to be seriously considered in formulating future strategies for AWS for the future and are summarised below:

(1) The need for definite and consistent policies and rapid policy responses to meet changing socio-economic situations.

(2) Reliable water resources and water management systems is a key success factor.

(3) The Granary Policy recognises the need for economies of scale for sustainability and continuous economic development. It also provides for more economic and efficient resource management not

only for water but also for other resources management necessary for agriculture production.

(4) Laws, rules and regulations are necessary to protect Government investments, inculcate uniform adoption of good practices and in the long-term could establish an imbedded culture for sustainable development and management even if these are not necessarily enforced in full any more.

(5) A dedicated institution for AWS allows for focus, capacity building and thorough knowledge acquisition over a long-term as well as attracting and retaining talents.

(6) A long-term Institutional and end-user relationship establishes strong professional bonding and mutual respect. Coupled with a good track record for services and system performance, this instils a high sense of confidence for the farmers to be retained and continue production as well as encouraging the private sectors to invest in new business activities.

(7) A long-term existence of a dedicated institutions allow for local STI development. Farmers have also shown capability in STI development given the environment and technical support to accommodate their STI efforts.

(8) Public participation is an important aspect of agriculture water services. The formal platform allows for interaction in decision-making, accommodate a sense of ownership in the system management and long-term confidence building to invest and sustain production.

(9) Systematic and regular capacity building programs for all stakeholders are also important aspects for sustainable water management.

(10) Active and long-term participation in international institutions and programs are important source of knowledge and ideas for addressing global and local issues for sustainable development.

4.2 Emerging Issues

National water security is emerging as a major issue. This needs to be addressed in a concerted manner and transforming the water management approach from sectorial to IWRM is imperative. Agriculture is in the position to support this and especially as it is still the biggest water user and consequently the biggest sector returning used water to the system. Improving agricultural water productivity would significantly contribute to water resources availability and security levels for all other sectors in the WEF Nexus.

However, the concern is that the present capacity of Agriculture with respect to AWS to support those efforts appears to be inadequate compared to other sectors namely the Water Supply and Energy (Hydroelectric) and to ensure the successful transition from Agriculture to Agribusiness and sustaining this.

Agriculture is water dependent and also exposed to water hazards. Thus, climate change impacts could be disastrous to production and therefore the jobs associated with it. At present there appears to be no affirmative action plans particularly by the individual farmers and private agriculture investors to address this issue. This should be one of the major roles of AWS – to prepare and advise the sector on responses to climate change.

4.3 Vision for the Future of Water and Agriculture

The vision for the future of water and agriculture is that a distinct and strong AWS to support the vision for agriculture to be an agribusiness. The AWS shall be at par with water services of the Water Supply and Energy sector.

Table E1: Irrigation and Drainage Development and Management Attributes 1932 – 2004

NO.	STRATEGIES	INSTRUMENTS / ENABLERS	IMPACT
1.	**Policy**	• Poverty Eradication Policy • Food Security Policy • Crop Diversification Policy • Granary Policy • Government responsible for public investment; farmers responsible for on-farm private investment • Federal Government investment for infrastructure • Joint Federal – State financing for systems Operations and Maintenance	• Clear, defined, consistent and long-term policies • Allowed for long-term investments and time for return on investments • Rapid policy response to socio-economic needs • Strategic resource management (Granary Policy) • Provide for economies of scale • Farmers confidence to invest and continue production • Efficient and effective resource management
2.	**Dedicated Institutions for Paddy Irrigation and Agriculture Drainage**	• Formation of the JPS at Federal and State levels to focus on implementing the policies and achieving the objectives • Formation of MADA • Formation of KADA • Formation of National Water Management Training Centre (NWMTC) • Formation of National Hydraulic Research Institute Malaysia (NAHRIM) for large volume agriculture water management • Formation of Integrated Agriculture Development Project (Area) (IADP/IADA) for specific large-scale; water dominant projects (the Granaries; large-scale drainage (e.g. Western Johor Agriculture Development Project))	• Allowed for long-term development of skills and knowledge for continuous improvements • Long-term Federal-State relationship • Focused and specific development programs • Bonding with end-users; manager-farmer confidence building • On-site Integrated and multi-disciplinary approach to agriculture development and management
3.	**Laws, Rules and Regulations**	• Irrigation Areas Act 1953 (Revised 1989) Act 386 and Act 354 • Drainage Works Act 1954 (Revised 1989) • Sabah Enactment No. 15, the Drainage and Irrigation Ordinance 1956	• Protect Government investments • Instil discipline of stakeholders in use of facilities • Allowed for formal platform for Government-Private/Public Sector participation • Provided for a formal Governance structure • Provision for payment and collection of water and water services charges from users • Long-term development of management procedures and processes leading to in-built management culture and self-Governance

4.	Science, Technology and Innovations	• Development of local-based planning, design, construction and management criteria, practices and tools • Rapid adaptation for technical and management adjustments to engineering and socio-economic needs • Encourage local adaptations and innovations including by farmers (direct seeding technology) • Applications and adaptation of modern technology for management and farming	• Irrigation systems designs for paddy in humid tropics • From single to double cropping systems • Rapid systems design and management response to changes • Computer-based irrigation water management systems with telemetric system support, automation and remote control of hydraulic structure • Hydrology and water resources assessment and planning tools • Direct seeding in place of labour-intensive transplanting • Farm mechanization
5.	**Public Participation**	• Stakeholders (farmers) participation and consultation in infrastructure development and system management • Formation of Water User Groups (WUGs) in irrigation schemes • Drainage Boards in gazetted Drainage Areas	• Concensus in irrigation scheduling for water resource management and streamlining other farm input resources management – seed, machinery, fertilizer, pesticide, transport, mills, distribution • Water saving efforts in terms of reducing wastage in use and on-farm infrastructure improvements • Cooperation for efficient irrigation water management and water savings • Instil sense of system ownership and care
6.	**Wealth Creation**	• Increased and stable income for farmers • Mechanisation provided increased off-farm job and income opportunities • Development of new farm-support industries and services (rural jobs and income sources) – services and support services for land preparation, seeding, seed production and broadcasting, fertilizer and pesticide applications, transportation, harvesting • Ready for export of agriculture water services to cooperate with other developing countries in irrigation and drainage development (e.g. Nigeria and other African countries)	• Long-term existence, economies of scale and proven system performance encouraged investments in new business opportunities • Original investments in large-scale agriculture drainage and continuous systems management has allowed for rapid non-agriculture development and economic growth • Skills, knowledge and experience gained can be shared with other developing countries for their wealth creation
7.	**Capacity Building and Enrichment**	• Systematic training programs by NWMTC for managers and farmers at the centre as well as on-site • DID Manual (DID, 1960) (updated 2012) • Hydrological Procedures (DID, 2010) • Planning and Design Procedures Publications • Specific training programs for system planners, designers and managers	• Skills and knowledge have ensured continuous rice production twice-a-year every year over the past 40 years in the Granaries and active non-Granary irrigation schemes
8.	**International Participation and Collaboration**	• International Commission on Irrigation and Drainage (ICID) • International Water Management Institute (IWMI) • FAO • Japan International Cooperation Agency (JICA)	• Long-term active participation has built recognition and respect for local expertise • Continuous exchange of knowledge and skills to address current and future issues. • Higher levels of contribution to local and international knowledge and skills

4.4 The Strategies

The recommended strategies to develop AWS for agribusiness are shown in Table E2.

As a summary and towards affirmative IWRM approaches, the recommended strategies can be summarised as follows:

(1) Enabling Environment:

- *Strategy 1 – Formulate an affirmative AWS policy for agribusiness for all sub-sectors of the Agriculture Sector.*
- *Strategy 2 – Promulgate law, rules and regulations for AWS.*

(2) Institutional Framework:

- *Strategy 3 – Form a dedicated government institution for AWS with adequate capacity to support agribusiness and allow for private sector involvement as AWS Providers.*
- *Strategy 4 – Formalise the formation of agriculture water user groups (for individuals and agribusinesses) with special platforms or forums for interaction with Government and private AWS providers and that these platforms are linked to the Federal and State Water Resource Councils.*
- *Strategy 5 – Replicate the Granary model for all other key production areas and commodities of each of the agriculture sub-sectors.*

(3) Management Instruments:

- *Strategy 6 – Develop agriculture water accounting and auditing tools that is harmonized with other water sectors.*
- *Strategy 7 – Develop WEF Security Nexus and Water Security Management Tools.*

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
A	**Governance**	**Strategy 1**	Form a dedicated Agriculture Water Services Governance Structure	• Individual and commercial agriculture would require a formal Agriculture Water Services Governance system for sustainable water and agriculture development
		Strategy 2	Develop and instal a comprehensive agriculture Water Accounting, Water Auditing and Feedback System	• This is the basis of all efforts for governance, transparency, integrity in efforts to improve sustainable water management • To harmonisation of technical terms and definitions with all other Water Sectors (Water Supply, Sewerage and Environment) for Integrated Water Resources Management • Regular and systematic water services performance assessment is necessary
B	**Policy**	**Strategy 3**	To incorporate Agriculture Water Services Policy in Agriculture Policy and key development plans	• The National Water Resources Policy covers a broad area of sectors, uses and users. A specific policy for the agriculture sector level is still necessary to ensure adequacy of water and water management to meet agriculture needs and development objectives and at the same time instil commitment for water savings and water quality management with IWRM approach for inter-sector harmonization
		Strategy 4	All Agriculture and Agriculture Water Services development shall be based on the principals of Integrated River Basin Management approach	
		Strategy 5	To designate focused production areas and for all sub-sectors (non-paddy food crops, industrial and commodity crops, aquaculture and livestock)	• This is replicating the Granary Policy for paddy production. It allows for focused and efficient resource management and long-term confidence building with agriculture investors and producers for sustainable development and production of specific National agriculture target output • Also in line with the NBOS • To develop non-granary irrigation schemes designated for diversified use

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
		Strategy 6	Develop and apply the WEF Nexus Approach for medium and long-term decision making in relation to Agriculture Water Services and water resources needs for agriculture development	• Long term WEF Nexus management would require negotiation and agreement for water resources trade-offs to balance security levels of the Nexus elements. This trade-offs can be between states, within sector and between sectors e.g. within Agriculture is accommodating aquaculture in Kerian Granary trading off water for rice; Agriculture may need to reduce irrigation areas by accelerating non-Granary areas conversion to other crops to release more water for Water Supply; Energy Sector could reduce output from hydropower dams to release more for Agriculture and Water Supply sectors and substitute energy production from other sources or locations; Agriculture could increase use of grey water and reduce freshwater use that would relief Water Supply needs • To develop small reservoirs to increase agriculture water security • This approach would also allow for possible development of cross-sector financing models for infrastructure investments and management • This approach could also be a tool to resolve transboundary issues (as in the NCER inter-State interests and vis-à-vis National wealth and security interests) • Also in line with the NBOS
		Strategy 7	All STI development for agriculture water services to be towards National ownership of the technology	• Support STI policies for increased water productivity • Wealth creation

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
C	**Laws, Rules and Regulations**	**Strategy 8**	Promulgate an Agriculture Water Services Act	• To ensure focused and high level water services for commercial agriculture • To protect Government investments in agriculture water services infrastructure and ensure long-term commitment to production in line with Government Policies • To instil discipline of end-users to care and protect the system, practice water savings and water quality management through rules and regulations that include penalties for non-compliance • To provide for the need to form Water User Group organisations and platform for end user participation and communication • Should include the review and update of the principles and provisions of the Irrigation Areas Act and the Drainage Works Act. These Acts to be repealed subsequently • To allow and facilitate for PPP financing and management approach for Agriculture Water Services such as provision for Agriculture Water Services Operators similar to that of the Water Supply Services Industry and Energy Services • To consider for the formation of the Agriculture Water Services Commission with allowance for private sector end-user representation • Should provide for the registration of all Farm Investors (Farmers) and Agriculture Services Providers and related rules and regulations for providing the services (e.g. mechanization services, fertiliser and pesticide application services, water management services)

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

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

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

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

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
		Strategy 22	Develop irrigation and drainage planning and design criteria for large-scale agricultural services system for oil palm, rubber, fruits and other food crops, industrial and commodity crops, livestock and aquaculture	• Non-paddy agriculture is mainly rain-fed. For commercial enterprises, water management facilities and services are necessary for increased and stable production (risk management) • On-farm irrigation and drainage system development and installation of new irrigation technology are now on the initiatives of individual investors. There is a need of systematic agricultural services to integrate these individual systems for sustainability
		Strategy 23	Development of Waste-to-Energy plants in the Oil Palm, Rubber and Livestock industry	• Green Technology for Green Growth Economy • For climate change mitigation and adaptation • For higher yields and environmental management • To increase water availability to within agriculture sector and other sectors
		Strategy 24	Development of Zero Discharge technologies for the Oil Palm, Rubber and Livestock industries	
		Strategy 25	Development of Water Recycling Plants in the Paddy Granaries and Rubber Industry	
		Strategy 26	Development of surface water-groundwater conjunctive use of water technologies for agriculture water management	
		Strategy 27	Develop existing Granary irrigation and drainage system network for multi-use to service all sectors and ultimately plan for this as a regional and national water management grid. All new agricultural water services system should also be planned for this	• For efficient use of existing facilities and cost and resource savings for new infrastructures • In line with the National Blue Ocean Strategy • To ensure stability of supply over a wider region
		Strategy 28	Develop planning and design criteria for agriculture area to be part of the local, regional and national integrated flood system	• This is to be a component of the Integrated Flood • Management approach for the country

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
H	**Financing**	**Strategy 29**	Develop and implement PPP financing models for Agricultural Water Infrastructure and Services	• There are already Malaysian financial models in other sectors e.g. the Water Supply Services Industry, Highways, Flood Mitigation, Federal Road Maintenance, Federal Building Maintenance • PPP in Agriculture Water Services models are also in France and certain developing countries • The World Bank has developed principles and frameworks for Governance and risk sharing for PPPs
		Strategy 30	Develop cross-sector Financing Models as part of the WEF Nexus management and multi-use of existing and new infrastructure	• Water savings efforts by the Agriculture Sector are for the benefit of the Water Supply Sector else the Water Supply Sector would have to develop new resources. Thus the cost of improved irrigation system could be finance by the Water Supply Sector • New sectorial infrastructure investments including dams and adjustments to existing infrastructure would need to account or accommodate the needs by other sector water requirements (including flood management) thus the benefiting sectors could also contribute to the financing (e.g. multi-purpose dams) • This is also in line with the NBOS

Table E2: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

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

5. Implementing the Proposed Strategies for AWS

5.1 The Time Frame

The year 2020 is the target for Malaysia to realise the vision to be a developed nation with high-income status. The practical approach would be to target 2030 as the year for full implementation of the AWS proposal. The year 2030 is also the target date for achieving UN post-2015 Sustainable Development Goals and implementing the AWS should be in tandem with this timeline.

5.2 The Plan

The plan within the Rancangan Malaysia Ke11 (RMK-11) time frame would be to focus on the soft aspects of AWS implementation. The main enabling activity would be installing the AWS policy and establishing a dedicated institution for AWS with the existing BPSP as the nucleus but for a more multi-disciplinary organisation. The proposed target is that by 2020, the AWS is ready to be implemented effectively.

5.3 The Stakeholders

The MOA should be the lead stakeholder in establishing the AWS for Agribusiness and supported by the MPIC. All the Departments and Agencies under both the Ministries are stakeholders too and will need to actively participate in this development. In addition, the NRE and Ministry of Energy, Green Tech and Water (KeTTHA) and their respective Departments and Agencies will need to be involved as both are water-related Ministries. As land and water are under the purview of the States, their representation is critical. Completing the representation would be the farmers and agriculture investors as well as from the water industry players.

5.4 The General Program

The general program based on the proposed strategies is shown in Table E3.

6. Conclusions and Recommendations

The capacity of AWS at the Federal and State levels was drastically reduced upon the restructuring of the water-related Ministries in 2004. Yet the vision to transform Agriculture to Agribusiness would require higher levels of water-related risk management than before to encourage and sustain this not only for wealth creation but for food security as well. With water issues becoming more prominent and intricate as the country develops, the Agriculture sector will need to be able to defend its needs but as the same time manage its waters in harmony with other sectors. The approach would have to be based on IWRM for Water Security enhancement and the WEF Nexus management.

The present AWS needs to be strengthened and restructured to be at par with the other major water sectors namely Water Supply and Energy (Hydroelectric). The main strategies include formulation of affirmative agricultural water policies, formation of a dedicated and multi-disciplinary AWS institution under the MOA and increased agriculture end-user participation.

Table E3: General Program for Implementing the AWS Strategies

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
A	**Governance**	**Strategy 1**	Form a dedicated Agriculture Water Services Governance Structure			
		Strategy 2	Develop and instal a comprehensive agriculture Water Accounting, Water Auditing and Feedback System			
B	**Policy**	**Strategy 3**	To incorporate Agriculture Water Services Policy in Agriculture Policy and key development plans			
		Strategy 4	All Agriculture and Agriculture Water Services development shall be based on the principals of Integrated River Basin Management approach			
		Strategy 5	To designate focused production areas and for all sub-sectors (non-paddy food crops, industrial and commodity crops, aquaculture and livestock)			
		Strategy 6	Develop and apply the WEF Nexus Approach for medium and long-term decision making in relation to Agriculture Water Services and water resources needs for agriculture development			
		Strategy 7	All STI development for agriculture water services to be towards National ownership of the technology			
C	**Laws, Rules and Regulations**	**Strategy 8**	Promulgate an Agriculture Water Services Act			

Table E3: General Program for Implementing the AWS Strategies (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
D	**Institution**	**Strategy 9**	Form a dedicated Department for Agriculture Water Services to develop and manage large-scale irrigation and drainage areas for all crops (food, industrial and commodity crops) and, aquaculture and livestock. Able to implement the Governance system			
		Strategy 10	Establish a CoE for Agriculture Water Services for all Crops for applied research on water and agriculture and including training and capacity programs for farmers and managers			
		Strategy 11	Establish WUG Dialogue Platform, Water User-Water Manager Integrated Dialogue Platform and extend this to all areas with Agriculture Water Services and establish formal linkages with the MOA and other Ministries and with State and National Water Resources Councils			
E	**Operations and Maintenance Service Levels and Performance Assessments**	**Strategy 12**	Develop Operations and Maintenance system based on service level delivery for end-users that include measurement indicators for cost of service with a view of remuneration for water services in the future			
F	**Data and Information**	**Strategy 13**	Integrate data and information collection and sharing system with all other Water Sector managers and end-users			
G	**STI**	**Strategy 14**	Develop agriculture water accounting, water auditing and performance feedback tools and systems			

Table E3: General Program for Implementing the AWS Strategies (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 15	Develop agriculture water development and management sustainability tools			
		Strategy 16	Develop advance software for agriculture water services planning, design and management tools			
		Strategy 17	Develop and instal water quantity and quality measurement and control devices for all sub-sectors of agriculture			
		Strategy 18	Develop WEF Nexus assessment tools			
		Strategy 19	Develop Water Footprint Tools for all agricultural sectors to support the WEF Nexus Assessment tools			
		Strategy 20	Redesign existing and new Granary Irrigation Systems and components to strengthen the gravity system and to incorporate climate change adaptation needs			
		Strategy 21	Develop planning and design criteria for non-paddy crops, livestock and aquaculture to increase yields, stabilise production, flood resilience and sustainable development			
		Strategy 22	Develop irrigation and drainage planning and design criteria for large-scale agricultural services system for oil palm, rubber, fruits and other food crops, industrial and commodity crops, livestock and aquaculture			

Table E3: General Program for Implementing the AWS Strategies (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 23	Development of Waste-to-Energy plants in the Oil Palm, Rubber and Livestock industry			
		Strategy 24	Development of Zero Discharge technologies for the Oil Palm, Rubber and Livestock industries			
		Strategy 25	Development of Water Recycling Plants in the Paddy Granaries and Rubber Industry			
		Strategy 26	Development of surface water-groundwater conjunctive use of water technologies for agriculture water management			
		Strategy 27	Develop existing Granary irrigation and drainage system network for multi-use to service all sectors and ultimately plan for this as a regional and national water management grid. All new agricultural water services system should also be planned for this			
		Strategy 28	Develop planning and design criteria for agriculture area to be part of the local, regional and national integrated flood system			
H	**Financing**	**Strategy 29**	Develop and implement PPP financing models for Agricultural Water Infrastructure and Services			
		Strategy 30	Develop cross-sector Financing Models as part of the WEF Nexus management and multi-use of existing and new infrastructure			
I	**Wealth Creation**	**Strategy 31**	Facilitate WUG to increase non-farm income sources within and outside of the Agriculture Water Service Areas			

Table E3: General Program for Implementing the AWS Strategies (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 32	Identify and encourage the development of Agriculture Water Services Providers industry and new business opportunities			
		Strategy 33	Export Agriculture Water Services industry to cooperate with countries still in the development stages of large-scale irrigation and drainage system for paddy and other non-paddy agriculture activities			
J	**Public Participation**	**Strategy 34**	Encourage the formation of WUG in Agriculture Water Services Areas with formal linkages to Policy Makers and Water Managers			
		Strategy 35	Planned handover of tertiary systems operations and management to WUGs			
K	**Capacity Building**	**Strategy 36**	Develop comprehensive capacity building programs for agriculture water managers and agriculture water services providers			
		Strategy 37	Develop comprehensive capacity building programs for WUG and Service Providers related or have impact on agriculture water management			
L	**International Participation and Collaboration**	**Strategy 38**	Long-term membership and active participation in Internationally renowned organisations			

CHAPTER 1:
THE NEED FOR AGRICULTURAL WATER SERVICES

CHAPTER 1: THE NEED FOR AGRICULTURAL WATER SERVICES

1.1 Introduction

Developing countries in the Asia Pacific region are at various stages of economic transition towards becoming a developed nation. Malaysia is one of the fastest economies in transit amongst these. From a largely agriculture-based economy, the country has transited tremendously into one with very diversified economy; particularly rapid over the last 35 years since the 1980s. The aim is that by 2020, Malaysia would be a developed and high-income status country.

One major characteristics of a transiting economy is that the contribution of agriculture to the National GDP declines in tandem with the increasingly diversified economy. For Malaysia, this is projected to decline to 7.8% in 2020 (Table 1), and to only to 4.0% in 2050 (GoM (e), 2012).

Table 1: Percentage (%) Contribution to Gross Domestic Product (GDP) by Economic Activity, 2010-2020

Sector	Based on 2010 prices							Average Annual Growth Rate, %	
	Actual (%)					Estimate (%)	Target (%)	Estimate Tenth Plan	Target Eleventh Plan
	2010	2011	2012	2013	2014	2015	2020	2011- 2015	2016 - 2020
Agriculture	10.1	10.2	9.8	9.5	9.2	8.8	7.8	2.4	3.5
Mining and Quarrying	10.9	9.9	9.5	9.2	9.0	8.8	7.1	0.9	1.3
Manufacturing	23.4	23.5	23.2	23.0	23.0	23.0	22.1	4.8	5.1
Construction	3.4	3.4	3.8	4.1	4.3	4.5	5.5	11.1	10.3
Services	51.2	52.0	52.5	53.2	53.5	53.8	56.5	6.3	6.9
Plus: Import Duties	0.9	1.0	1.1	1.1	1.2	1.2	1.0	10.1	1.4
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0	100.0	100.0	5.3	5.6

(Source: EPU, 2015)

However, Governments of many developing Asian countries still need to recognise the importance of sustaining the agriculture sector in their respective transiting economies for food security as well as for social and economic development. Moreover, experience from the Asian Financial Crisis of 1999 has proven the resilience of agriculture compared to other economic sectors under such severe economic stress.

In absolute terms, the agriculture contribution to the GDP in Malaysia is still significant with projected increase from RM 93 billion in 2015 to RM 110 billion in 2020 (EPU, 2015), and with a target growth of 3.5% between 2016 and 2020 under the Eleventh Malaysia Development Plan (Table 2). The ETP (PEMANDU, 2010) also recognises Agriculture (based on eight sub-sectors with high growth potential) as one of the twelve NKEAs.

Table 2: Gross Domestic Product by Economic Activity, 2010-2020

	RM million, in 2010 prices							Average Annual Growth Rate, %	
	Actual					Estimate	Target	Estimate Tenth Plan	Target Eleventh Plan
Sector	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2011-2015**	**2016 - 2020**
Agriculture	82,882	88,555	89,406	91,097	92,979	93,184	110,707	*2.4*	*3.5*
Mining and Quarrying	89,793	85,373	86,751	87,789	90,645	93,673	100,024	*0.9*	*1.3*
Manufacturing	192,493	202,960	211,921	219,216	232,868	243,895	312,479	*4.8*	*5.1*
Construction	28,213	29,524	34,880	38,646	43,190	47,704	78,022	*11.1*	*10.3*
Services	420,382	449,854	479,300	507,935	541,185	571,835	796,722	*6.3*	*6.9*
Plus : Import Duties	7,672	8,654	10,004	10,577	11,639	12,425	13,351	*10.1*	*1.4*
Gross Domestic Product	**821,434**	**864,920**	**912,261**	**955,260**	**1,012,506**	**1,062,715**	**1,411,305**	**5.3**	**5.6**

Notes: Based on GDP in 2010 prices
Numbers may not necessarily add up due to rounding

(Source: EPU, 2015)

The 16 EPPs and 11 BOs under this Agriculture NKEA (Table 3) is expected to deliver an incremental GNI impact of RM 28.9 billion and 74,600 additional jobs by 2020. Oil palm, an important sector of Agriculture, is also recognised as an NKEA and its eight EPPs (Table 4) and three BOs is expected to provide an incremental GNI impact of RM 125.3 billion and generating additional 41,600 jobs in 2020.

The ETP aims to increase the GNI from RM 23,000 per capita in 2009 to RM 48,000 per capita by 2020. This is to be achieved through higher productivity and through the creation of high-value job opportunities. This programme also emphasises on "inclusivity" and therefore, those involved in agriculture production should not be straggling economically compared to other sectors.

The "inclusivity" is an important point for agriculture sector development sustainability in a developed and high-income nation. This implies that agriculture development should now be transformed from the general notion that "agriculture is a poor man's occupation" to one that is "an attractive and rewarding occupation and an industry comparable to all other sectors" in a developed nation. In fact, this is reflected by the theme of the MOA policy that "Agriculture is Business" and the approach under the ETP as "Transitioning from Agriculture to Agribusiness".

These themes are not only for agriculture sub-sectors under the ETP. The ETP is a special program to accelerate the economic transformation program. It is based on NKEAs. Instead, the themes are applicable for all crops as indicated in the NAP 2010-2020 under the MOA and for all plantation industry and commodity crops such as rubber, cocoa, pepper and kenaf under the respective policies of the MPIC.

One of the critical success factors in achieving those aspirations is adequate water. Agriculture, and therefore the jobs in this sector, is highly water-dependent.

Table 3: Agriculture EPPs

EPP No.	Title	Project Owner	GNI Impact (RM Billion)	Jobs Created
1	**High Value Herbal Products**	MOA – HDO/ ITTP	2.21	2,000
2	**Edible-Nest (EBN) Swiftlet Farming**	DVS	4.54	20,800
3	**Seaweed Industry**	DOF	1.41	13,000
4	**Integrated Cage Farming (i-CAGE)**	DOF	1.38	10,100
5	**Further Integration in Oil Palm**	DVS	0.15	3,600
6	**Replication of Integrated Zone for Aquaculture (IZAQ)**	DOF	1.27	12,000
7	**Premium Market for Fruits and Vegetables**	DOA	1.57	9,100
8	**Food Park**	MOA – IAT	0.88	5,000
9	**Fragrant Rice Variety**	MOA – IPB/ MARDI	0.22	4,998
10	**Strengthen Productivity of Paddy Farming in MADA**	MOA – IPB/ MADA	1.03	14,900
11	**Strengthen Productivity of Paddy Farming in Other Granaries**	MOA – IPB/ MOMA	1.37	9,600
12	**Expansion of Feedlotting**	DVS	0.18	2,000
13	**Dairy Cluster**	DVS	0.33	800
14	**Seed Industry Development**	MOA – KSI/ MARDI	0.47	5,400
15	**Participations of Multinational Corporation (MNC) in Agriculture Biotechnology *(Transfer to MOSTII March 2012)***	MOSTI	0.82	1,200
16	**Overseas Joint-Venture (JV)/Acquisition**	DVS	0.12	Nil
17	**Developing Pasar Komuniti and Karavan (PAKAR)**	MOA – KSI/ FAMA	0.53	35,360
	TOTAL		**18.49**	**149,858**

(Source: Azhar Mohd Isa, 2013)

Table 4: Oil Palm EPPs

EPP No.	Title	Project Owner	GNI Impact (USD Billion)	Jobs Created
1	Accelerate Replanting of Old Palms	MPIC / MPOB	1.53	Nil
2	Improve Fresh Fruit Bunches (FFB) Yield	MPIC / MPOB	3.40	1,600
3	Improving Worker Productivity	MPIC / MPOB	0.57	28,000
4	Increasing The Oil Extraction Rate	MPIC / MPOB	4.57	10,000
5	Developing Biogas At Palm Oil Mills	MPIC / MPOB	0.97	2,000
6	Developing Oleo Derivatives	MPIC / MPOB	1.93	5,900
7	Commercialising Second Generation Biofuels	MPIC / MPOB	1.10	1,000
8	Food & Health Based Downstream Products	MPIC / MPOB	1.63	74,900
	TOTAL		**15.7**	**123,400**

(Source: Vijaya Subramaniam, 2013)

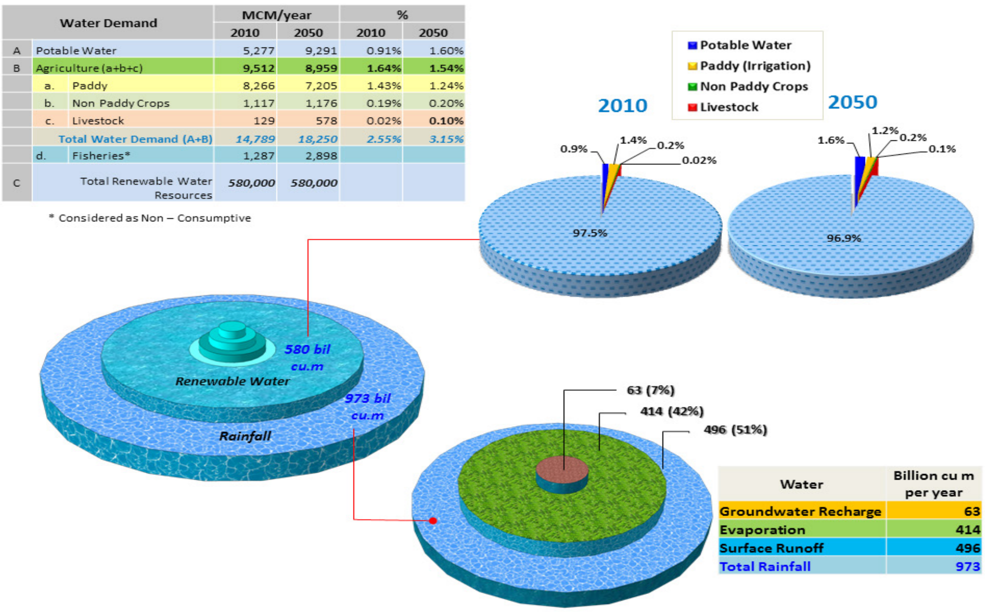
State	State Area (Km²)
Perlis	821
Kedah	9,500
P.Pinang	1,048
Perak	21,035
WP Kuala Lumpur	243
WP Putrajaya	49
Selangor	8,396
Negeri Sembilan	6,686
Melaka	1,664
Johor	19,210
Pahang	36,137
Terengganu	13,035
Kelantan	15,099
Peninsular Malaysia	**132,923**
Sabah	73,631
Sarawak	124,450
FT Labuan	91
East Malaysia	**198,172**
Malaysia	**331,095**

No.	Information		Unit	Peninsular Malaysia	Sabah	Sarawak	Total Malaysia
1	**Area**		**km²**	**132,923**	**73,631**	**124,450**	**331,095**
2	**Population (2015)**		**million**	**25.3**	**3.6**	**2.9**	**31.8**
3	**Hydrology:**						
	3.1	*Rainfall*	mm	2,496	2,560	3,640	2,940
	3.2	*Actual Evaporation*	mm	1,284	1,190	1,250	1,250
	3.3	*Groundwater Recharge*	mm	148	190	240	192
	3.4	*Surface Runoff*	mm	1,064	1,180	2,150	1,499
4	**Flood Prone Area**		**km²**				**29,799**
	4.1	*Urban*		*464*	*93*	*249*	*806*
	4.2	*Agriculture*		*7,576*	*944*	*3,772*	*12,293*
	4.3	*Forest*		*3,728*	*899*	*473*	*5,100*
	4.4	*Others*		*3,852*	*1,348*	*6,401*	*11,601*

(Source: GoM (e), 2012)

Figure 1: Malaysia Hydrology Information

Malaysia (Figure 1) with an average annual rainfall of 2,940 mm yielding an estimated renewable water resource of 580 billion cu.m is relatively "water-rich" compared to many other countries in the world. However, often overlooked is that for this "water-richness", the country is blessed with a wealth in biodiversity. The present water use for human activity (principally for Water Supply and Agriculture) is only 2.55% of the renewable water resources in 2010 (Figure 2). The percentage may seem small but any increase could mean a reduction in available water resources to sustain the present wealth in biodiversity.



Water Demand			MCM/year 2010	MCM/year 2050	% 2010	% 2050
A	Potable Water		5,277	9,291	0.91%	1.60%
B	Agriculture (a+b+c)		9,512	8,959	1.64%	1.54%
	a.	Paddy	8,266	7,205	1.43%	1.24%
	b.	Non Paddy Crops	1,117	1,176	0.19%	0.20%
	c.	Livestock	129	578	0.02%	0.10%
	Total Water Demand (A+B)		14,789	18,250	2.55%	3.15%
	d.	Fisheries*	1,287	2,898		
C	Total Renewable Water Resources		580,000	580,000		

* Considered as Non – Consumptive

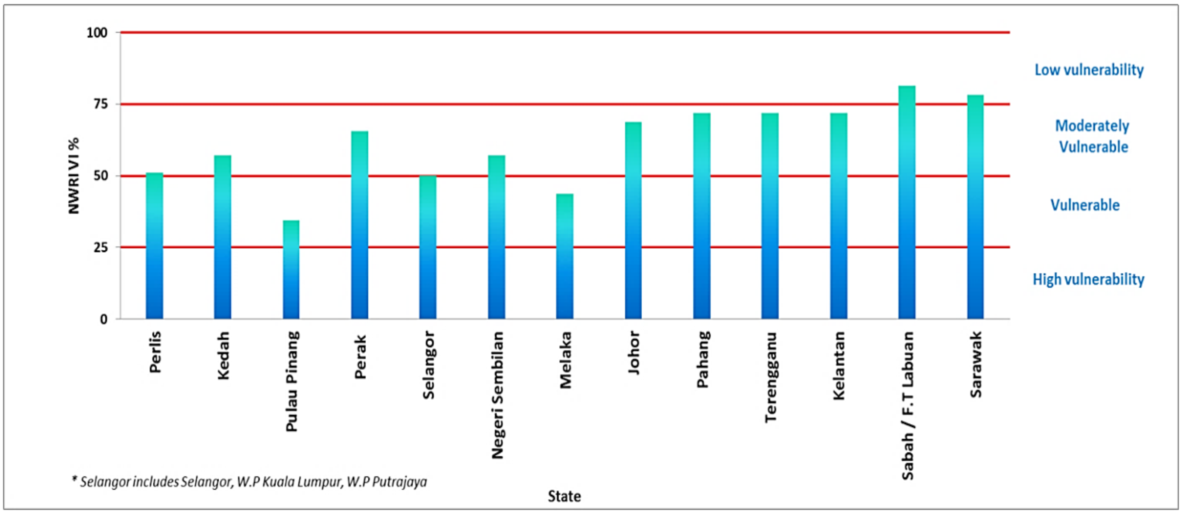
Water	Billion cu m per year
Groundwater Recharge	63
Evaporation	414
Surface Runoff	496
Total Rainfall	973

(Source: GoM (e), 2012)

Figure 2: Water Resources and Water Demands

In fact, the percentage is projected to increase to 3.15% by 2050 due to increasing demands of a growing population (projected to increase from 32 million in 2015 to 42 million in 2050), and a rapidly expanding economy.

However, the available water resource necessary to support the growth (both in terms of quantity and quality) in Malaysia is on a declining trend. Five of the States (all in the Peninsular) are already in deficit and the others are trending downwards. The NWRVI (reflecting the water quality status) indicates that all States in the Peninsular are already in the Moderately Vulnerable Category of which four are already in the Vulnerable Category. Only Sabah and Sarawak are still in the Low Vulnerability Category but only just (Figure 3). This situation could be exacerbated by climate change impacts.



(Source: GoM (e), 2012)

Figure 3: NWRVI by States

For the agricultural development aspirations and the water resources situations above, it is of concern that, unlike the Water Supply and Energy (Hydroelectric) sectors, there is no affirmative policy and strategy for Agriculture water management in the key national development policies and plans. The NAP 2010-2020 is silent on agricultural water management. The Eleventh Malaysia Development Plan (RMK11) has no distinctive plan, unlike the Water Supply and Energy sectors, on agricultural water development and the ETP does not recognise water development and services as an NKEA, but only implies them as necessary to support the programmes and project. The NWRP was introduced in 2012 but this is not specifically addressed to the sectorial needs of agriculture.

Yet, agriculture will continue to be a significant social and economic component even when Malaysia realises the ambition to be a developed and high-income status nation. Equally important is that, as the biggest sectorial water user and well as returning its used water back to the system, managing agriculture water would be a critical factor in the overall national water resources management.

An extensive and intensive diversified economy has another challenging characteristic. This is the issue of water security and impact on water resources demand and availability in terms of both water quantity and water quality for development sustainability for all sectors. The threat on sustaining agriculture would be the increasing pressures for its present and future water resources allocations to be diverted away to other sectors from what was a priority for agriculture needs.

The purpose of this report is to emphasise the importance of water and agriculture. It is also to urge the need for distinct agriculture water policies and strategies. This is in particular for Agricultural Water Services to ensure water adequacy and productivity for the Agriculture sector as well as for a harmonised national water resources management with all other sectors. It is also for water, energy and food security management and ultimately, for sustainable development and wealth creation.

1.2 Defining Agriculture Water Services

AWS in Malaysia is widely known as “Irrigation and Drainage services” for historical reasons.

It is prudent to recall that the introduction of a systematic approach to AWS in Malaysia was in fact due to the policies on food security and rural poverty eradication introduced in the early 1930s. These policies were introduced in response to frequent and at times severe food shortages incidences and widespread extreme poverty in the rural areas in the late 1920s. To achieve those policy objectives, the systematic approach to AWS was introduced as one of the significant strategies to implement these policies. This was the most appropriate strategy then as agriculture was the main economy and occupation, and increases in agriculture produce and production stability would directly increase and stabilise income.

Providing the AWS was through the formation of a dedicated department, the DID in 1932, to plan, develop, and manage agricultural drainage schemes and paddy irrigation schemes. Over the years and by the 1990s, the DID under the MOA developed and provided a wide range of AWS activities covering agricultural land reclamation, agriculture drainage, irrigation, water resources development, river management, coastal protection works and flood management for the Agriculture Sector. Completing the spectrum of AWS are operations and maintenance of the systems, hydrological data and information services, applied research and capacity building for system managers and farmers.

The AWS policy has always been for the Government to provide for infrastructure and services that were beyond the capacity of the farmers or in situations that require intervention for a balanced and harmonious water management at local and regional levels. This is in the form of providing infrastructure for managing large volumes of water on an extensive scale. Farmers remain responsible for on-farm water management and support for this is provided as part of the agriculture extension services by the DOA.

In the present, socio-economic environment context AWS would be specifically for agriculture sector just as Water Supply Services and Energy Services are for their respective sectors. The role of the Government in AWS would continue to be in infrastructure development, system management and manager-end user capacity building but with provisions for private sector involvement as AWS providers similar to Water Supply Operators and Energy Service Providers. This would also require the Government to instal and lead the Governance structure for AWS. Common services needs by all sectors such as water resources management, river management, hydrological services, coastal protection works and flood management would be by the DID under the NRE.

In general, AWS could be defined as *“managing large volumes of water with the provision of agriculture water supply and drainage facilities in agricultural schemes and subsequently to operate, maintain and manage the systems for all types crops, livestock and aquaculture produced by individuals and business entities to ensure reliable and sustainable water management for the upstream production side in the overall agricultural production chain and in harmony with other water sectors”.*

1.3 Review of Current Status and Needs Assessment

The Agriculture Sector had the privilege of a wide and full spectrum of AWS for over 70 years until the 2004 restructuring of water management related Government organisations that saw the move of the DID and NAHRIM from the MOA to the NRE. The net impacts in the succeeding years are concerns on the gaps and capacities of AWS for the Agriculture Sector. These include drastic staffing capacity reduction (at Federal and State levels) for planning, design and systems operations and maintenance, draw out of training facilities and capacity building programmes for system managers and farmers, and draw out of facilities for applied research in large volume agriculture water management. The gradual erosion of knowledge, skills and experience due to non-permanent staffing arrangements (seconded staffs from DID) at the Irrigation and Agricultural Drainage Division (responsible for AWS) is also of concern.

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

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

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

Transiting from "Agriculture to Agribusiness" requires, amongst others, the need to transform the present levels agriculture water infrastructure and management approach to fit the characteristics and needs of the business. It also requires the change in mind set of farmers, particularly the smallholders and agricultural landowners, as well as system managers that business is:

(1) for returns on investments more than for individual income;
(2) to know and accept risks on investments and that these need to be managed;
(3) to share that responsibility of risk management between the Government and the investor;
(4) about professional approaches to production;
(5) about receiving performance based service levels; and
(6) to appreciate that there are associated costs to agriculture water services as with other costs of services and inputs.

Agribusiness is the next progression level of agriculture to transform agriculture from merely income generation to wealth creation. In that progression however, the role of agriculture for maintaining food security remains consistent and will continue into the future. Sustaining agribusiness to achieve both wealth and food security is a complex challenge just as when it was throughout the years of agricultural progression. For example, the agribusiness approach to production would tend to favour commercially high value crops at the expense of lower commercial value crop but for high food security levels (e.g. rice). Nonetheless, Malaysia has a long experience in managing such conflicting situations in agriculture in the past and lessons learned can form the foundation for supporting the transition from agriculture to agribusiness. One of these is the need for long-term reliable agriculture water services. This need is best explained by illustrating the achievements of agriculture sustainability and progression through the provision of agriculture water services since the early days of development.

Food security and poverty issues in the late 1920s were the drivers for establishing a systematic approach to provide nationwide large-scale agriculture water services in the country by the Government. The response was to introduce policies to alleviate poverty and to increase national food (particularly rice) security levels.

With agriculture as the country's main economic base then, one of the strategies to implement these policies was to develop, expand and intensify the agriculture sector. The other was to provide drainage and irrigation facilities and water management services for agriculture. These were necessary as farming was then mainly for subsistence, highly dependent on rainfall and therefore the success and consistency of farm production subjected to the vagaries of weather.

The achievements of the Agriculture Sector in Malaysia since the 1930s and supported by the full spectrum of agriculture water services are truly inspiring. Agriculture augmented by reliable drainage and irrigation systems contributed tremendously towards achieving the policy objectives of poverty eradication in the rural areas particularly over 50 years between the 1930s and 1980s when agriculture was the main source of occupation and income.

Reliable and long-term performance of agriculture water services have not only increased yields, stabilised production and income, but have also gained the confidence of farmers and producers to continue planting and support national development objectives in a diversified economy. The oil palm industry for example has developed into a premier agriculture industry contributing RM 80.41 billion annually to the national economy. For food security, the paddy production industry has, consistently over the past 35 years, successfully delivered beyond the 70% Self-Sufficiency Level policy target. Overall, the agriculture facilities and services including agriculture water services has led to achieving comfortable Self-Sufficiency Levels for a wide range of food produce for the nation.

Beyond income and production, the confidence in agriculture water services is also reflected in the continuous development and investments by the private sector in new agriculture businesses and services opportunities. The MADA Granary provides one good example. It is the premier paddy production area for the nation covering an area of 96,558 ha and contributing 50% to the total production of all the Granaries and 37% of national production. Its main feature is an extensive network of irrigation and drainage infrastructure and agriculture water services to support the farmers. Over the past 50 years, the systems reliability and service levels have managed to build not only farmers confidence to continue planting a crop for food security, but have also been able to create an environment that encourages the development and private sector investments in new business opportunities related to the paddy industry. Of prominence is the development of the service provider industry for land preparation, harvesting and farm input and output transportation. This has transformed the farmers from labouring to “toil the soil” to being farm managers instead.

Similar transformation and new business development have occurred in other agricultural areas as well such as in the drainage schemes along the coastal plains of the country.

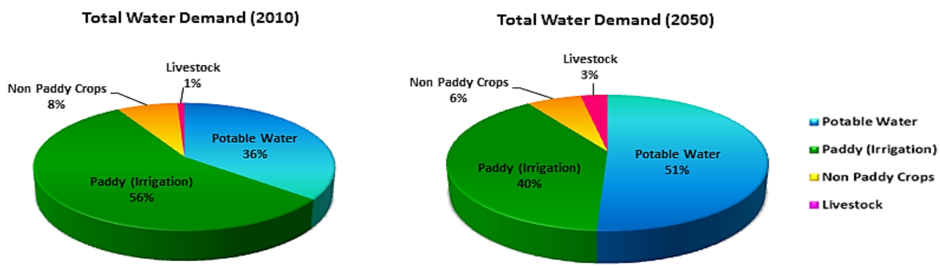
Thus, as in all business sectors, the success of agribusiness to develop and sustain is highly dependent on a conducive environment for investments. There are many inter-related factors and reliable long-term agriculture water services is one of the most important components for mitigating risks and building confidence for agribusiness investments and its sustainability. The only difference now is that the services too will have to be transformed in tandem to match the expectations of the agribusiness as well as meet the objectives of water, energy and security for the country.

Agriculture is one of the water sensitive industries both in terms of water needs (irrigation) and drainage. As an agribusiness then, water management needs is one of the highest risk management factors to ensure returns on investments and sustainability in agriculture. Thus, a high AWS level would be a prerequisite. Delivering AWS requires a team with in-depth knowledge and skills in the science and engineering of surface and subsurface hydraulics and hydrology as well as the soil-plant-water continuum. These need to be coupled with the fine art of managing within sector and inter-sector system managers and end-users.

At the local, regional and even national levels, AWS would be an important component for the total water resources security management of the country for the future. Agriculture is the biggest water user accounting for 64.3% of the total water demands for human activity. Of this, 55.9% is for paddy irrigation that is still returning low water productivity (Figure 4). With water demand management, the potential for water savings here is estimated to be 1,067 MCM or 2,927 MLD, a substantial relief for the Water Supply Sector (Table 5).

Water Demand		MCM/year		%	
		2010	2050	2010	2050
A	Potable Water	5,277	9,291	35.7	50.9
B	Agriculture (a+b+c)	**9,512**	**8,959**	**64.3**	**49.1**
	a. Paddy (Irrigation)	8,266	7,205	55.9	39.5
	b. Non Paddy Crops	1,117	1,176	7.6	6.4
	c. Livestock	129	578	0.9	3.2
	Total Water Demand (A+B)	***14,789***	***18,250***	***100.0***	***100.0***
	d. Fisheries*	1,287	2,898		

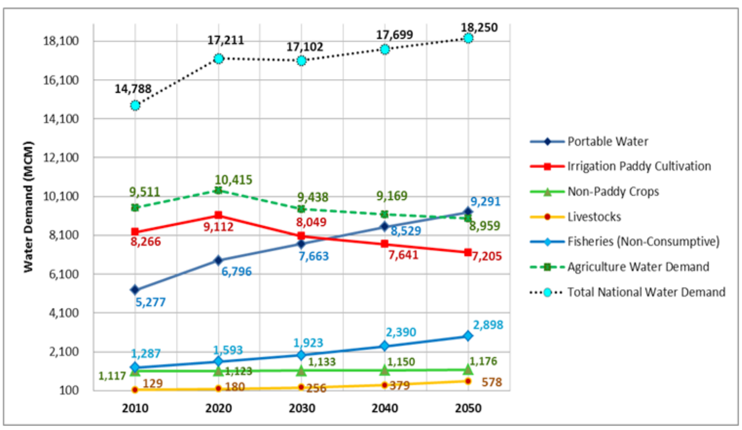
** Considered as Non-Consumptive Demand*



(Source: GoM (e), 2012)

Figure 4(a): Water Demand 2010 - 2050

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



Water Demand by Sectors

(Source: GoM (e), 2012)

Figure 4(b): Water Demand by Sectors

Table 5: Potential Irrigation Water Savings in the Granaries

No	Granary	River Basin Management Unit (RBMU)	Area (ha)	Present Efficiency %	Irrigation Water Use (MCM/ year)	Target Efficiency (%)	Target Irrigation Water Use (MCM/year)	Irrigation Demand Reduction (Savings) (MCM/year)	Equivalent (MLD)	Notes
Matured 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. Sungai 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**	

(Source: ASM, 2015)

Notes:

1. *Figures on water use reduction are potentials only.*
2. *Calculation based on MADA Granary Data*
3. *"Efficiency" refers to canal delivery efficiency and therefore not the total effectiveness (water productivity) of water use.*
4. *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.*
5. *Present efficiency are estimates and derived from selected Performance Evaluation Studies ([MOA, FAO, MANCID (2013)]*
6. *The four (4) new granaries are still at development stage and 50% efficiency assumed at start.*

Comparatively, water demand for non-paddy agriculture (non-paddy crops, livestock and fishery) is relatively small but is projected to increase by 84% between 2010 and 2050. However, when these are consolidated in a large contiguous area, the impact on water resources as well as the industry's sustainability can be significant as in the case of the vegetable and flower industry in the Cameron Highlands. Traditionally rain-fed crops too may turn to irrigation for yield increases. Oil palm, for instance, has the potential to increase yields from 19 tons/ha up to 32 to 62 tons/ha with irrigation (Table 6). Modern aquaculture too is increasingly developing as a "water consumptive" industry.

Table 6(a): 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 & water)	**60**
India (irrigated)	**32**
India (non-irrigated)	**8**

(Source: Yusof Basiron, 2014)

Table 6(b): Positive Yield Response to Irrigation

EXPERIMENT DETAILS	RESULTS REPORTED	*REFERENCE*
Drip or furrow irrigation of oil palms (non-effluent)	30% yield increase from irrigation & mulching	*Chan K.W et al (1985)*
Flatbed irrigation on oil palm (non-effluent)	11% yield increase with irrigation	*Lee C.T et al (2011)*
Furrow application of rubber effluent on oil palm	4-40% yield increase with irrigation	*Mohd Nazeeb et al (1983)*

(Source: Yusof Basiron, 2014)

Whilst floods would be under the purview of DID, scheme level drainage and water table management would still have the responsibility of the Agriculture sector and therefore part of the AWS role.

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

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

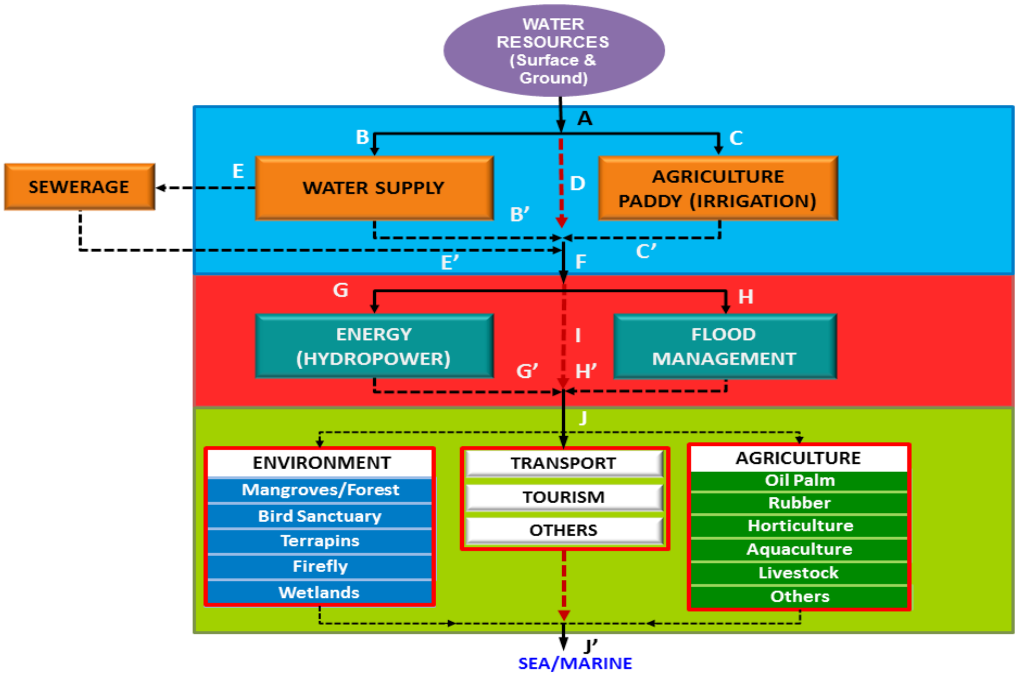
Overall, a strong and formal AWS institutional structure is necessary to ensure the development and sustainability of agriculture as a business as well as for national food security. At the same time, AWS will need to interact harmoniously with all other water sectors for national water security.

1.4 The Integrated Water Resources Management Approach for AWS

Water resources and water development has always been sectorial and is now well entrenched in this country. There are a number of reasons for this. One is the different needs of sectors namely agriculture, energy, water supply and floods in terms of the timing of development phases and needs and the locality of these needs. The other is that the land and water availability far exceeded the demand when the country was at early development phase.

The development and management of water facilities were assigned to the respective sectorial organisations and institutions established by the Government, each with its own mandate to ensure the success of its own sector. At development stage, the objective was to provide the quantity and accessibility to end-users. This is usually referred to as Supply Management. The main characteristics of Supply Development are water resources development (e.g. dams, barrages, water treatment plants) and instalation of water delivery and distribution infrastructures.

At development stages, the sectorial boundaries of influence on each other were far apart, not infringing and with little impact on land and water resources. The focus was also on quantity for use more than the quantity and quality of water returned to the system. There was also low consideration on inter-sector needs and water needs of the environment have been almost completely overlooked (Figure 5).



(Source: ASM, 2015)

Figure 5: Sectorial Water Connectivity

As the country develops, the sectorial development intensities increased, their boundaries expanded and subsequently began to infringe on each other. The consequences now include increasing pressures on each sector to source for common resources namely land and water to further intensify their facilities to meet their respective sectorial increasing demands. This is becoming more challenging. Land and water resources are increasingly limited and present development plans are constraint by social and environmental factors. This situation is gradually increasing pressures on sectors to impose upon each other's existing resources. Defending individual boundaries is almost an instinctive reaction by sectorial institutions.

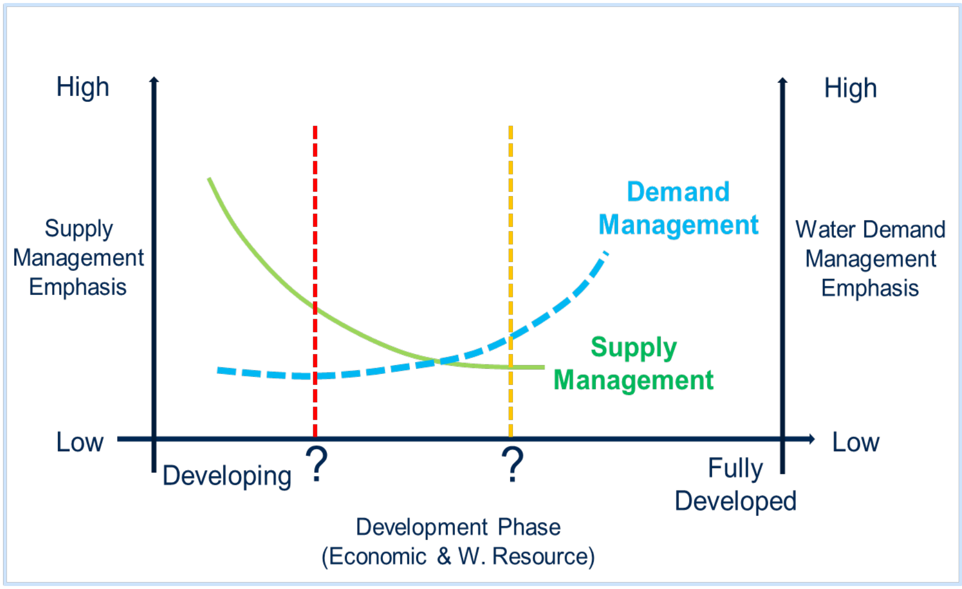
However, the increasing pressure has already caused some of the sectorial boundaries to be breached. The Kerian Granary irrigation system that was almost exclusively instaled for the paddy sub-sector of the Agriculture for example, has now increasingly serve the Water Supply Sector, the Tourism Sector as well as for aquaculture. Similar situation has also occurred in the MADA Granary that now also serves the Water Supply and Energy (an IPP plant) sectors.

Such pressures are typical of countries rapidly progressing toward developed status. The need is now for a systematic approach to water resources management for the sustainable sector development. This is the transformation from the Sectorial Approach to the IWRM (Box 1). Within this is the need to shift from emphasis on Supply Management to WDM (Figure 6).

IWRM

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

(Source: GWP,2010)



(Source: ASM, 2015)

Figure 6: Transiting from Supply to WDM

The Agriculture Sector has already acquired a long experience and knowledge in IWRM approach and practices for its water resources development and water services. Agriculture development and management has always been on a consultative and participative approach between institutions (JPS, DOA, DVS, DOF, Lembaga Pertubuhan Peladang (LPP), MPIC/MPOB) involving not only multi-disciplines but also the end-user i.e. the farmers. The Drainage Works Act (1954) has provision for the formation of a Drainage Board comprising Government representatives as well as the private sector. Implementing the Irrigation Areas Act (1953) requires system manager-end user consensus before gazetting irrigation schedules every season.

The IWRM approach is also reflected on the ground by institutions such as MADA, KADA and the IADAs for paddy and non-paddy crops with all of them integrating the various service and professional components under a single dedicated organisation. Since the 1980s, Water User Groups comprising farmers were formed. This is in recognition that the success of water demand management is highly dependent on their support and active participation at planning, design, construction, capacity building and on-farm water management in harmony with systems water management.

Beyond the sector, the breach of agriculture water boundaries by other sectors as in the MADA Granary and the Kerian Granary should be accepted positively as an affirmative response of this sector for IWRM approach with other sectors.

The IWRM approach is in fact encouraged by the NBOS introduced in 2009 (refer Box 2) for sharing of resources for development.

What Is NBOS

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

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

NBOS
STRATEGI LAUTAN BIRU KEBANGSAAN

The Malaysian National Development Strategy (MyNDS)

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

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

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

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

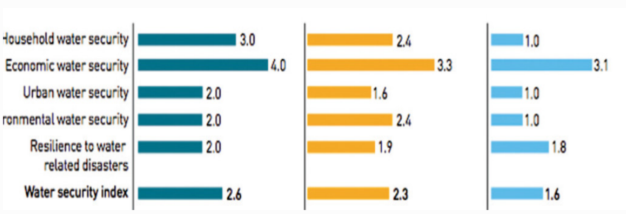
(Source: www.nbos.gov.my)

BOX 2: NBOS

Overall, developing the AWS for Agribusiness should be based on the IWRM approach and principles. This is needed to ensure agriculture water security (Box 3) for wealth and prosperity of Agribusiness. This is also for agriculture to be equally responsible with other sectors in ensuring National Water Resources Security (Box 4) that is one of the fundamentals for WEF securities for sustainable development of a nation.

Water Security Index In Asia

Asian Development Bank (ADB) latest study on water security in the region (ADB, 2013) revealed that all sub-regions in Asia-Pacific are contending with various degrees of water security concerns. Agriculture of course, with its prominent water withdrawal ratios in the region (of up to 90% in some countries), is a major determinant of the overall economic water security, though most of the major increases in water demand are expected to occur in the industrial and domestic sectors. In particular, China has to date achieved a higher degree of water productivity; whereas India's agriculture water withdrawals still continue to rise. With water use increasing in the other sectors, the ADB study underscores how it becomes ever more critical to improve agricultural water management because of its larger share in the overall water management landscape.

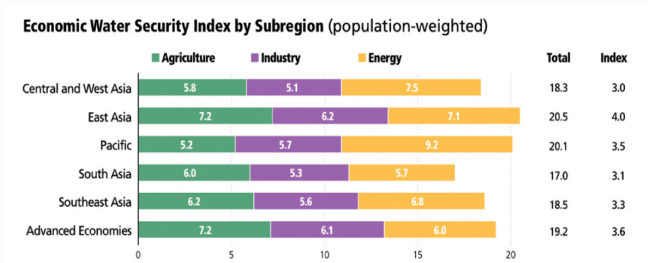


(Source: ADB 2013a,cited in FAO 2014a, cited in Thierry Facon and Marisha Wojciechowska, 2015)

BOX 3: Water Security Index in Asia

Economic Water Security Index By Sub Region (Population-weighted)

The AWDO Key Dimension 2: Economic Water Security Index is composed of three sub-indexes: agricultural, industrial and energy water security. The agricultural water security sub-index is in turn composed of three sub-indexes: productivity of irrigated agriculture; independence from imported water and goods (computed from water footprint data); and resilience (% of renewable water resources storage in large dams). Indicator values are generally below 7 out of 10 in the agricultural water security sub-index indicating there is potential to improve agricultural water security.



Note: The subindicator range is 1-10. No data were available for Taipei, China and Hong Kong, China (East Asia); Maldives (South Asia); Brunei Darussalam and Singapore (Southeast Asia); or Cook Islands, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, and Vanuatu (Pacific). Estimates for the Pacific region are derived from expert judgment evaluations provided by a range of regional specialists.

(Source: ADB 2013a, cited in Thierry Facon and Marisha Wojciechowska, 2015)

BOX 4: Economic Water Security Index by Sub Region (Population-weighted)

For AWS to serve the agriculture sector based on the IWRM principle, itwould need to be at par with the services of other sectors too. This would require the AWS to be developed based on three key approaches for agribusiness sustainability of the business itself, and the industry as a whole, as well as from the perspectives of water resources security and for water, energy and food security. Those approaches are the SOM approach, the Risk Management approach and the WEF Security Nexus approach.

The SOM Approach

The Service-Oriented Management (SOM) (Box 5) approach is based on an agreed level of service between the Supplier (Government or private entity) and the User (the business entity or farmers). This is a shift from the traditional top-down rigid approach (FAO Masscotte) to one that allows for higher operational flexibility for the supplier and the user.

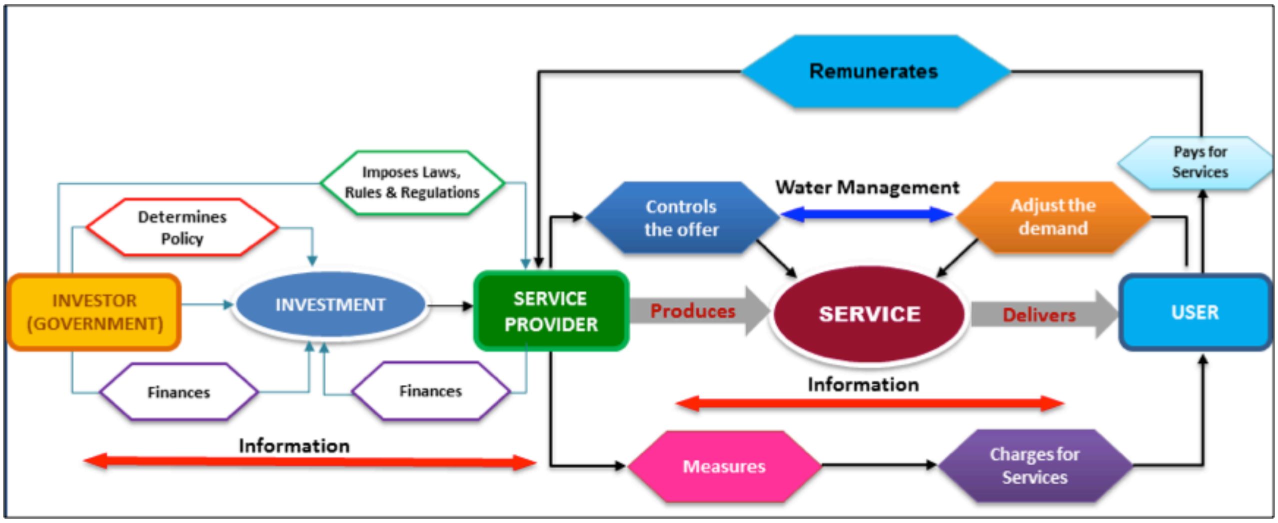
Investments in the systems and the service facilities can either be by the Government or the private sector or both PPP. The Service Provider provides and delivers the service to the Users based on the agreement as to where, when, how and how much (refer Figure 7). The User then remunerates the Service Provider. This is similar to that of the Water Supply and the Energy Sector services. The system should have some level of flexibility for the user to specify demands in relation to seasonal needs.

Service-Oriented Management (SOM)

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

(Source: Daniel Renault, Thierry Facon, Marisha Wojciechowska and Robina Wahaj, 2007)

BOX 5: A Definition of SOM



(Source: Adapted from Renault and Montginoul, 2003 cited in Daniel Renault, Thierry Facon, Marisha Wojciechowska and Robina Wahaj, 2007)

Figure 7: Investment-Service Linkages for SOM

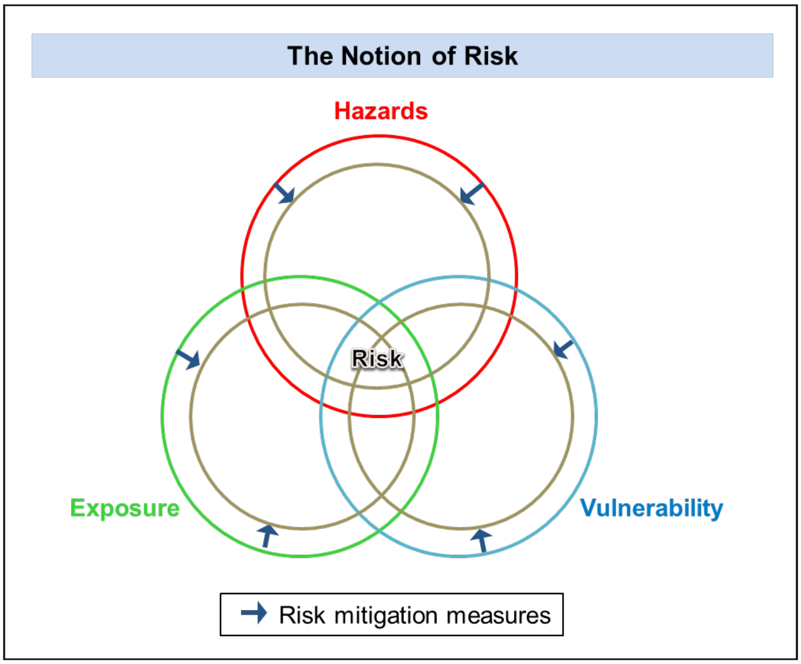
Remuneration for AWS remains a contentious issue but this is actually already practised under the Irrigation Areas Act (1953) and Drainage Works Act (1954) although the rates have not been revised for many years. Unlike the Water Supply Sector, the measurement unit is based on operating area and not on volume of water used. A possibility for the future is to relook at the idea of allocating part of the *Zakat* contributions from agriculture producers to remunerate the AWS. This idea was mooted in the 1960s and 70s for World Bank loan justification for infrastructure cost recovery and funding for operations and maintenance for paddy irrigation development.

Remuneration by users may not be implemented within the near future but at least there should be a system of measurement, value assessment for the AWS and information flow between the User and the AWS provider.

The agribusiness, as in any other business in the long-term, would have to appreciate the need to pay for services and AWS is one of them. The idea would be to prepare the business to be ready to remunerate for AWS in the future.

The Risk Management Approach

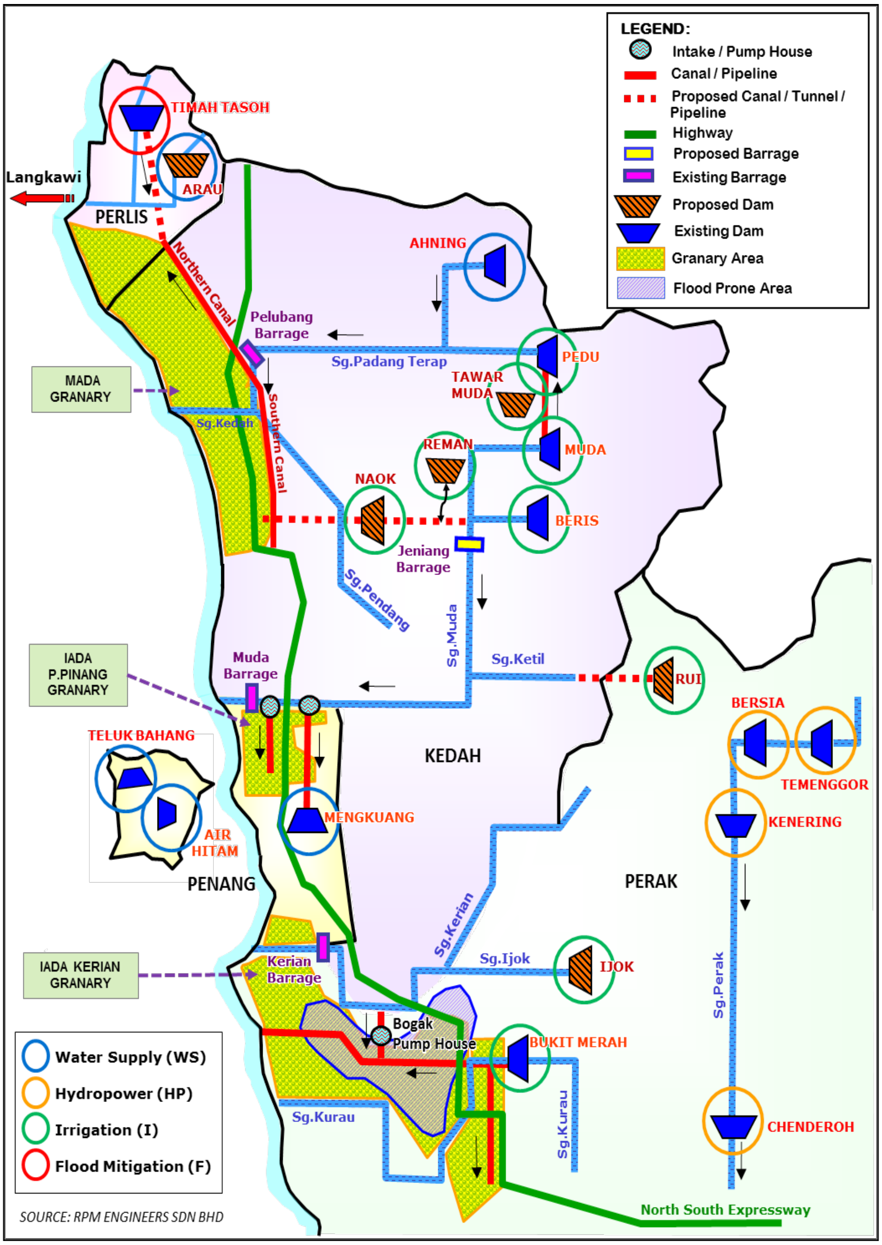
A good understanding and appreciation of risk in Agribusiness are important for system planners, managers and investors in Agribusiness. Risk is the probability (or chances) of damage or loss when vulnerable and exposed to a hazard (Figure 8). Hazard is any event that can cause damage or losses. Vulnerability is the degree of susceptibility and resilience to cope and recover when exposed to the hazard. Exposure is the presence or the position of the business when a hazard occurs.



Source: Associated Programme on Flood Management (AFPM), 2016

Figure 8: The Risk Management Approach

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

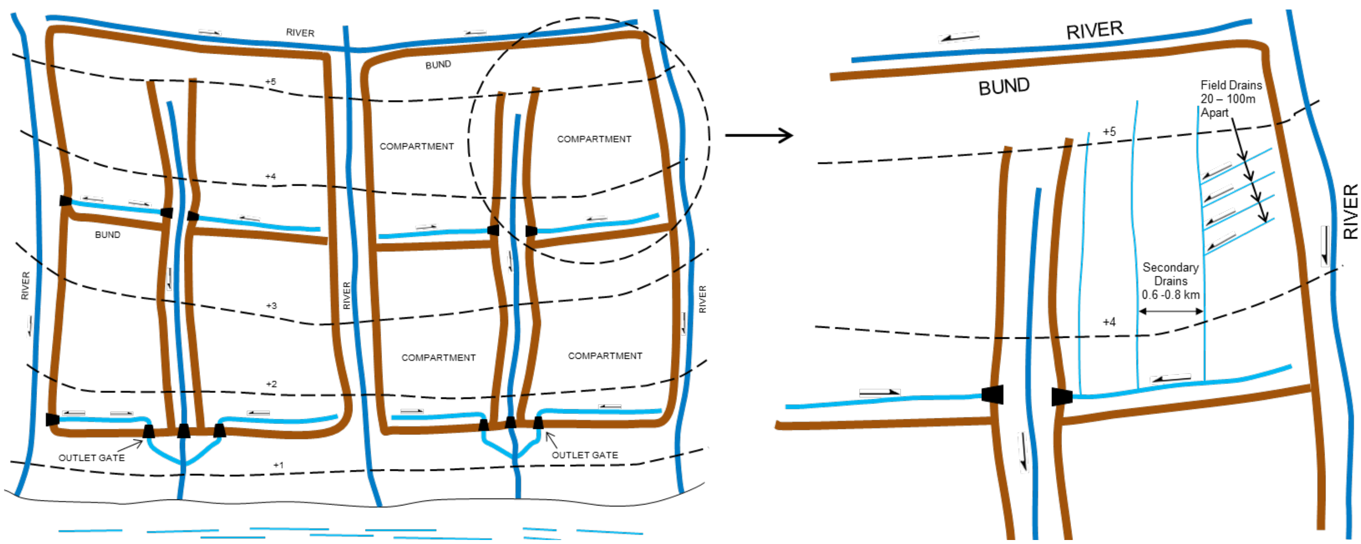


(Source: Mohd Adnan, Liam, and Shiamala, 2014)

Figure 9: Water Resources and Distribution Network in the NCER

Agriculture is vulnerable to water hazards (e.g. floods, droughts, water logging) and exposed to the vagaries of weather (e.g. rainfall pattern, duration and intensity). The risks involved are not only on the success of planting the crops but also on the production system as a whole such as land preparation, crop husbandry, harvesting and transportation. Managing water hazard is therefore one of the most important strategies in the risk management for agribusiness. This is one of the reasons for instaling an extensive primary and secondary agriculture water management facilities and networks, including services in the NCER covering the States of Perlis, Kedah, Pulau Pinang and northern Perak (Figure 9). The density of 30m/ha for canals, drains and farm roads at tertiary levels have been proven to be adequate thus far.

The intensive drainage networks for tree crops and other non-paddy crops in the coastal plains were also instaled for the same reason (Figure 10).



(Source: DID cited in Mohd Adnan Mohd Nor, 2000)

Figure 10: Typical Drainage Scheme Layout

Exposure is managed by defining limits of the system capacity and often expressed in terms of ARI of rainfall event. At present, the ARI for paddy irrigation is 1:5 years and drainage at 1:20 years with allowances for floods retention in the fields from 24 to 48 hours. For tree crops, the ARI applied is for 1:20 years event with allowances for a 7-day on-farm flood retention.

Risk management is not only by structural measures but non-structural measures too. Systems vulnerability (and exposure) is managed through operations and maintenance activities, flood and drought warning systems, planting schedules and standard operating procedures for disaster management and recovery. Even capacity building programmes are considered as part of the non-structural measures. In addition, there are also, on a case-by-case basis, cash compensation from the Government for relief and recovery from severe incidences leading to income losses such as due crop diseases and floods. Farmers in the MADA Granary for example were awarded cash relief for crop damages due to floods (Table 7).

Table 7: Flood Damage Compensation in MADA Granary

Period	Year	Month	Frequency	Area Flooded	Impact		
					Crop Damaged	Government Aid	Average Government Aid
				(Hectare)	(Hectare)	(RM Million)	(RM/Hectare)
1970 – 1979	-	-	-	-	-	-	-
1980 – 1989 (1 times)	1988	November	1	19,449	9,857	-	-
1990 – 1999 (3 times)	1997	August	1	10,158	258	-	-
	1998	November	1	6,447	1,556	0.48	309
	1999	October	1	3,667	3,676	0.99	269
2000 – 2009 (11 times)	2000	November	1	4,111	747	0.40	535
	2003	October	1	10,445	9,295	5.37	578
	2005	December	1	19,185	18,246	39.35	2,157
	2006	October	1	9,792	8,304	4.76	573
	2007	Sept/Oct/Dec	3	6,948	5,099	5.85	1,147
	2008	Sept/Oct	2	22,366	10,119	6.78	670
	2009	Sept/Nov	2	7,345	5,256	4.51	858
2010 – 2015 (12 times)	2010	Jun/Sept/ Nov	3	37,424	26,972	23.86	885
	2011	Mar/Aug/ Sept	3	685	520	0.94	1,807
	2012	September	1	827	789	1.42	1,800
	2013	October	2	2,989	1,134	1.75	1,543
	2014	November	1	3,496	2,416	1.96	811
	2015	July/September	2	2,341	2,074	2.47	1,191
1988 – 2015 (27 times)	TOTAL	-	27	167,675	106,317	100.89	
			(avg. 1:1 year)	**(avg. 6,210)**	**(avg. 3,938)**	**(avg. RM3.74)**	**(avg. RM1,009)**

(Source: Nasiruddin Abdullah, 2015)

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

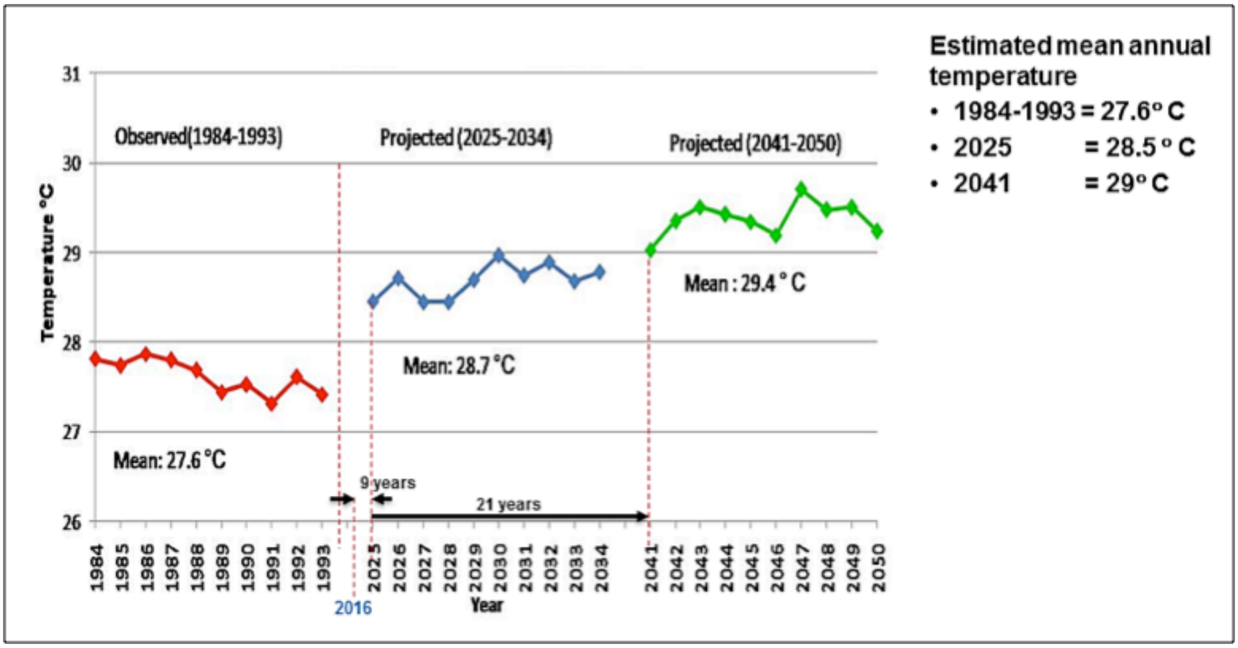
Apart from risk management for water requirements, agribusiness also needs to be responsible for environmental impacts on water resources security and the environment. This also requires risk assessment and the impact on the business. This concern is not only on local but also international impacts.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

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

On climate change, whilst awareness levels are high, advocacy to mitigate and adapt its impacts is still relatively low. Forward planning with specific action plans to adapt to climate change should now be given higher priority to manage risks in agriculture investments. As in illustrations (Figure 11 and Figure 12), in less than 10 years, the oil palm estate in Pulau Carey, Selangor would be subject to the projected temperature increase by about 1°C in 2025 onwards and a further 1°C in about 20 years on (2041). A severe dip in annual precipitation is projected to occur in 12 years (2028).

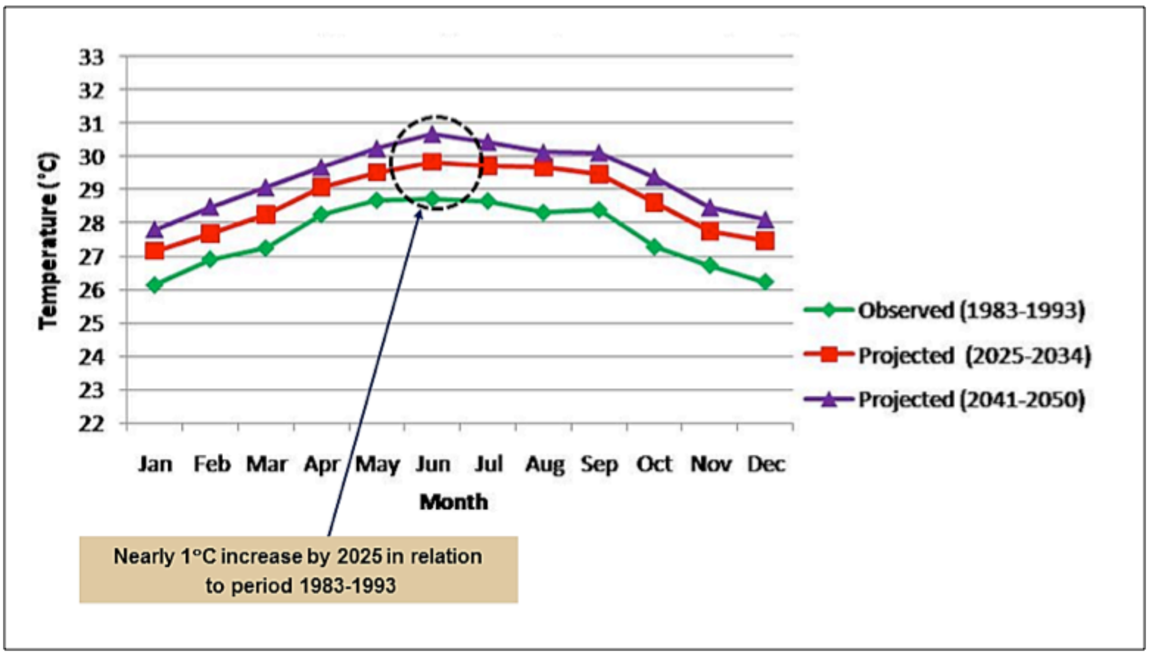
Recovery to average mean then is projected to take nearly 3 years and followed by potential extreme rainfalls and, again, followed by continuous and significant dip in mean annual precipitation over the following 3 years (Figure 13). The impacts on agriculture water management could be severe. The available time frame for developing and implementing mitigation, adaptation strategies and measures is increasingly limited.

The quantum of targets of the respective agricultural policies and especially the NKEAs and the respective EPPs (Table 3 and Table 4) and their locations (Figure 14; Figure 15) would provide some general guide to risk assessment and risk management strategies for water hazards such as floods (flood maps) and droughts in relation to exposure and vulnerabilities.



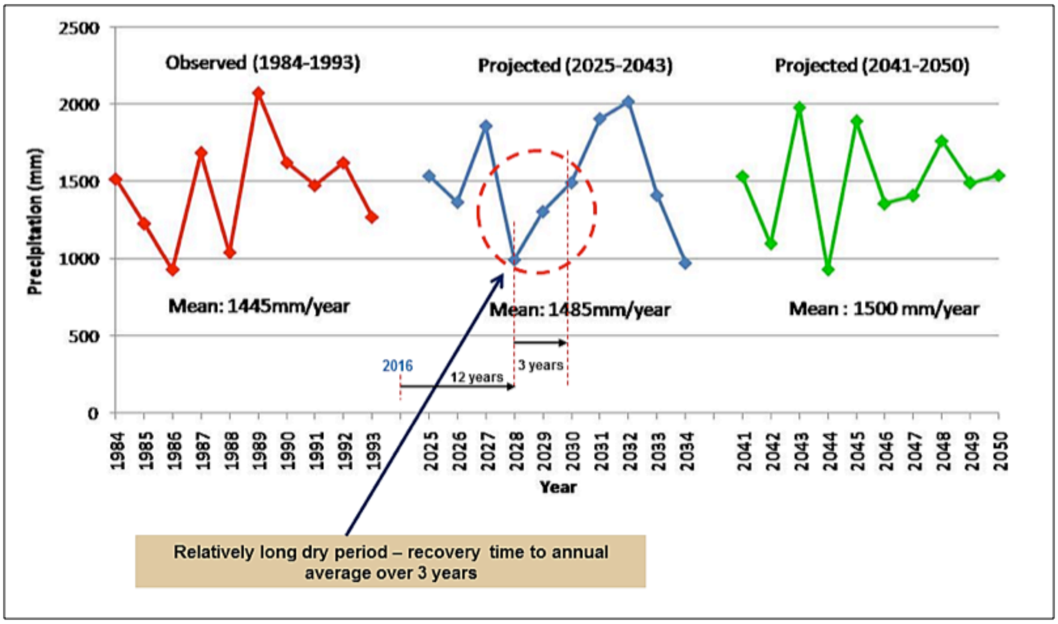
(Source: Sime Darby Plantation, 2010)

Figure 11: Projected Annual Average Temperature (ºC)



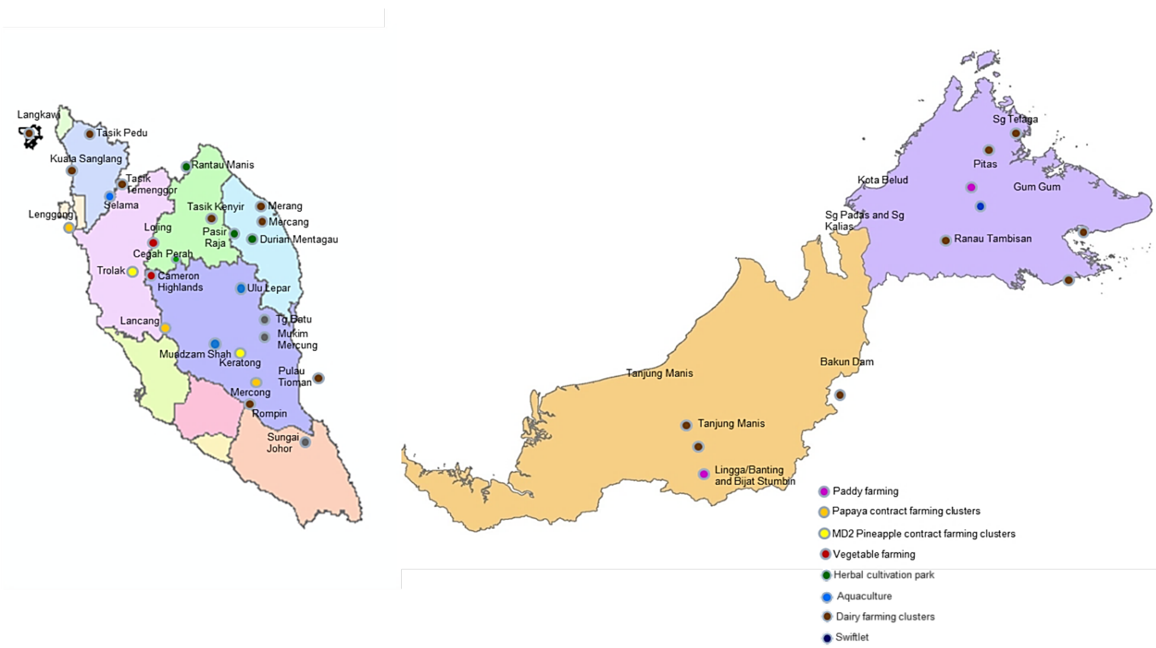
(Source: Sime Darby Plantation, 2010)

Figure 12: Projections for Average Daily Temperature (ºC)



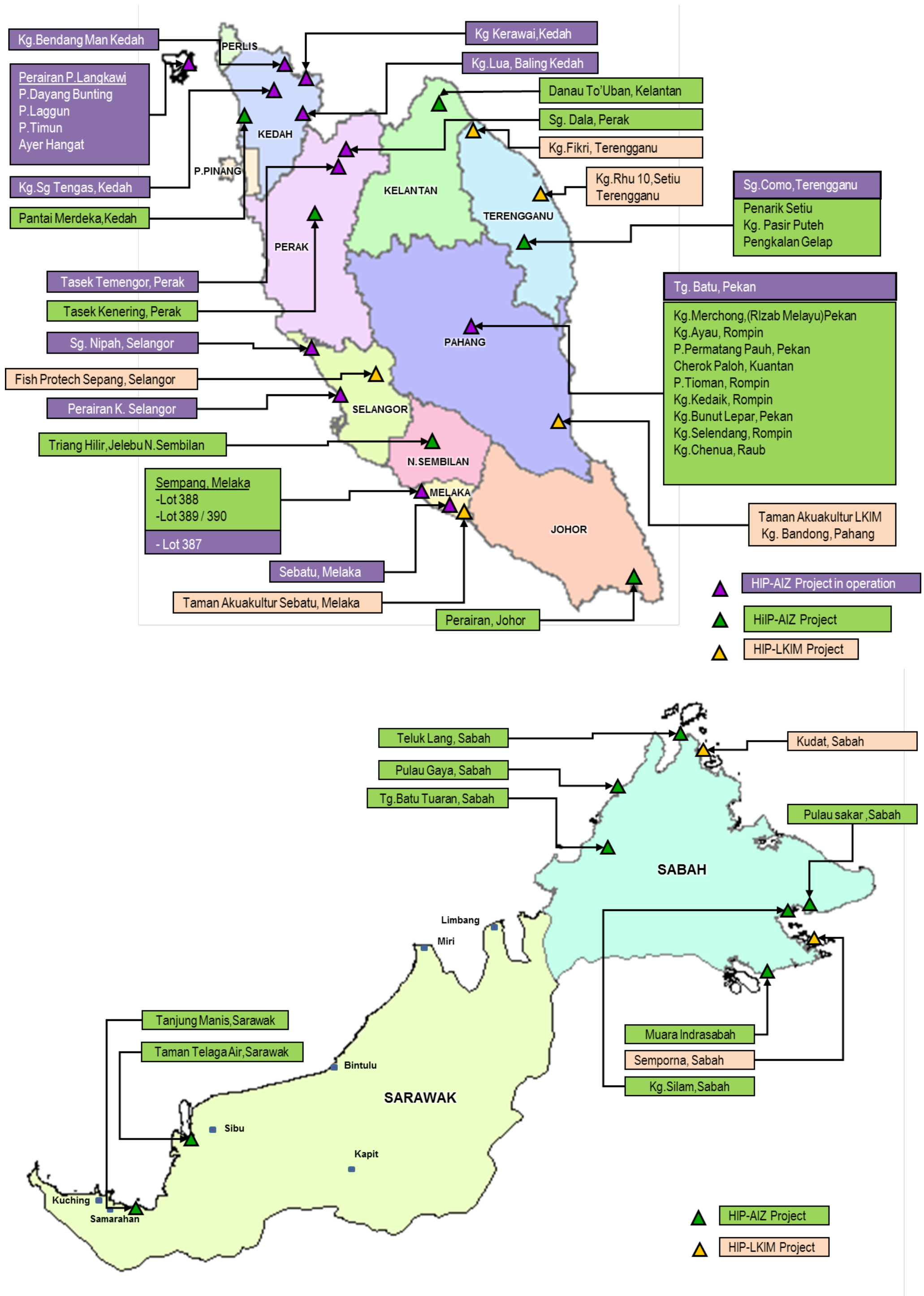
(Source: Sime Darby Plantation, 2010)

Figure 13: Projected Annual Precipitation



(Source: Azhar Mohd Isa, 2013)

Figure 14: Spread of Agriculture EPPs

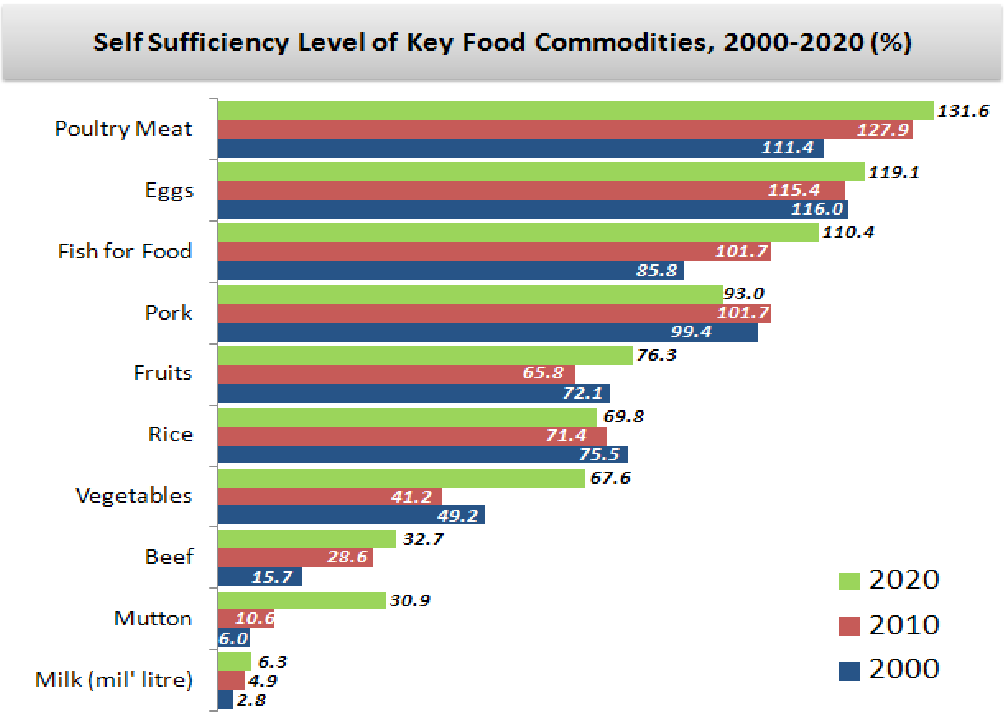


(Source: Mazuki and Yeo, 2015)

Figure 15: AIZ Sites in Malaysia

The WEF Nexus Approach

That Malaysia has achieved comfortable food SSLs (Figure 16) is indeed commendable. However, SSL is by no means a representative indicator for food security levels. SSL refers mainly to production targets in the country, and for certain food (e.g. rice), the availability would still be dependent on external supply to satisfy local demands. From a food security perspective, this availability from local and international sources is based on physical and economic accessibility for dietary needs and preferences.

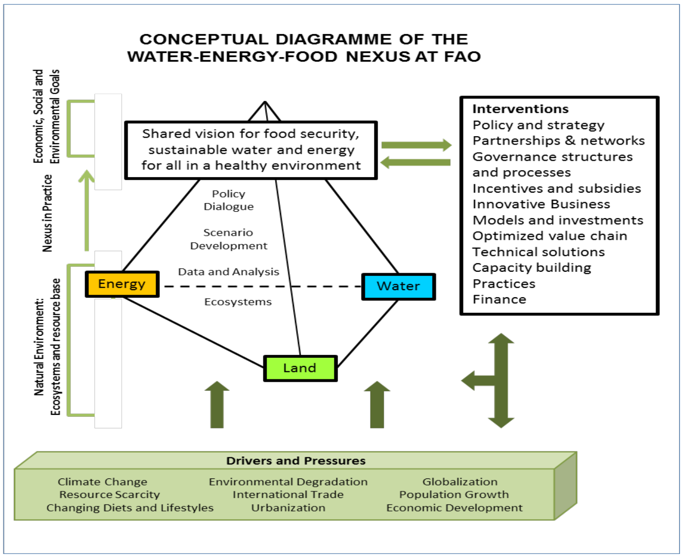


Source: Zalilah Selamat, 2013)

Figure 16: SSL for Key Food Production

The Security Nexus WEF approach is gaining interests of policy-makers and sector managers. There are several approaches to analyse these three key inter-related elements of security for sustainable development (Hezri, 2015). The FAO concept for the WEF Nexus management (refer Figure 17) is based on fundamental drivers and pressures that influence the impact on the WEF elements and consequential responses.

An example on “International Trade” pressure is the food price crisis in 2007/2008 (refer Box 6). The impact on Malaysia was a retailed rice



(Source: Thierry Facon and Marisha Wojciechowska, 2015)

Figure 17: FAO Conceptual Diagram of the Water-Energy-Food Nexus

supply shortage incidence in 2008. Although for only a short period (less than a month) and localised (in central Peninsular), the policy response was swift and significant. The SSL for paddy was revised to be more than 70%, four new Granaries were added to the existing eight matured Granaries and investments in paddy irrigation were increased and included for active non-Granary irrigation schemes with considerations that these be added to the adjacent Granaries.

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

The conceptual model for AWS in relation to managing the WEF Security Nexus and Water Resources security is shown in Figure 18. The AWS would have to be established based on similar service and governance standards and models for the Water and Energy Sectors. The interactions between the respective sector services and Governance are applications of the IWRM approach for improved water resources security.

The WEF Nexus

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

(Source: Thierry Facon and Marisha Wojciechowska, 2015)

BOX 6: Example of the WEF Nexus Issue

Analysing these for decision-making however is complex as it involves multi-dimensional consideration of factors including quantity, quality, time, financial, economic, sectorial, environmental, social, and political. Added to these are also consideration on climate change mitigation, impacts of climate change, adaptation and resource sustainability on each of the Nexus elements, and its resultant impact on the others. For a country that has long enjoyed the luxury of “abundance” of water in relation to supply and demand, this is a major shift in agricultural water management approach.

Models to analyse the WEF Nexus have yet to be developed for Malaysia. However, from the aspect of water resources and water management and quantity as the primary indicator for these three sectors, and from the perspective of the Agriculture Sector (FOOD), there are already examples of significant issues of the Nexus at regional and local levels that require urgent attention. A detailed consideration of these could be the initial basis towards developing practical approaches and strategies for the future agriculture water services in managing the WEF Nexus.

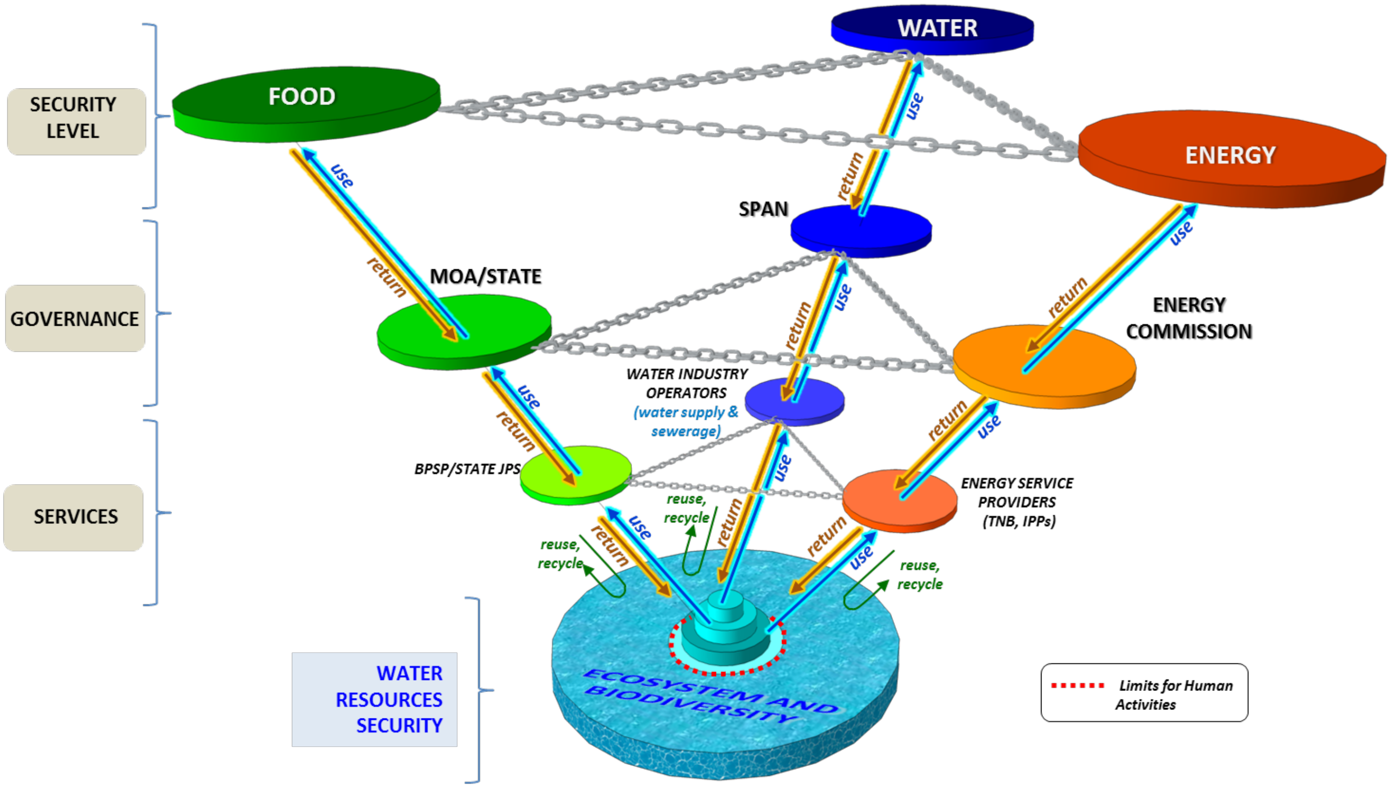


Figure 18: Concept of WEF Security Nexus driven-by Water Resources Security

Some examples of WEF Nexus Issues are discussed below:

(A) The Northern Corridor Economic Region (NCER)

The level of present and future development of the NCER covering the States of Perlis, Kedah, Pulau Pinang and Perak (Northwest) is achievable mainly due to the support of intensive water resources and water distribution network development and management. This is because of the regional climatic characteristic of having distinct dry seasons every year. The major water management systems were developed (since the 1900s and intensified in the 1960s and 1980s) and continued to be managed by the Agriculture Sector for paddy production (FOOD). Now the region is host to three (3) of the twelve (12) National Granaries namely the MADA (the Nation's premier Granary), IADA Pulau Pinang and the IADA Kerian. These three Granaries cover a total area of 135,114 ha. and contribute 52% of the total National paddy production.

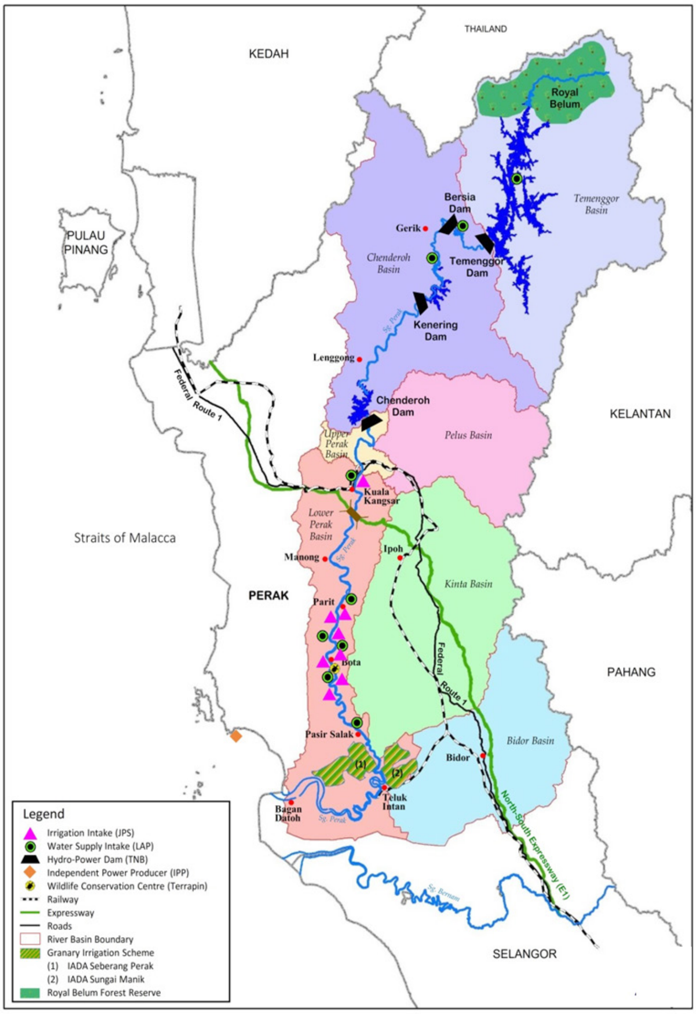
Muda River is the "River of Life" for this region. It is the main source of water for the MADA Granary in the Kedah River Basin. Water is transferred from this river via an inter-basin transfer tunnel from Muda Dam into the Pedu Dam and distributed onwards via an extensive distribution network (Figure 9).

Over the years as the regional economy progressed, demands from the Water Supply sector increases in tandem. Since early 2000, the Energy Sector was added to the demands. From a situation of near exclusivity, developed and managed by the Agriculture Sector (the MADA Granary), portions of this water for food have now to satisfy the increasing needs for the Water Supply Sector (WATER) to North Kedah (now at 400 cusec), Langkawi (at 20 cusecs), Perlis (at 110 cusecs) and for energy production by an IPP (10 cusec) (Loh, 2016 (*pers comm*)).

The unregulated flow in the stretch of the Muda River downstream of the Muda Dam has also to cater for the IADA Pulau Pinang Granary and minor irrigation schemes in Kedah (for food) as well as Water Supply demands of South Kedah and Pulau Pinang. More demands will be imposed on this river when the Mengkuang Dam (for Water Supply) in Pulau Pinang is fully operational and also when the planned water transfer scheme, the Jeniang Transfer Scheme, from this river to the southern areas of the MADA Granary (for Food) is implemented in the near future. This in turn would impose additional stresses on water availability to meet the near future needs of the IADA Pulau Pinang Granary and Pulau Pinang Water Supply further downstream.

In the southern area of the NCER is the Kerian Granary, which is developed and managed by the Agriculture Sector for food since the 1900s. The Bukit Merah reservoir and Kerian River are the principal sources of water for the irrigation system. Over the years, the exclusivity of this system for paddy production has been gradually breached by the need to support the increasing demands from the Water Supply sector as well for Aquaculture (for food and ornamental fish (Arowana)). The operational capacity of the Bukit Merah reservoir is also increasingly limited by the conditions imposed by the holiday resort facilities (Tourism Sector), storage space to absorb increasing and frequent flood flows (Environment) and to protect the railway causeway (Transport Sector) across the reservoir. Under the circumstance, new efforts are needed to ensure the stability of supply for irrigation here and water supply as well as in anticipation of rapid local development spurred upon the completion of the Sultan Abdul Halim Mu'adzam Shah in Pulau Pinang.

As it is, the Water Supply situation in Pulau Pinang is rapidly approaching potential shortage situations. However, the available unregulated flow in this region, even without considering ecosystem needs, is already in deficit and projected to be increasingly severe towards 2050. Several options are now being offered to address this situation including instaling desalination plant in Pulau Pinang, implementation of water demand management programs for all sectors and, a water transfer scheme from Perak river basin sourcing water from the hydropower reservoirs (Energy Sector).



(Source: RPM Engineers, 2012)

Figure 19: WEF Nexus in Sungai Perak River Basin

(B) Sungai Perak River Basin Development

The Sungai Perak river basin development also provides an interesting example of increasing WEF Nexus issue. This river basin is host to the IADA Seberang Perak Granary, the IADA Sungai Manik Granary (part of the IADA Kerian-Sungai Manik Granary) and a number of active non-Granary irrigation schemes. These schemes are serviced by eight (8) irrigation intakes along the river. Along the river too are a number of in-river aquaculture farms.

There are also eight (8) Water Supply intakes located along this river. At the upstream stretch is a series of four cascading hydropower dams for (ENERGY) electricity production. These are the Temenggor (1978), Bersia (1983), Kenering (1984) and Chenderoh Dams (1930). The total storage of these four dams is 6,555 MCM.

The constructions of these dams have changed the Perak river regime and with continuous development throughout river basin, sediment loads have increased. This in turn results in shallow river beds that affect the performance of the irrigation and water supply intakes. Flood is also increasingly becoming an issue as sedimentation has reduced the river hydraulic capacity, affecting the aquaculture industries and other agricultural areas adjacent to the river.

As the development pace increases, the pressure on the hydropower dams to release more water for irrigation and water supply increases. Due to the distance and the open channel hydraulic characteristics, the volume of dam releases would have to be higher just to attain the water levels necessary at the irrigation and water supply intakes located as far as 200 km downstream of the dam. Whilst the daily Water Supply requirements is nearly constant, irrigation is seasonal and with high peak water requirements. Thus, the hydropower operations for releases would also have to be able to match the irrigation schedules.

Apart from the need to satisfy demands within the Perak river basin (Figure 19), there is also the idea of an inter-basin water transfer scheme from this river to meet the supply shortfalls for irrigation and water supply for the NCER.

(C) The Cameron Highlands Vegetable Industry

Informal (private initiatives) agriculture water management system in Cameron Highland

(Photo Credit: RPM Engineers)

Figure 20: Informal Private Initiatives Agriculture Water Management System in Cameron Highland

Cameron Highlands hosts the premier vegetable and flower production industry for the country. Although the volume of water is not as much as that needed for paddy irrigation, this shows that when commercial non-paddy farming is intensive and concentrated in a large contiguous area, the effect of one i.e. FOOD in the WEF Nexus could cause significant impacts on the other two, ENERGY and WATER.

By practice and culture, the Cameron Highlands farmers developed their water supply system individually. Each would source water from the highland areas and instal pipes to deliver water by gravity to their farms (Figure 20). This system in now intensive and there are reports that this is affecting the water resource for the Water Treatment Plant especially during the dry periods.

As commercialisation advances, the preference of farmers is now to instal and farm under rain shelters. This reduces the permeable area for rainfall to infiltrate the ground and increases the surface flow. The roofs collect the rain and drain it via pipes instaled and then released it into the open area surfaces and local drainage systems and on to the rivers. The increased flow causes erosion and carries sediment into the rivers, increasing turbidity of water at the treatment plant and reducing the storage capacity of hydropower dams (Machang, Jor and Ringlet) downstream. It is estimated that the sediment load into the Ringlet reservoir due to land development upstream increased tremendously in just over a 9 year period from 200,000 m3/yr in 1990 to 300,000 m3/yr in 1999. This resulted in the TNB having to acquire 80 ha. (200 acres) of State land to deposit about 2.5 million cu.m of sediment from the reservoir (TNB, 2003).

CHAPTER 2:
WATER AND AGRICULTURE

CHAPTER 2: WATER AND AGRICULTURE

2.1 Key Action Areas (KAA)

The set of KAA for Food and Nutrition Security from the perspective of sustainable water resources development for agriculture proposed by the White Paper as the principal basis towards developing policies, presented by the Food and Agriculture Organisation of the United Nations (Thierry and Wojciechowska, 2015) at Regional Process of the World Water Forum 7 in 2015, is shown in Box 7. These are relevant to all economies in transit and for Malaysia, these will have to be viewed from the perspective of attaining a developed nation status by 2020 and beyond Food and Nutrition Security into agriculture for wealth creation in line with the development themes of “transiting from Agriculture to Agribusiness” and that “Agriculture is Business”.

Following from the above, the KAAs for AWS in the Malaysian context, and towards developing strategies and action plans are proposed as follows:

KAA1: Developing water accounting and auditing system
KAA2: Risk Management
KAA3: AWS for Food Security and Wealth Creation
KAA4: Investments and Financing for AWS
KAA5: Managing the WEF Nexus
KAA6: Public Participation and Capacity Building

Food and Nutrition Security

To tackle these transitions and ensure rural prosperity, the following vision for water and food security in Asia and the Pacific has evolved and is proposed, in conjunction with the Sustainable Development Goals to 2030:

“Food and nutrition security for all and vibrant rural communities in a water-secure Asia-Pacific, through managing the region’s multiple social and economic transitions equitably and sustainably”.

In practice, the proposed agenda and expected components of action plans and solutions proposed for Water and Food Security in the Asia-Pacific is articulated along the following axes of Key **Action Areas (KAA),** seen as levers to accelerate reaching the vision:

KAA 1: Implementing sound and innovative water accounting and auditing to support decision- making and management.

KAA 2: Evolving risk management strategies for national food security policies under water constraints and economic transitions.

KAA 3: Adapting agricultural and rural water management to promote a renewed focus on ensuring farmer and rural prosperity for managing socio-economic transitions sustainably: plotting new futures for irrigation and drainage under long -term vision.

KAA 4: Supporting investments boosting ecosystem and water productivity, maintaining water quality across agriculture, fisheries, aquaculture, irrigation and drainage-recognizing its multiple services - and their supply chains and supporting rural transformations.

KAA 5: Managing the changing dynamics of the WEF Nexus.

KAA 6: Capacity development.

(Source: Thierry Facon and Marisha Wojciechowska, 2015)

BOX 7: The set of KAA for Food and Nutrition Security

2.2 The KAAs for Food Security and Agribusiness

KAA 1: Water Accounting and Auditing

The present water resources accounting is based on the approach as adopted by the RNWRS 2012. This is mainly based on freshwater resources and on quantity more than quality assessments. Nonetheless, it does provide a useful guide on the status of water resources in the country and provides some basis for developing strategies and actions plans for water and agriculture development. A full water auditing system has yet to be developed. For the agriculture sector, water accounting is still based on a simplified approach using assumed values for various soil-plant-water parameters. For the paddy irrigation sub-sector, periodic accounting and auditing is by the irrigation performance assessment applying the Modernization of Management, Operation and Maintenance of Irrigation System (MASSCOTE) approach (Daniel Renault, Thierry Facon, Marisha Wojciechowska and Robina Wahaj, 2007). This exercise, however, is not performed on a consistent cycle and in fact has not been performed for many years. A more refined approach for water accounting and auditing is now necessary not only for Agriculture but one that is harmonised with all other water sectors (refer Box 8).

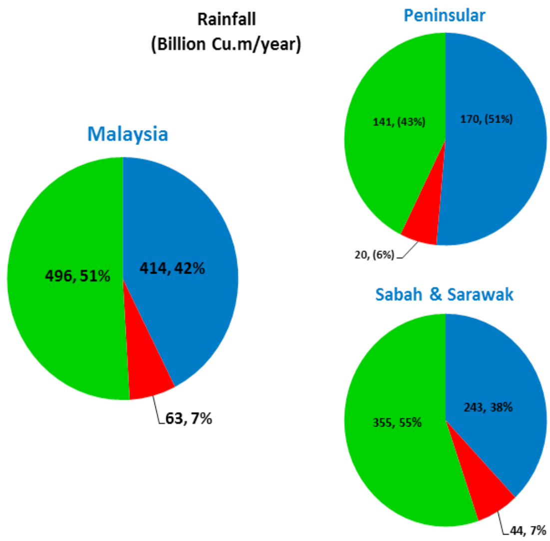
Water Accounting Plus (WA+)

The need for standardized reporting on water resources has prompted FAO with its partners UNESCO-IHE and the International Water Management Institute (IWMI) to develop an accounting system for water resources. An accounting system based on remote sensing measurements has been developed recently under the name Water Accounting Plus (WA+). Unbiased and scientifically verified sheets, tables and maps related to water, land and ecosystems are computed and uploaded on www.wateraccounting.org with free access to all stakeholders. The methodology can be applied to ungauged basins and does not require lengthy and expensive data collection procedures. Several applications studies have been launched in the Asia and Pacific region including the Helmand Basin, Mekong Basin, Red River Basin and the Ca Basin, which demonstrates that the data democracy in river basin management is currently going through a period of great changes. While the emphasis varies in these studies between new remote sensing technologies, integration with hydrological models, local institutional strengthening, capacity building, green growth, ecosystem service metrics and sustainable landscapes, the fact of having one common database and terminology on water resources does contribute to better decision making in water management. With a new Asian Development Bank project on water accounting covering all basins in Vietnam upcoming, WA+ will become a standard ingredient for all departments, planning institutes and river basins in Southeast Asia.

(Source: Wim Bastiaanssen, UNESCO-IHE cited in Thierry Facon and Marisha Wojciechowska, 2015)

BOX 8: Water Accounting

State	Unit in Billion Cu M per year			
	Rainfall	Actual Evaporation	Groundwater Recharge	Surface Runoff
Peninsular Malaysia	331	170	20	141
Sabah, Sarawak , F.T. Labuan	642	243	44	355
Malaysia	973	414	63	496



(Source: GoM (e), 2012)

Figure 21: Total Water Resources in Malaysia

Water for Agriculture

The RNWRS 2012 estimated that average annual rainfall provides for a yield 973 billion cu.m of water resources in Malaysia. Of this 493 billion MCM is surface water, 63 billion cu.m goes to groundwater recharge and 414 billion cu.m returns to the atmosphere through evaporation (refer Figures 21). From the total yield, the estimated renewable water resource for the country is estimated to be 580 billion MCM annually (FAO. (2016). Aquastat.).

The total water demand based on consumptive use by Agriculture and the Water Supply sectors is projected to increase by 23% from 14,789 MCM (2.55% of total renewable water resource) in 2010 and projected to 18,250 MCM (3.15%) by 2050 (Figure 2). Of this, Agriculture is the biggest user of at 9,511 MCM in 2010 (64.3% of the total water demand). Within the Agriculture sector, the biggest water user is by the Paddy Irrigation sub-sector at 8,266 MCM in 2010 forming 55.9% of the total water demand and 64.3% of the total agriculture water demand.

However, the Agriculture sector is projected to decrease its demand to 8,959 MCM by 2050. This decrease is expected to be from the Paddy Irrigation sub-sector water demand reduction by 1,061 MCM, thus reducing its demands to 7,205 MCM by 2050. The water demands for the non-paddy crops is projected to increase from 1,117 MCM in 2010 to 1,176 MCM (5% increase) in 2050. Over the same period, the Livestock sub-sector is also projected to increase from 129 MCM to 578 MCM (348% increase). Water demands for Fisheries, considered as non-consumptive water user under the (RNWRS 2012), is also projected to increase from 1,287 MCM in 2010 to 2,898 MCM by 2050 (125% increase).

Overall, the total water demand (Water Supply and Agriculture) is projected to increase from 2.55% in 2010 to 3.15% of the total renewable water resource in 2050. Over the years, the Water Supply Sector (Potable Water) demand will surpass Agriculture's by 2035 as Agriculture Sector demand is projected to decrease from 1.64% in 2010 to 1.54% of the total renewable water resource by 2050.

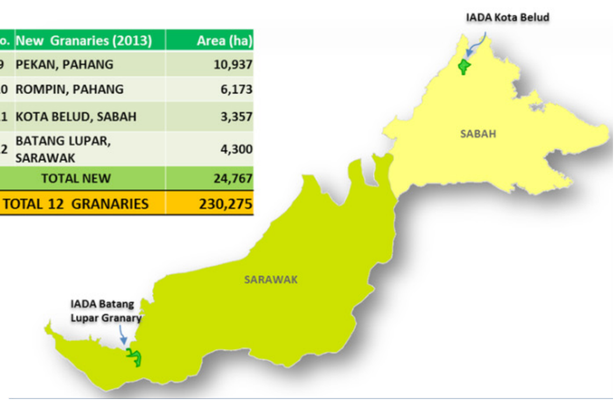
Areas of concern

(a) Projections of Irrigation Water Demand reduction may not be achievable

The projected reduction of 1,061 MCM from 2010 and 2050 in water demands by the Irrigation sub-sector is based on the assumptions made at the time of the RNWR in 2012; that the paddy production areas will be restructured (conversion of non-granary irrigation schemes into non-paddy use), the eight (8) matured Granaries will be the main production areas and that there will be investments for irrigation efficiencies to be increased to 75%. Those assumptions may not be entirely valid now.

No.	Matured Granaries	Area (ha)
1	MADA	96,558
2	SEBERANG PERAI	10,138
3	KERIAN-SG MANIK (a) KERIAN (b) SG MANIK	28,448
4	SEBERANG PERAK	8,529
5	BARAT LAUT SELANGOR	19,701
6	KADA	31,464
7	KEMASIN SEMARAK	5,560
8	KETARA (BESUT)	5,110
	TOTAL EXISTING	205,508

No.	New Granaries (2013)	Area (ha)
9	PEKAN, PAHANG	10,937
10	ROMPIN, PAHANG	6,173
11	KOTA BELUD, SABAH	3,357
12	BATANG LUPAR, SARAWAK	4,300
	TOTAL NEW	24,767
	TOTAL 12 GRANARIES	230,275



(Source: MOA and MANCID, 2013)

Figure 22: Granaries in Malaysia

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 ration 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 of 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 Water Resources Group (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: UNESCO, 2015)

BOX 9: Irrigation Water Use Efficiency

In 2013, four (4) new Granaries were added to the existing 8 matured Granaries (refer Figure 22), thus increasing the total Granary area from 205,508 ha to 230,275 ha. At the same time, there are considerations to add to the eight (8) matured Granaries about 17,500 ha of active non-Granary irrigation schemes at their respective fringes (Chan Chee Seng, 2013). These additions would inevitably increase the water demands of the Irrigation sub-sector.

Improving their efficiencies could contribute significantly to water savings. The estimated potential savings is 1,067 MCM (or equivalent to 2,927 MLD) (ASM, 2015) (refer Table 5). However, improving irrigation efficiencies is not really a definitive measure of water savings in irrigation when large portions of the water delivered are returned to the system for other possible beneficial uses and users. The objective would instead be to aim for water productivity that includes good water control from delivery and on-farm water management by farmers (refer Box 9). Under this concept, the water accounting approach for irrigation would need to be revised to account for not only for freshwater demands and efficiency of use, but also to incorporate quantity and quality of the used water returned to the system.

(b) Declining available unregulated flow

The RNWRS also projected a declining trend of available unregulated flows (refer to Table 8) in all States. Of these, five States in the Peninsular are already in deficit with the situation projected to decline further towards 2050. Four of these States, Perlis, Kedah, Pulau Pinang and Selangor, are hosts to three of the eight (8) matured Granaries, namely MADA, IADA Pulau Pinang and IADA Barat Laut Selangor. The available unregulated flow in Perak is also hovering on the low side and this State hosts the IADA Kerian-Sungai Manik and the IADA Seberang Perak Granaries.

Table 8: Projected Unregulated Flows in Malaysia

NWRS 2000-2050 (Reviewed 2012)
Unregulated flows in 5 States already deficit, others declining

States	Land Area (sq. km)	Total Consumptive Water Demand (mm)					Effective rain (mm)	Excess/(Deficit)(mm) - Unregulated Flows				
		2010	2020	2030	2040	2050		2010	2020	2030	2040	2050
Perlis	**821**	**372.1**	**364.2**	**348.1**	**345.7**	**342.8**	**70.5**	**(301.6)**	**(293.7)**	**(277.6)**	**(275.2)**	**(272.3)**
Kedah	**9,500**	**307.6**	**313.2**	**299.1**	**302.4**	**302.8**	**112.5**	**(195.1)**	**(200.7)**	**(186.6)**	**(189.9**	**(190.3)**
Pulau Pinang	**1,048**	**729.9**	**790.9**	**797.1**	**834.2**	**853.3**	**120.0**	**(609.9)**	**(670.9)**	**(677.1)**	**(714.2)**	**(733.3)**
Perak	21,035	92.7	91.4	85.5	85.6	86.1	139.5	46.8	48.1	54.0	53.9	53
Selangor	**8,396**	**266.6**	**296.6**	**306.1**	**328.7**	**348.0**	**114.0**	**(152.6)**	**(182.6)**	**(192.1)**	**(214.7)**	**(234.0)**
Negeri Sembilan	6,686	50.9	54.0	53.6	54.7	56.0	73.5	22.6	19.5	19.9	18.8	17.5
Melaka	**1,664**	**194.1**	**219.9**	**225.9**	**245.7**	**263.7**	**85.5**	**(108.6)**	**(134.4)**	**(140.4)**	**(160.2)**	**(178.2)**
Johor	19,210	37.2	45.8	53.8	60.6	67.7	171.0	133.8	125.2	117.2	110.4	103.3
Pahang	36,137	20.1	26.2	24.8	25.2	26.5	165.0	144.9	138.8	140.2	139.8	138.5
Terengganu	13,035	67.8	74.8	74.4	76.6	78.7	253.5	185.7	178.7	179.1	176.9	174.8
Kelantan	15,099	108.1	107.2	105.0	106.0	106.2	175.5	67.4	68.3	70.5	69.5	69.3
Pen. Malaysia	**132,631**	**96.5**	**103.0**	**102.2**	**105.9**	**109.2**	**159.0**	**62.5**	**56.0**	**56.8**	**53.1**	**49.8**
Sabah	73,631	12.4	18.4	18.9	19.6	20.0	177.0	164.6	158.6	158.1	157.4	157.0
FT Labuan	91	197.7	264.3	285.0	304.0	318.0	322.5	124.8	58.2	37.5	18.5	4.5
Sarawak	124,450	8.5	17.4	17.1	17.5	18.1	220.5	212.0	203.1	203.4	203.0	202.4
Sabah, FT Labuan & Sarawak	**198,172**	**10.0**	**17.9**	**17.9**	**18.4**	**18.9**	**268.5**	**258.5**	**250.6**	**250.6**	**250.1**	**249.6**
Total Malaysia	**330,803**	**44.7**	**52.0**	**51.7**	**53.5**	**55.1**	**225.0**	**180.3**	**173.0**	**173.3**	**171.5**	**169.9**

Sourc: NWRS 2000-2050 (Reviewed 2012)

Demand Increasing

Unregulated Flow in Deficit ***Unregulated Flow Declining***

(Source: GoM (e), 2012)

This decline could also affect future development of non-paddy crops, livestock and fisheries. The water demand volumes may be small compared to the Water Supply sector and the Paddy Irrigation sub-sector, but their projected increases are substantial. Their impact on local water demands could be significant especially when their development are concentrated in a contiguous area or location as in the case of the Cameron Highlands vegetable and flower agribusiness. It could also limit realising the potential of non-paddy crop yield increases through irrigation such as that for oil palm. Irrigated oil palm has the potential of increasing yields from about 19 tons/ha to between 32 to 62 tons/ha, or between 11 to 30% yield increases (Table 6).

For livestock, modern production systems include the use of water for animal housing cooling systems (e.g. 125 l/day/head for dairy cattle and buffalo farms; 3.8 l/day/head for pig farms; waste management at 96.4 l/day/head, drinking requirement) as well as for feed production (Kamarudin M.I et al., 2015).

For Fisheries, the traditional production that was non-consumptive has now changed to include consumptive production systems such as use of off-river aquaculture ponds. This is estimated to require up to 46,800 cu.m/year/ha pond area (Marzuki Hashim and Yeo Moi Eim, 2015).

The situation would also result in lower water table situations for tree crops (especially rubber and oil palm) in the low-lying coastal drainage schemes that would affect yields.

This declining state of available unregulated flow however refers mainly to freshwater resources. For the future, the water accounting system would have to be more sophisticated with considerations of wastewater as a resource too for use in certain sectors of agriculture. The water resource accounting elements could also be categorised in terms of Blue, Green and Grey water as in the Water Footprint approach for freshwater management (Haslawati Baharuddin 2013; Zainura Zainon, 2015).

Adjusting the concept of 'more crop per drop' to include 'more added value per drop' in agriculture

Simply increasing the physical value of production per unit of water is not enough. Policies for enhancing the value of water used in agriculture involve not only increasing yields, changing from low to high-value crops, reallocating water from low to higher value sectors or lowering the cost of inputs. They should also optimize the creation of quality jobs and related environmental aspects. For instance, policies should achieve more livelihood support per unit of water (more jobs, nutrition and income for the same amount off water), while increasing health benefits and the value of ecological services of agriculture (CAWMA, 2007).

(Source: UNESCO, 2016)

BOX 10: More Added Value Per Drop

(c) Declining Water Resources Vulnerability Index

The NWRVI is indicating a decline in water quality status (refer to Figure 3). All States in the Peninsular are already in the Moderately Vulnerable Category with four (4) States, Perlis, Pulau Pinang, Selangor and Melaka in the Vulnerable Category. Only Sabah and Sarawak are in the Low Vulnerability Category but only just.

The Necessary Greening of Agriculture

The present paradigm of intensive agricultural production can no longer meet the challenges confronting us today and the risks to sustainability highlighted above. For sustained growth, agriculture must conserve and enhance natural resources and use an ecosystem approach that draws on nature and applies appropriate external inputs at the right time and in the right amount. This requires a major shift away from the homogeneous and technology transfer-driven model of agricultural production towards knowledge-specific farming systems which are more resilient to natural and economic uncertainties and which use biodiversity and associated biological technologies that enhance soil fertility, reduce erosion, reduce chemical use and conserve water use, i.e. Sustainable Production Intensification (a concept introduced by FAO in Save and Grow, FAO, 2011b)

(Source: Thierry Facon and Marisha Wojciechowska, 2015)

BOX 11: The Necessary Greening of Agriculture

Agriculture pollution management is regulated under the Environmental Quality Act 1974 (Julaidi, 2015). This Act has provisions on the need for Environment Impact Assessment (EIA) for Agriculture Development under EIA Order 2015 – Prescribed Activity. There are also regulatory requirements for palm oil mill effluent discharges and rubber mill effluent discharges (refer Tables 9 and Table 10). These, however, are for point-source pollution management.

Water for Aquaculture

Whilst capture fisheries and a few aquaculture practices such as cage aquaculture and sea-weed farming can be considered water non-consumptive activities, aquaculture in general is heavily dependent on the availability of adequate and clean water supply. Water use in aquaculture can range from less than 3,000 litres/kg to more than 45,000 litres/kg of fish production depending on the type of aquaculture practices (Costa-Pierce et al. 2012). Freshwater fish culture and recycling aquaculture system use about 11,500 litres/kg product and 63,000 litres/kg product, respectively (Brummet 1997, Verdegem et al. 2006). Globally, aquaculture is the fastest food growing sector at about 9% perannum. In Malaysia, aquaculture production is expected to reach 1.76 million metric tons by 2020. With the high target, water supply for aquaculture industry in the country needs to be ascertained. During 2010, the estimated rate of freshwater withdrawn for aquaculture in USA was 9.42 billion gallons per day (35.659 million m^3/day), with surface water being the source of about 81 percent of the withdrawals.

(Source: Fatimah Yusof, 2016)

BOX 12: Water for Aquaculture

Agriculture has also been one of the prime suspects for non-point source of pollution in the rural areas that at times affect the performance of Water Treatment Plants and all other agricultural activities especially aquaculture (Box 12).

Fertiliser and pesticide use over long-term and impact on surface water quality as well as groundwater resources and the expected increase for higher yields are of concern. For paddy irrigation, the water quality deteriorates from Class I Water Quality Index (WQI) for the irrigation supply to between Class II and III when drained out from the paddy fields for the MADA Granary and IADA Pulau Pinang

Granary. For the KADA Granary, the drainage water quality ranges from Class II to Class IV (refer Table 11) (Nasiruddin Abdullah, 2015).

There are certain locations where the WQI is at Class IV for Dissolved Oxygen (DO), Ammonia Cal Nitrogen and Phosphate contents.

Table 9: Regulatory Requirements for Palm Oil Mill Effluent Discharges

Parameter	Proposed New Standard	Existing Standard
BOD_3	20 mg/l	100 mg/l
Suspended Solids	200 mg/l	400 mg/l
Oil and Grease	5 mg/l	50 mg/l
Ammonia Cal-Nitrogen	20 mg/l	150 mg/l
Ph	5 – 9	5 – 9
Temperature	45°C	45°C

(Source: Julaidi, 2015)

Table 10: Regulatory Requirements for Rubber Mill Effluent Discharges

Parameter	Existing Standard
BOD_3	100 mg/l
Suspended Solids	150 mg/l
COD	250 mg/l
Ammonia Cal-Nitrogen	40 mg/l
Total Nitrogen	60 mg/l
pH	6-9

(Source: Julaidi, 2015)

Table 11: Water Quality Parameter and WQI (min-max)

	Unit	DOE	Japan	Muda Irrigation Scheme	Seberang Perai Pulau Pinang	KADA
Parameter				2004 - 2011	1990 - 2007	2006 - 2007
pH		5-9	6.0-7.5	6.92	6.63	5.85
DO	mg/L	<3	5 ≤	5.56	4.35	3.47
BOD	mg/L	12	-	2.06	-	13.86
COD	mg/L	100	≤ 6	10.15	18.74	32.72
NH_3-N	mg/L	2.7	-	0.11	-	0.52
SS	mg/L	>300	≤100	61.45	-	37.97
WQI		31-51.9		71.6 – 85.8	69.9-82.2	50 - 83
Classes		**IV**		**II - III**	**II - III**	**II - IV**

(Source: Nasiruddin Abdullah 2015)

Water quality issues and impact assessments on the ecosystem, and groundwater reservoirs are not extensively studied and monitored. Again, these are critical parameters necessary in developing water resources accounting and auditing systems for future water management.

(d) Urbanisation

Urbanisation is expanding rapidly. By 2020, it is projected that 75% of the population would be in urban areas and increasing to 80% by 2030 (EPU, 2016 (the Eleventh Malaysia Plan 2016-2020). The impact on agriculture is that the agricultural drainage systems have now to cater for urban drainage and flood flows. Flood flows management require the water levels in the drains be kept low to accommodate flood flows whilst agriculture drainage is for ground water table management to avoid subsurface water logging and maintaining a relatively higher water table for water availability to crop with shallow root systems such as oil palm. These conflicting urban-agriculture water management requirements are not easily managed and will need adjustments to the agriculture drainage management systems to ensure consistent farm output.

KAA 2: Evolving Risk Management Strategies

A good understanding and appreciation of risk in Agribusiness are important for system planners, managers and investors in Agribusiness. Risk is the probability (or chances) of damage or loss when vulnerable and exposed to a hazard (Figure 8). Hazard is any event that can cause damage or losses. Vulnerability is the degree of susceptibility and resilience to cope and recover when exposed to the hazard. Exposure is the presence or the position of the business when a hazard occurs.

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

Risk Management Strategies

Risks are increasingly complex and the world is ill-prepared for them according to the World Economic Forum's Global Risks Perception Survey 2015, which maps the most likely and impactful global risks. Among others, the reports points to high concerns regarding the failure of climate change adaptation and looming water crises. Water crises ranked highest in terms of impact and top 8th in terms of likelihood. While the report assesses that good progress has been made to address food crises in the last 10 years, there has been little progress for coping with water crises and very little for coping with extreme weather events.

(Source: Thierry Facon and Marisha Wojciechowska, 2015)

BOX 13: Risk Management Strategies

Following the above, agribusiness need to understand the limitations of the water management systems also take on the responsibility for risk sharing and management with the system managers. In fact, the idea for transiting towards agribusiness is for the private sector to accept and able to manage higher risk levels in relation to the Government limits of investment in system infrastructure and management. In other words, the agribusiness would also need to invest in water infrastructure, participate in water management activities, plan for options for recovery such insurances and cash reserves and, in the long-term consider payment for higher agriculture water service levels for improved risk management (Box 13).

Managing hazards, exposure and vulnerabilities

Agriculture is highly exposed to the vagaries of weather (e.g. rainfall pattern, duration and intensity) and vulnerable to water hazards (e.g. floods, droughts, water logging). The risks involved are not only on the success of planting the crops but also on the production system as a whole such as land preparation, crop husbandry, harvesting and transportation. Managing water hazard is therefore one of the most important strategies in the risk management for agribusiness. This is one of the reasons for installing an extensive primary and secondary agriculture water management facilities and networks including services in the NCER covering the States of Perlis, Kedah, Pulau Pinang and northern Perak (Figure 9). The intensive drainage networks for tree crops and other non-paddy crops in the coastal plains and drainage schemes were also instaled for the same reason (Figure 10).

Transiting to Agriculture will now necessitate the review of present design criteria to match the acceptable risk levels of the agribusiness and that will have to incorporate climate change impacts and adaptation needs.

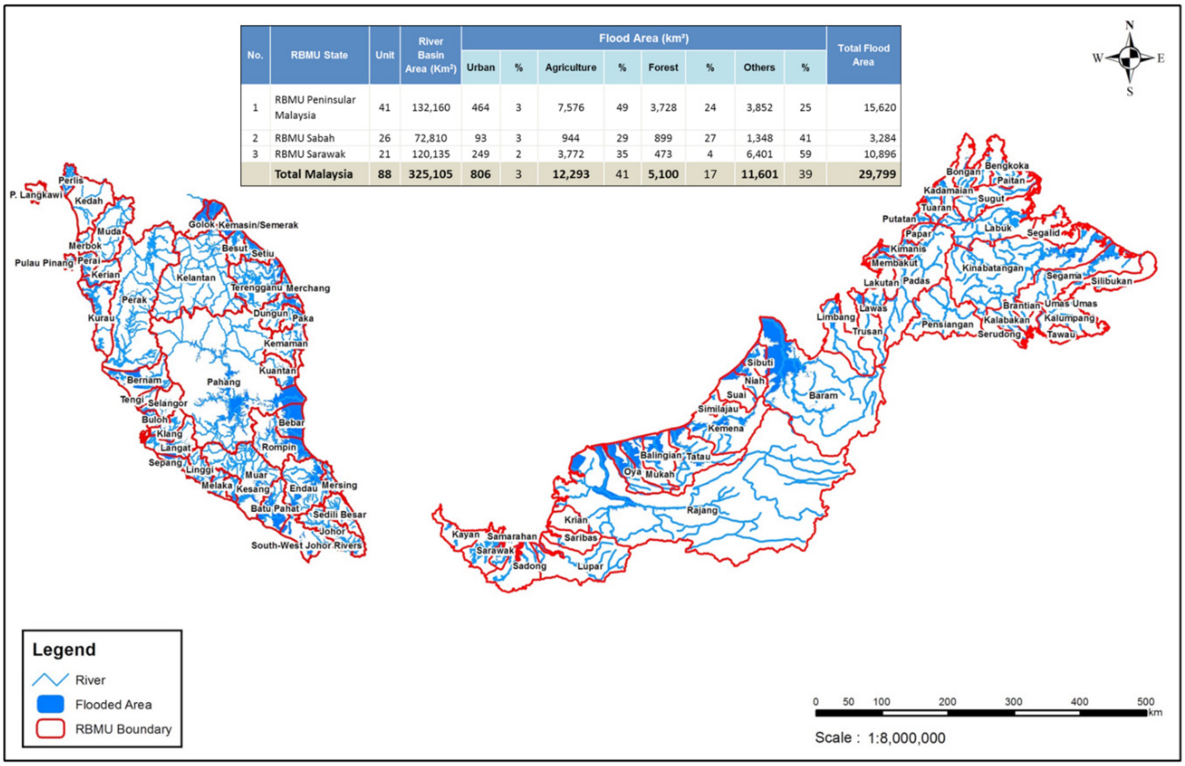
The present design for paddy irrigation is based on 1:5 years ARI and drainage at 1:20 years ARI with allowances for flood retention in the fields from 24 to 48 hours and with canal, drain and farmroad density of 30 m/ha. For tree crops, the ARI applied is for 1:20 years event with allowances for a Seven-day/7-day on-farm flood retention with infrastructure densities ranging from 9 to 19 m/ha. Agribusiness needs could possibly require higher levels of protection.

With paddy production migrating from individual to commercial farming for attaining an average 8 tonnes/ha yields for every season and twice a year, then the risk management approach may have to consider higher levels of protection (higher ARI figures for irrigation and drainage), more intensive and higher load bearing farm roads as well as more intensive on-farm investments in land-levelling and field-channels. Higher value food crops would need higher protection levels such as 1:50 years ARI for irrigating vegetables. Similar review will be needed for both water supply and drainage systems for tree crops, livestock and aquaculture too. Oil Palm as an NKEA contributing to RM 58 billion to the GDP (Vijaya Subramanian, 2013) should now be considered as a high value crop. So too are certain ornamental fishes for export such as Arowana.

A potential area for improved risk management would be the non-Granary irrigation schemes identified for conversion of landuse from paddy to other agricultural activities particularly for oil palm and aquaculture. Many of these schemes were abandoned not for lack of water but for economic reasons.

In 1988, a Study on Crop Diversification in these schemes was undertaken by DID with the cooperation of JICA (DID and JICA, 1990). The study identified the schemes with the potential for diversification (refer Table 12). Many of these schemes could already have been diversified but managed without the instaled irrigation and drainage systems that were already in place. A review of these schemes should be studied with the objective of assessing the possibility of reactivating the irrigation and drainage systems.

Floods in agricultural area continue to be one of the major hazard (Figure 23) and flood events in the MADA Granary (Table 7) shows that this appears to be an annual recurring event over the last 27 years and recurring more than once in certain years. The average area of crop damage is 6,210 ha and the Government has provided cash relieve compensation for damages at an average of RM 1,009/ha/event. Implementing flood mitigation projects are under planning.



No.	RBMU State	Unit	River Basin Area (Km²)	Flood Area (km²)								Total Flood Area
				Urban	%	Agriculture	%	Forest	%	Others	%	
1	RBMU Peninsular Malaysia	41	132,160	464	3	7,576	49	3,728	24	3,852	25	15,620
2	RBMU Sabah	26	72,810	93	3	944	29	899	27	1,348	41	3,284
3	RBMU Sarawak	21	120,135	249	2	3,772	35	473	4	6,401	59	10,896
	Total Malaysia	**88**	**325,105**	**806**	3	**12,293**	41	**5,100**	17	**11,601**	39	**29,799**

(Source: DID, 2003)

Figure 23: Flood affected Areas in Malaysia

Developing non-structural measures for risk management

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

An example of cash relief provided for flood damages is for affected farmers in the MADA Granary (refer Table 7). The records show that flood occurrence, at a frequency of about one a year, were awarded cash relief by the Government averaging RM 1,009/ha/event and totalling RM 100.89 million over 27 years. This relief support could be the basis for developing a detailed vulnerability improvement plan as part of the risk management by the Government and agribusiness including the possibility of insurance coverage.

The MADA Granary has also adjusted the water management systems in canals and drains to maximise storage to absorb flood flow of up to about 17.4 MCM (Nasiruddin Abdullah, 2015), and providing preparatory logistic support for flood relief system that include pumps, lorries, boats and excavators in anticipation of flood events.

Service-Oriented Management (SOM) in AWS

Agribusiness investors would now demand higher AWS levels for yields and production consistencies. Thus, the present irrigation and drainage services provided by the Government would need to be reviewed and restructured to match those expectations. This has already been done and implemented by the Water Supply and Energy Sectors. For AWS, the present service approach should now be restructured to be a SOM approach.

The SOM (Box 5) approach is based on an agreed level of service between the Supplier (Government or private entity) and the User (the business entity or farmers). This is a shift from the traditional top-down rigid approach (FAO Masscotte) to one that allows for higher operational flexibility for the supplier and the user.

Investments in the systems and the service facilities can be either by the Government or the private sector or both PPP. The Service Provider provides and delivers the service to the Users based on the agreement as to where, when, how and how much is required (refer Figure 7). The User then remunerates the Service Provider. This is similar to that of the Water Supply and the Energy Sector services. The system should have some level of flexibility for the user to specify demands in relation to seasonal needs. Remuneration for AWS remains a contentious issue but this is actually already practiced under the Irrigation Areas Act (1953) and Drainage Works Act (1954) although the rates have not been revised for many years. Unlike the Water Supply Sector, the measurement unit is based on operating area and not on volume of water used.

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

Replicating the Granary Model

The Granary policy for paddy production evolved in response to wide scale abandonment of paddy areas, irrigated and rain-fed, in the 1980s and 90s that threatened national food security status. The large contiguous irrigated schemes proved resilient by economies of scale and these then were deemed the National Granaries. This policy has proven to be advantageous from many aspects.

Apart from economies of scale, the regional spread is also a risk-spreading strategy in case of inevitable disasters or stresses affecting performance such as due to major floods, droughts and diseases. The policy has also allowed for regional and local access to products and job opportunities. In the long-term is has allowed for the farm activities to evolve into an industry. This influence of this progress is beyond the Granary boundaries. The paddy areas at the fringes continue to be active and developed to be in a position to be considered for incorporation into the nearby Granary. Also, it allows for a focused long-term planning and operations of resources including water resources and AWS development as well as for hazard management such as floods (refer Figure 23). Perhaps the one major setback is that the arrangement could be restrictive to diversification into other more locally and regionally attractive economic activity such industrialisation and housing development. The Granaries, however, have managed to address such issues pragmatically.

There are other sub-sectors of Agriculture that has developed to be similar models informally and driven by private sector initiatives or induced by special regulations. One example is the pig farming industry. The vegetable industry in Cameron Highlands is another. The oil palm industry is commercially driven but its regional sustenance is indirectly encouraged by oil palm mills acting as the nucleus that “bind” the surrounding farms and estates.

Developing agribusiness that is supported by an efficient AWS will need to consider replicating the Granary model. The potential locations are already indicated in the regional spread of the Agriculture EPPs (refer Figure 14). These EPPs could perhaps be the nuclei and catalysts for expanding into an economically viable local and industry. The AIZ sites of the Aquaculture sub-sector is already in place and these too could be formalised as agriculture business and industrial zones similar to the Granary model (Figures 15) (Azhar Mohd Isa, 2015; Marzuki Hashim and Yeo Moi Eim, 2015).

Table 12: Diversification Categories of Non-Granary Irrigation Scheme

State	Categories								Total No. of schemes
	1	2	3	4	5	6	7	8	
Perlis	3	2	5	-	-	11	1	-	22
Kedah	4	21	9	-	-	11	30		75
P.Pinang	6	-	5	-	-	-	3	-	14
Perak	6	37	6	-	-	10	4	-	63
Selangor	-	10	-	-	-	-	7	-	17
N.Sembilan	14	140	-	-	-	1	1		156
Melaka	9	39	1	-	-	-	5	-	54
Johor	9	5	3	-	-	4	2	-	23
Pahang	77	45	-	-	-	2	18	148	290
Terengganu	-	13	5	-	-	8	12	1	39
Kelantan	16	18	12	-	-	11	20	-	77
Sabah	-	3	-	-	-	16	32	5	56
Sarawak	-	1	-	-	-	-	37	-	38
Total	**144**	**334**	**46**	**-**	**-**	**74**	**172**	**154**	**924**

Categories:

Category 1 : Scheme to be converted to high value crop cultivation under irrigated condition.

Category 2 : Scheme to converted to tree crop cultivation

Category 3 : Scheme with two-cropping system planting paddy during the main season and short-term annual crops during the off-season

Category 4 : Scheme to be converted to animal feed crop cultivation or cattle raising field.

Category 5 : Scheme to be converted to freshwater fish culture ponds

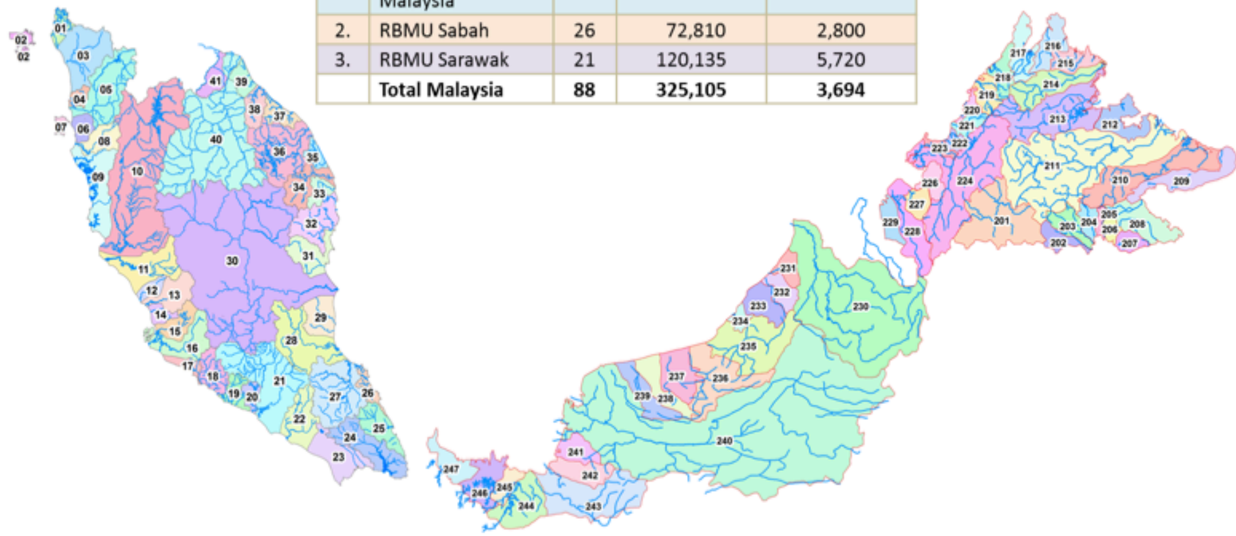
Category 6 : Scheme to be maintained as paddy Cultivation(mini-granary) areas

Category 7 : Scheme to be maintained as paddy cultivating areas for a definite period of time due to social consideration and thereafter to be further categorised, and

Category 8 : Scheme to be converted to housing/industrial and others uses

(Source: DID and JICA, 1990)

NO.	RBMU	UNIT	River Basin Area (Km²)	Average
1.	RBMU Peninsular Malaysia	41	132,160	3,223
2.	RBMU Sabah	26	72,810	2,800
3.	RBMU Sarawak	21	120,135	5,720
	Total Malaysia	88	325,105	3,694



(Source: DID, 2003)

Figure 24: River Basin Management Units (RBMUs), Malaysia

Another possibility for focused area production with distinct AWS support is the non-Granary irrigation schemes identified for conversion to non-paddy agriculture. Inventory and categorisation of these schemes were prepared in 1995 under the crop diversification study by DID with the cooperation of JICA (refer Table 12). Many of these schemes would have already been converted to oil palm particularly. The irrigation and drainage systems in these areas could be re-activated to support the needs of the relevant agribusinesses. Overall, future development planning should be based on the Integrated River Basin Management (IRBM) (Figure 24).

Improving Agriculture Water Security

Improving agricultural water management is deemed critical "because of its larger share in the overall water management landscape" (refer Box 3). The agricultural water security sub-index for Southeast Asia also shows potential to improve agricultural water security. The vulnerability of water for agriculture can be visualised from the conceptual inter-sector water management linkages. From here, paddy irrigation sub-sector with reservoir facilities would have higher levels of water security compared to others. Other schemes and agriculture sub-sectors are without and therefore vulnerable to drought and unregulated flows that are already in deficit in some regions.

Table 13: Large and Small Dams 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

(Source: RPM Engineers, 2014)

At present, there are 11 dams for paddy irrigation (Table 13) with total storage of 1,997 MCM (2% of total reservoir storages) (refer Table 14). Eight dams, all for paddy, are planned for the future (Paya Peda Dam for IADA Kawasan Pembangunan Pertanian Bersepadu Terengganu Utara (KETARA) (Besut) Granary) is under construction with a potential increased storage of 564 MCM (Table 15). There is effectively neither reservoir nor specific water resources facilities (as that for IADA Barat Laut Selangor, IADA Seberang Perak and KADA Granary) for other agricultural sub-sectors.

Table 14: Number of Dams and Storage Capacities by Sector in Malaysia

No	Sector	No. of Dams	%	Storage			Range (MCM)	Notes
				Capacity (MCM)	%	Average Capacity (MCM)		
1	Hydropower	13	14	79,142	95	6,088	0.4 - 44,000	Mahang - Bakun
2	Water Supply	57	61	2,326	3	41	0.01 - 760	Matang - Linggiu
3	Irrigation	11	12	1,997	2	182	0.14 - 1,073	Padang Saga - Pedu
4	Flood Mitigation	5	5	130	0	26	15 - 33.3	Sembrong - Timah Tasoh
5	Environment	4	4	0	0	0	0 - 0.038	Old Repas - New Repas
6	Recreation	3	3	27	0	9	0.06 - 26.5	Putrajaya
	Total	**93**	**100**	**83,623**	**100**	**899**		

Source: RPM Engineers, 2014)

Table 15: Storage Capacities of Potential Future Dams

No.	State	Purpose												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.

(*Source: RPM Engineers, 2014)*

Planning for new dam projects for agriculture is possibility but implementing them would be faced by several social, environmental and financial constraints. The way forward is for agriculture to promote and implement IWRM approach with all other water sectors. This would open the possibility of sharing of existing and available water resources in control by other sectors, especially by the Energy Sector that has an estimated total storage of 79,142 MCM (95% of National total) with potential future increase of more than 885 MCM. The Agriculture Sector has already supported the sharing of water resources with the Water Supply and Energy Sector in the MADA Granary and IADA Kerian Granary.

There is also an option to develop small reservoirs for agriculture. An inventory of potential sites for these was prepared in 1995 (refer Table 16) and could be reviewed for agribusiness objectives.

Table 16: Types of Small Reservoir Sites

Type of Small Reservoir		Number of sites	
Type A	Small dam across stream	112	(42%)
Type B	Pond in depression or swamp	95	(36%)
Type C	Oxbow of lakes	8	(3%)
Type D	Upstream of existing weir	35	(13%)
Type E	Tin mine pond or lake	13	(5%)
Type F	Others	3	(1%)
	Total	**266**	**(100%)**

a) Potential Small Reservoir

Purpose of Reservoir*		Number of sites	
1.	**Irrigation**		
	Paddy	128	(24%)
	Vegetables	141	(27%)
	Fruits	89	(17%)
	Others	30	(6%)
2.	**Domestic Supply**	30	(6%)
3.	**Industrial Use**	12	(2%)
4.	**Fisheries**	46	(8%)
5.	**Agro-Tourism**	54	(10%)
	Total	**530**	**(100%)**

b) Purpose of Potential Small Reservoirs

There are five types of structures for small reservoirs as follows:		
Type A	:	Low dam built on a small river, having a dam height less than 15m, a storage capacity of less than 1 million m^3 (100 ha-m), and a catchment area of less than $50km^2$;
Type B	:	Pond built by excavation, or dyking, or installation of regulating structures, in swamp, or low-lying land, or abandoned paddy field;
Type C	:	Pond formed by utilizing an oxbow lake adjacent to river course;
Type D	:	Reservoir created by widening a river width, excavating a riverbed, or heightening river banks upstream of an existing weir, and
Type E	:	Reservoir formed by a tin mine pond or a natural lake.

**The small reservoirs (266) mostly have more than one (1) purpose*

(Source: DID and JICA, 1995)

KAA 3: AWS for Food Security and Wealth Creation

Past experience has shown that one of the most important impacts of long-term and consistent AWS (as in Irrigation and Drainage services) is the increased level of confidence for farmers to continue and invest in agriculture, allowed for time and opportunities to develop capacities for income generation and on the whole, allowed for opportunities for wealth creation through the development of new business opportunities and industries. This is an important factor especially when food security objectives, particularly paddy, are more of a national agenda (Government's) than that of farmers. Agribusiness investors instead have returns on investments and maximising profits at the top of their agenda. Higher value crops would be more attractive or even, for agriculture landowners, converting the lands to non-agriculture investments.

For paddy, a food security crop, the conflicting agenda issue is addressed by the ETP through EPP10 and EPP11 with the exit plan for farmers. This "game changing" strategy for inclusivity in the GNI objectives is to encourage the shift from individual farming to commercial enterprises through offers of special financial packages for the exit. In their places would be the commercial farms operated by SPVs where they could also be shareholders or by external investors. In either case, the farmers would have the opportunity for employment in higher value jobs.

At present, the EPP10 efforts in the MADA Granary are focused on the exit plan and instaling tertiary systems for 50,000 ha. However, efforts now should also focus on developing a transformed AWS (refer to SOM above) to support the needs of wide scale commercial farms with a possibility for the tertiary systems to be operated and maintained by those enterprises or by private led AWS providers.

Similar efforts, for irrigation and drainage areas, are now necessary for all other sub-sectors of agriculture for food security and wealth creation – horticulture, fishery, livestock, plantation and commodities. Again, reflecting on the Cameron Highlands vegetable and flower industry, an AWS structure is now necessary to rationalise the agriculture water management for its development sustainability.

AWS for food security and wealth creation for rural prosperity should not be bounded by specific crops or by water sectors, but instead incorporating the needs of the local population and economies for growth and well-being. The breaches of paddy irrigation exclusivity to service the needs of multi-subsectors of agriculture (e.g. fishery in the Kerian Granary) and of other sectors (e.g. Water Supply (MADA and Kerian Granary, Energy (MADA Granary)) should be taken as positive changes supporting the ETP and as added responsibility of the AWS. Similar changes are also occurring in the agriculture drainage areas to accommodate drainage for urban growth.

Whilst AWS is to support food security and wealth creation, AWS by itself could be considered as an industry and should be structured as such. The AWS combined with the other water sectors such as Water Supply, Environment and Energy (Hydroelectric) as a Water Industry could form a significant economic sector and even qualify as an NKEA in the ETP. The global development direction is for Green Growth and in this case is to manage water as a natural capital for higher levels of economic and ecological quality in tandem with human capital development for higher skills and knowledge (Raekowon Ching, 2015). To put this in perspective, the world water industry (market) is projected to grow from USD 535 billion from 2012 to USD 865 billion by 2025 with an estimated growth rate at 5% annually after 2025 (Jeong-In Kim, 2015, from Environmental Business Journal 2014 Snapshot survey 2014; quoted in ASM 2015). In Malaysia, Suruhanjaya Perkhidmatan Air Negara/National Water Services Commission (SPAN) estimates that the Water Supply industry is already at USD 1.3 billion annually (ASM, 2015).

AWS as an industry would also provide for a systematic and market approach to advanced STI development and national ownership, one of the main characteristics of a developed nation. The potential is tremendous, ranging from softwares in planning and designs, to technologies for production, climate change mitigation and adaptation as well as for environmental enhancement.

STI will be needed to increase oil palm yields from 19.2 tons/ha to 26.2 tons/ha, worker productivity from 1.5 to 2.8 tonnes/worker/day and OER from 20.5% to 23% by 2020 (Vijaya Subramaniam, 2013). Green Growth technologies would be expected for methane gas capture (GHG savings of 16.3 million tCO2eq/yr) for electricity production (Electricity displacement of 5.8 million tCO2eq/yr).

A number of STIs are already being practiced, such as zero burning techniques by recycling of biomass and environmentally friendly pest management techniques (Tang Meng Kon, 2014). New ones are also emerging such as zero waste-zero discharge techniques (Sardar Ali, 2014) (refer to Figure 25).

The Rubber industry has already begun research on Wastewater recycling that has the potential to produce 60 million litres of potable water per day. This is on the use of membrane separation technology with recovery of value-added raw materials and Up-Flow Anaerobic Sludge Blanket (UASB) and membrane system with the capacity of processing 300 cu.m of wastewater daily (Preetiba and Christine Lee, 2015).

The STI for aquaculture would be towards intensive aquaculture system, Recirculating Aquaculture System (RAS) and "Closed System" (Mazuki Hashim, Yeo Moi Eim, 2015). In the Livestock sub-sector, mixed farming (integration of livestock and feed crops) for a better agro-environment ecosystem is encourage higher water productivity (Kamarudin M.I, Ramlan M, Moktir S and Helen M, 2015). Wastewater recycling and biogas for energy production are also emerging technologies applicable for large-scale farming.

MARDI has also begun research on water savings STI (Chan C S, Ayob H, Eddy H and Mohamed Fauzi, 2015). This includes on-farm Tail Water Reuse system, on-farm water reuse system, on-farm water harvesting, cultural practices for water savings and development of aerobic rice variety that requires less water for production, tests on Sustainable Resource Initiative (SRI), short duration rice variety and drought tolerant variety development. New high-technology equipments are also being tested for higher levels of precision farming.

Future agriculture water management would also need STIs for data and information management for system managers and farmers (Elizabeth Malangkig, 2015).

For aquaculture, oil palm and selected agriculture process, researches in Agriculture Sector Water Footprint has also begun (Haslawati Baharuddin, 2013; Zainura Zainon Noor, 2015) and would be useful for refining future policies, strategies and action plans for agriculture water management. At present, the tendency is for applications of advanced technologies imported from elsewhere. There is a need to shift this approach so as to vigorously encourage local STI development.

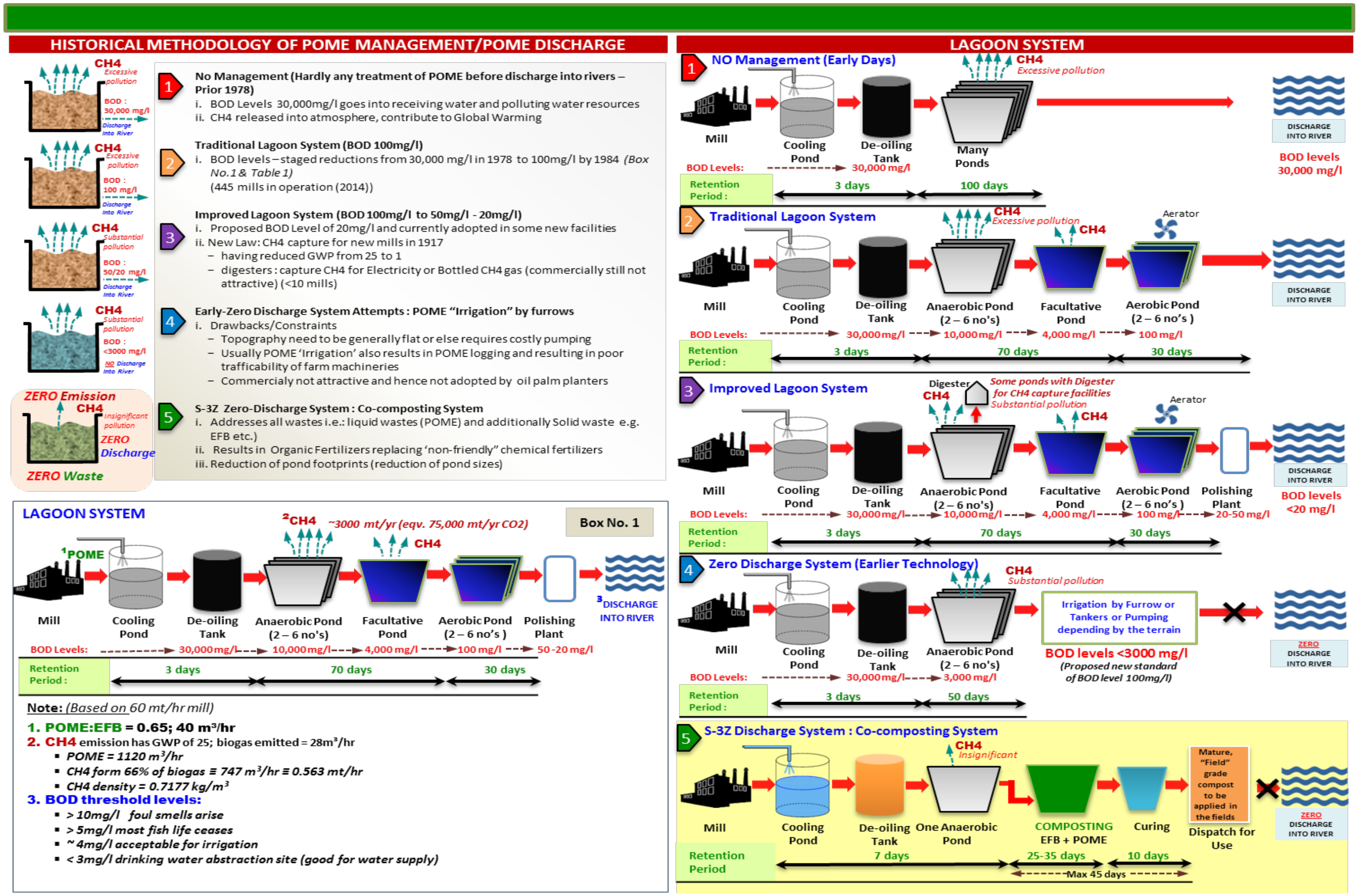
Benefits of Information and Communication Technologies (ICT)

Case: Attracting youth into agriculture

ICTs are changing the image of farming from a back-breaking , hardly remunerative, labour-consuming task to a much more profitable and decent source of income. ICTs not only improve the farming sector in general but also the status of young persons using it. According to recent research into three projects located in Western Kenya (Eldoret, Kakamega and Kisumu), youngsters who used to see farming as a type of last resort source of income without much perspective now regard the sector as a potentially strong source of rewarding business. Aside from being able to obtain information about the best market prices, ICTs also provide young farmers with access to new farming practices and agricultural (including irrigation) technologies, information on pest and disease control as well as communication with other farmers. Early adopters of ICTs for farm management receive recognition from family and community members for their technical knowledge and higher incomes that inspire others to follow suit in the adoption of ICTs for farming.

(Source: UNESCO, 2016)

BOX 14: Benefits of Information and Communication Technologies



(Source: Sardar Ali, 2015)

Figure 25: Development of Zero Waste – Zero Discharge Systems

KAA 4: Investment and Financing for AWS

One of the key expected outcomes of the ETP through the EPPs is job generation, especially that of high value. The EPPs under Agriculture alone is expected to generate 109,335 jobs. The expectation is that these EPPs would be able to be replicated and expand to provide for more opportunities.

Agriculture is a highly water-dependent industry, and therefore, the jobs too. It is estimated that 95% of the jobs in agriculture is heavily dependent on water (Richard Connor and Marc Paquin; Carlos Carrion-Crespo in Water and Jobs (UNESCO, 2016)). Beyond agriculture, the estimates are 30% in industry and 10% in the services sector. Therefore, investments for agriculture water with water productivity objectives are crucial for job opportunities and sustenance within the sector (the biggest water user and returning used water) and beyond.

Typical interventions in water for types of farmers are shown in Table 17 (Water and Jobs). In the transition to agribusiness, all of these (in varying scope) have relevance in the national context and deserves consideration under the inclusivity criteria of the ETP and other overriding development policies.

Allocating water for Growth and jobs

The allocation of water resources and the provision of water services to different economic sectors will largely dictate the growth potential for high quality jobs at country and local levels.

(Source: UNESCO, 2016)

BOX 15: Allocating Water for Growth and Jobs

Investing in water is Investing in jobs

Water investments are a necessary enabling condition for economic growth, jobs, and reducing inequalities. Conversely, failure to invest in water management not only represents missed opportunities, but may also impede economic growth and job creation.

(Source: UNESCO, 2016)

BOX 16: Investing in Water is Investing in Jobs

A modernisation study for five Granaries was undertaken in 1998 by the DID with the cooperation of JICA. These will need updating and review of criteria. Based on the study, the investment for upgrading seven matured Granaries is RM 1.7 billion (refer Table 18 (from WDM)). There is also a proposal to establish a CoE for Irrigation and Drainage estimated to be RM 30 million.

Apart from the traditional financing approach for water infrastructure and services, agriculture now would need to consider other financing models for investment and services. The AWS could be based on the Federal Road and Federal Building maintenance model implemented by the KKR. This is a long-term performance-based contract and has shown advantages in improved services as well as strengthening the private sector capacities in this sector. Financing models for AWS such as those in the Water Supply and Energy sectors by appointing services providers should be seriously considered for a developed status nation.

Benefits of Investing in Irrigation

In the agricultural sector, numerous studies show that investments in irrigation have an overall multiplier effect on the economy estimated between 2.5 and 4 (CAWMA, 2007; Bhattarai et al.,2007; Hussain and Hanjra, 2004; Lipton et al.,2003; Huang et al., 2006). Investments in water management and savings, such as canal lining or micro irrigation, require a workforce for producing, installing and maintaining necessary equipment (UNEP/ILO/IOE/ITUC, 2008). This can be a relevant source of employment for the rural poor (CAWMA, 2007). Increased farm output also stimulates demand for farm labour in terms of number of workers and length of employment.

(Source: UNESCO, 2016)

BOX 17: Benefits of Investing in Irrigation

CAWMA : Comprehensive Assessment of Water Management in Agriculture

Table 17: Targeting Water Interventions to Different Types of Farmers in Asia

Type of farmers	Typical interventions in water	Typical interventions in water
Large	Modernisation of irrigation infrastructure and management, adoption of sustainable groundwater governance mechanism, disaster risk management	Facilitating market linkages
Medium	Conjunctive use of canal water and groundwater, investments in technologies and management models that contribute to improved water productivity	Facilitating market linkages
Commercial, small	Adoption of sustainable groundwater governance mechanisms, adoption of more effective management models in community-based irrigation schemes	Development of entrepreneurship, facilitating market linkages, promote linkages with large agribusiness, improves and quality of financial services
Subsistence, small	Rainwater management through intermediate forms of water control, access to groundwater, access to small scale technologies to capture, store and distribute water	Access to basic services, rural infrastructure, diversification of income, social status
Diversified	Multiple-use water service for domestic water and household gardens, livestock, atomistic irrigation	Rural infrastructure, training and support for non-farm activities
Women farmers	Empowerment involvement in water users associations and decision-making processes, development of irrigation technologies adapted to their specific needs	Enhanced capacity and skills in farm marketing, access to microcredit
Landless	Design of water service that consider the specific needs of the landless	Training to support non-farm activities

(Source: FAO (2014d, Table 4.1, p. 80) cited in UN-WWDR 2016)

Table 18: Estimated Developments Costs for Irrigation Modernisation

No.	EFFICIENCY IMPROVEMENT	UNIT	RM/ UNIT	QUANTITY	TOTAL COST (RM MIL)	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	CoE for Irrigation Management Modernisation	No		1	30	Set-up cost only Operating cost is RM 10 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**	

(Items No, 2, 3 and 4 derived and adjusted from Government of Malaysia (DID) and JICA (1998), The Study of Modernization of Irrigation Water Management System in the Granary Areas of Peninsular Malaysia
(Source: ASM, 2015)

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

The PPP approach as in the Built Operate and Transfer (BOT) approach for Water Supply, Energy and Transportation sectors (expressways, LRT and MRT). Such models are already being implemented in the Agriculture Sector in France with the participation of end-users WUGs as shareholders in the venture. The French PPP enterprises have advanced to include research, consultancy and STI development as part of their services. Some have even begun to invest in AWS PPPs in certain African countries.

Accelerating Water Innovations – Case Study

Europe

Like other European innovation partnerships, the European Innovation Partnership on Water (EIP Water) was initiated by the European Commission (EC) to accelerate water innovations, with a specific focus on those that serve to address societal challenges, foster the EU's competitiveness and support the EC's overarching goal of creating jobs and stimulating economic growth. The EIP Water is intended to create market opportunities for these innovations (inside and outside of Europe), remove barriers by advancing and leveraging existing solutions, and initiate and promote collaborative processes for change and innovation in the water sector across the public and private sector, NGO's and the general public. The implementation of the EIP Water started in May 2013, and it's primary vehicles are voluntary, multi-stakeholder Action Groups (almost 30 registered in 2015) and an online Market Place on the EIP Water online platform.

(Source: UNESCO, 2016)

BOX 18: Accelerating Water Innovations - Case Study

Major international funding institutions such as the ADB and World Banks are also providing support for similar models to be implemented in developing countries.

Benefits of Water Investments

The benefits of water investments – for employment, economic growth and well-being – can be remarkable. The US Department of Commerce's Bureau of Economic Analysis found that each job created in the local water and wastewater industry creates 3.68 indirect jobs in the national economy (United States Conference of Mayors, 2008b). Investing US$ 188.4 billion, the amount needed to manage stormwater and preserve water quality in the United States, could generate US$ 265.6 billion in economic activity, create nearly 1.9 million direct and indirect jobs (e.g. in manufacturing to supply equipment and machinery) and result in 568,000 additional (induced) jobs from increased spending (Green for All, 2011) . Furthermore, traditional water infrastructure is estimated to generate between 10 and 26 direct, indirect and induced jobs per US$ 1 million invested (Green for All, 2011; Pacific Institute, 2013).

Moreover, investments in sustainable water practices are estimated to generate: between 10 and 15 direct, indirect and induced jobs per US$ 1 million invested in alternative water supplies; between five and 20 direct, indirect and induced jobs per US$ 1 million invested in stormwater management; between 12 and 22 direct, indirect and induced jobs per US$ 1 million invested in urban conservation and efficiency; and between 10 and 72 direct, indirect and induced jobs per US$ 1 million invested in restoration and remediation (Pacific Institute, 2013).

(Source: UNESCO, 2016)

BOX 19: Benefits of Water Investments

In the above approaches, it is not only advantageous in terms of higher levels of service enjoyed by the end-users, but also in terms of cap acity development of the service providers from increased knowledge and skills, and attracting as well as retaining talents in the respective specialisation.

New investment funding structures should also now be considered as promoted by the NBOS.

Conversion of single-purpose systems to multi-use systems is a Blue Ocean strategy since it maximises the use of existing resources and facilities. Extending this concept is the possibility of cross-sector financing, such as Water Supply Sector investments in Agriculture Sector to increase water savings in paddy irrigation that would relieve water resources for the Water Supply Sector. This could defer the need for the Water Supply sector to develop new dams for example. Another possibility is for the Agriculture and Water Supply Sectors (and even for flood management) to jointly and proportionately invest in the "investment attractive" Energy Sector development of new dams for renewable energy production but for multi-purpose use. The possibility of raising the height of existing sectorial dams for increased storages and for multi-function could be another strategy for water security improvements through cross-financing.

Another possibility of a financing model is for selected agricultural areas to be designed to temporarily store floodwaters as part of the flood management system. This could reduce the need for heavy investments in flood control and flood management infrastructures to protect both urban and rural settlements. The case of cash compensation by the Government for flood damage crops in the MADA Granary could be studied in detail (Table 7) for this approach in flood management. The compensation could perhaps be developed to be an arrangement for fixed land rental of the flood susceptible paddy lands for excess flood flows.

As an initial assessment, from the average compensation of RM1,000/ha for flood damage over 4,000 ha, the average total compensation is RM 4 million/year in the MADA Granary. For over 10 years, this works out to be RM 40 million or RM25 million NPV at say, 10% discount rate. This amount is far less that physical flood management infrastructure project that could be as much as RM200 million (as say RM 50,000/ha including land acquisition) to protect 4,000 ha at 1:20 year ARI. This can be a very attractive approach to flood management financing that also reduces the need for land acquisition. However, the acceptance of farmers is critical to implement this.

KAA 5: The WEF Nexus Approach

That Malaysia has achieved a comfortable food SSL (Figure 16) is indeed commendable. However, SSL is by no means a representative indicator for food security levels. SSL refers mainly to production in the country (and locality) whilst the attributes for security cover elements that include physical and economic accessibility for dietary needs and preferences that is also dependent on supply from elsewhere in the country or from international sources. The WEF Security Nexus approach is gaining interests of policy-makers and sector managers. There are several approaches to analysing these three key inter-related elements of security for sustainable development (Hezri, 2015). The FAO concept for the WEF Nexus management (refer Figure 17) is based on fundamental drivers and pressures that influence the impact on the WEF elements and consequential responses. An example (International Trade) is the food price crisis in 2007/2008 (refer Box 6). The impact on

Malaysia was a rice supply shortage incidence in 2008. Although for only a short period (less than a month) and localised (in central Peninsular), the policy response was swift and significant. The SSL for paddy was revised to be more than 70%, four new Granaries were added to the existing eight matured Granaries and investments in paddy irrigation were increased and included for active non-Granary irrigation schemes with considerations that these be added to the nearest Granary.

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

The conceptual model for AWS in relation to managing the WEF Security Nexus and Water Resources security is shown in Figure 18. In the long term, the AWS would have to be established based on similar models for the Water and Energy Sectors with defined Governance structure. The interactions between the respective sector services and Governance should be the basis for IWRM and ultimately for achieving the desired levels of Water, Energy, Food and Water Resources security.

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

One is the NCER covering the States of Perlis, Kedah, Pulau Pinang and the northern region of Perak. This region is host to three of the 12 Granaries namely MADA Granary, IADA Pulau Pinang Granary and IADA Kerian Granary. The irrigation facilities for these are increasingly under pressure to service the Water Supply and the Energy Sector (an IPP in Kedah). Another is the Perak River basin (Figure 19) where the Energy Sector (hydropower) is under pressure to release more of its waters for agriculture (including the IADA Seberang Perak Granary) and water supply needs downstream. The case of informal (private sector initiative) irrigation for vegetable and flower industry in the Cameron Highlands is indicating severe impacts on the Water Supply and Energy (hydropower) Sectors as well as the Water Resources security here and even on the Agriculture Sector itself.

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

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

In fact, the pressure on water resources security is already becoming significant in many parts of the country especially in the water stress regions. One of the strategies that is crucial and has been continuously promoted is the IWRM approach.

The Agriculture Sector has already acquired a long experience and knowledge in IWRM approach and practices for its water resources development and water services. Agriculture development and management has always been on a consultative and participative approach between institutions (JPS, DOA, LPP) involving not only multi-disciplines but also the end-user i.e. the farmers. The Drainage Works Act (1954) has provision for the formation of a Drainage Board comprising Government representatives as well as the private sector.

The IWRM approach is also reflected on the ground by institutions such as MADA, KADA and the IADAs for paddy and non-paddy crops with all of them integrating the various service and professional components under a single organisation dedicated. Since the 1980s, Water User Groups comprising farmers were formed. This is in recognition that the success of water demand management is highly dependent on their support and active participation at planning, design, construction, capacity building and on-farm water management in harmony with systems water management. Beyond the sector, the breach of agriculture water boundaries as in the MADA Granary and the Kerian Granary should be accepted positively as an affirmative response of this sector for IWRM approach with other sectors.

The IWRM approach is in fact in line with the NBOS for sharing of resources for development.

Implementing the IWRM approach as one of the key strategies for the Nexus management in turn requires strategic enabling environment for sectorial boundary relaxation to accommodate inter-sector needs. Apart from this, the other major challenge for IWRM in Nexus management is transboundary water management (as in the NCER; inter-State transboundary rivers (e.g Muda, Kerian, Bernam, Linggi, Muar rivers) that involves inter-State Governments as well as the Federal Government. Transboundary relaxation to accommodate IWRM approaches too would require an enabling environment towards developing management protocols.

An enabling environment that could be a basis for structuring the IWRM and Nexus management protocol is a common and universally agreed water accounting and audit system.

KAA 6: Public Participation and Capacity Building

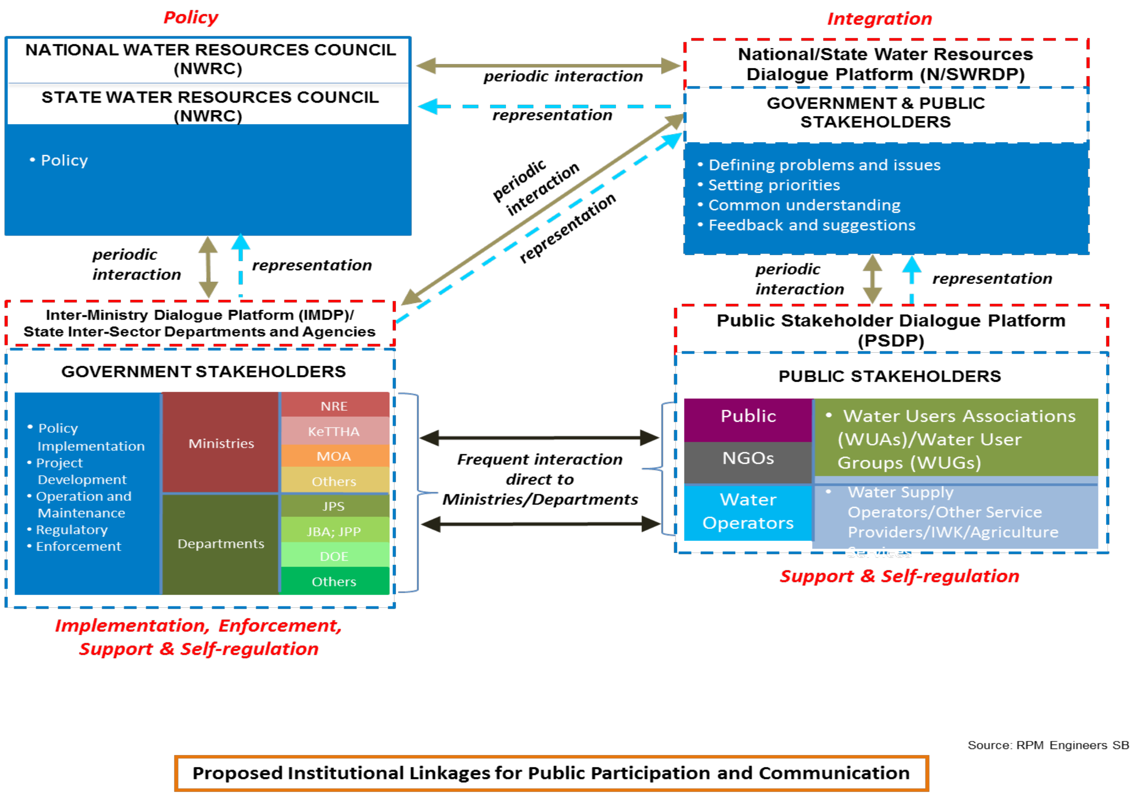
One of the characteristics of a developed nation is a high-level of public participation in local, regional and national water management.

As mentioned above, agriculture development and management has always been on a consultative and participative approach with direct farmers' (end-users) involvement for improved water management. Implementing the Irrigation Areas Act (1953) requires consultative sessions with the farmers to decide on seasonal irrigation schedule that form the pivot for all other farm activities. The agreed schedule is then gazetted for compliance. In the 1980s, Water User Groups were formed in irrigation schemes for improved on-farm water management. The performance of the WUGs declined in the 2000s but is now being revitalised by the MOA. The Drainage Works Act (1954) has provision for the formation of a Drainage Board comprising Government representatives as well as the private sector.

For Water Supply Sector, the Water Services Industry Act (WSIA) has provisions for Water Forum for the public. The Energy Sector (TNB) issues regular advisory messages to end-users on measures for energy savings.

The need is now to formalise the WUGs and form linkages with the Government water management institutions. Advanced countries such as France and Spain have already incorporated laws on the formation of WUGs (Water User Associations (WUAs)). The USA too has WUAs for all sectors of water uses including for lake management.

A proposed formal public participation institutional linkage is shown in Figure 26.



(Source: ASM, 2015)

Figure 26: Proposed Institutional Linkages for Public Participation and Communication

A formal structure and institutional arrangement allowing for public participation has many advantageous. Theses includes to improve end-user understanding of water issues and gaining their support in implementing strategies and plans for improvement, preparing them for stress and disaster situations and, important in the long-term, to increase their appreciation of water services and to prepare them to be ready that ultimately there is a need for cost sharing for the services.

New Themes for Capacity Development Promoting water integrity

The African Water Vision 2025 named inappropriate governance and institutional arrangements as core human threats to sustainable water management. The vision called for fundamental changes in policies, strategies and institutional arrangements for the adoption of participatory approaches, as well as for openness, transparency and accountability in decision-making processes. Specific attempts to promote water integrity with a coherent approach were taken during the implementation of the Capacity Building Programme on Water Integrity in the Western African sub region. The participants from 12 countries – Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Liberia, Mali, Niger, Nigeria, Sierra Leone and Togo – who attended the five regional training workshops organized in the sub region stemmed from all segments of society (government, business, members of parliament, representatives of civil society organizations and representatives of the media and river basins authority). At the end of each workshop, participants drafted a national water integrity action plan to be submitted for refinement, enrichment, validation and endorsement to a wider group of stakeholders at the national level.

Even more profound reforms concern the need to enhance the quality of governance in the water sector as a whole and the need to combat corruption in the water sector in particular. Insufficient understanding of roles and responsibilities leads to blurred accountability lines and procedures that can easily be captured by corrupt groups. The institutional fragmentation of the sector exacerbates corruption risks. To effectively promote integrity in such a context, a comprehensive approach is required that focuses on creating an enabling environment that fosters transparency, accountability, participation and anti-corruption.**

** Transparency, Accountability, Participation and Anti-Corruption, often abbreviated as TAPA, are the key elements of Integrity.

(Source: Françoise-Nicole Ndoume (WIN), based on UNECA/AU/AFDB (2000) and UNDP GWF (2014) cited in UNESCO, 2016)

BOX 20: New Themes for Capacity Development

Another advantage is that a formal structure facilitates capacity building programs on water management. For irrigation, the WUGs were the target groups for water management training at the National Water Management Centre (now converted to other non-agriculture training).

Managing a meaningful and effective public participation requires special capacity building program for the WUGs as well as the system managers. Another area of interest in developing capacity building programs is on the subject of integrity and transparency in agriculture water management and AWS.

New Themes for Capacity DevelopmentPromoting water integrity Training Approaches by Private Operators

At the beginning of a performance improvement contract, a private operator usually starts with an in-depth audit that covers the strategies, organizational structure, business processes, organizational performance and the workforce and managers. The findings usually show that training and organizational reforms are required to achieve necessary performance improvements. Such reforms may include a change of corporate culture, enhancement of key processes and working routines, as well as a change of work ethics and attitudes, and an injection of skills and technology into management and the labour force. In-depth reform is often undertaken through a multi-year change management programme that is developed in extensive consultations and negotiations with the local contracting authority and the workers unions.

These change programmes include a specific training component that runs the entire length of the contract. All staff and management levels receive appropriate training, including on the job, classroom training and mentoring. Larger private operator make use of international standards and practices, and have in-house networks of specialists, campuses, web-based trainings schemes, as well as partnership with local knowledge institutions. They aim to continuously develop employee skills through formal training programmes leading to diplomas, certifications and professional licenses (AquaFed, 2015).

Contributed by Jack Moss (AquaFed).

(Source: UNESCO, 2016)

BOX 21: Training Approaches by Private Operators

CHAPTER 3:
STRATEGIES FOR AGRICULTURE WATER SERVICES

CHAPTER 3: STRATEGIES FOR AGRICULTURE WATER SERVICES

3.1 The Approach

Developing strategies for water and agriculture for a developed nation requires an appreciation of models that have been practiced successfully, anticipation of problems and issues of the future, a vision for social and economic growth and incorporating opportunities for wealth creation and sustainability even beyond the boundary of agriculture.

The approach here is to review the following:

- Lessons learned and experience gained from the history of irrigation (paddy) and drainage schemes (for non-paddy) development and management;
- Emerging issues and current efforts; and
- Vision for the future of water and agriculture.

3.2 Lessons from History of Irrigation and Drainage

Large-scale development and management of agriculture water services in Malaysia has been primarily for irrigation for paddy and drainage for non-paddy crops. On a smaller scale, the services also included aquaculture development and drainage improvements for livestock industry.

Malaysia is one of the few countries that have developed large-scale irrigation systems principally for mono-cropping i.e. paddy. In many other countries, large-scale irrigation development are for multi-cropping.

The systematic approach to these two principal aspects of agriculture water services, irrigation and drainage, essentially began in 1932 (Table 19) and the experience and knowledge gained over the last 84 years are valuable in understanding the success factors as well as weaknesses in water management for sustaining agriculture over those years of tremendous social and economic changes. These lessons from history are important for formulating appropriate strategies for water and agriculture development for the future (Figure 27).

Policies

The issues of poverty in the rural areas and incidences of food shortages (rice) in the late 1920s were the drivers that led to Government intervention in providing a systematic approach to agriculture water services in Malaysia. This was the introduction of policies to increase rural income as well as to ensure adequate production of rice in the country for food security. Agriculture was the main economic activity and opportunity for income then and extreme poverty prevailed mainly amongst the farmers. Thus increasing rural income was directly related to increasing yields as well as production and this in turn improves the food security levels.

Table 19: Irrigation and Drainage Development and Management Attributes 1932 – 2004

NO.	STRATEGIES	INSTRUMENTS / ENABLERS	IMPACT
1.	**Policy**	• Poverty Eradication Policy • Food Security Policy • Crop Diversification Policy • Granary Policy • Government responsible for public investment; farmers responsible for on-farm private investment • Federal Government investment for infrastructure • Joint Federal – State financing for systems Operations and Maintenance	• Clear, defined, consistent and long-term policies • Allowed for long-term investments and time for return on investments • Rapid policy response to socio-economic needs • Strategic resource management (Granary Policy) • Provide for economies of scale • Farmers confidence to invest and continue production • Efficient and effective resource management
2.	**Dedicated Institutions for Paddy Irrigation and Agriculture Drainage**	• Formation of the JPS at Federal and State levels to focus on implementing the policies and achieving the objectives • Formation of MADA • Formation of KADA • Formation of National Water Management Training Centre (NWMTC) • Formation of National Hydraulic Research Institute Malaysia (NAHRIM) for large volume agriculture water management • Formation of Integrated Agriculture Development Project (Area) (IADP/IADA) for specific large-scale; water dominant projects (the Granaries; large-scale drainage (e.g. Western Johor Agriculture Development Project)	• Allowed for long-term development of skills and knowledge for continuous improvements • Long-term Federal-State relationship • Focused and specific development programs • Bonding with end-users; manager-farmer confidence building • On-site Integrated and multi-disciplinary approach to agriculture development and management
3.	**Laws, Rules and Regulations**	• Irrigation Areas Act 1953 (Revised 1989) Act 386 and Act 354 • Drainage Works Act 1954 (Revised 1989) • Sabah Enactment No. 15, the Drainage and Irrigation Ordinance 1956	• Protect Government investments • Instil discipline of stakeholders in use of facilities • Allowed for formal platform for Government-Private/Public Sector participation • Provided for a formal Governance structure • Provision for payment and collection of water and water services charges from users • Long-term development of management procedures and processes leading to in-built management culture and self-Governance

Table 19: Irrigation and Drainage Development and Management Attributes 1932 – 2004 (cont'd)

NO.	STRATEGIES	INSTRUMENTS / ENABLERS	IMPACT
4.	Science, Technology, and Innovations	• Development of local-based planning, design, construction and management criteria, practices and tools • Rapid adaptation for technical and management adjustments to engineering and socio-economic needs • Encourage local adaptations and innovations including by farmers (direct seeding technology) • Applications and adaptation of modern technology for management and farming	• Irrigation systems designs for paddy in humid tropics • From single to double cropping systems • Rapid systems design and management response to changes • Computer-based irrigation water management systems with telemetric system support, automation and remote control of hydraulic structure • Hydrology and water resources assessment and planning tools • Direct seeding in place of labour-intensive transplanting • Farm mechanization
5.	**Public Participation**	• Stakeholders (farmers) participation and consultation in infrastructure development and system management • Formation of WUGs in irrigation schemes • Drainage Boards in gazetted Drainage Areas	• Consensus in irrigation scheduling for water resource management and streamlining other farm input resources management – seed, machinery, fertilizer, pesticide, transport, mills, distribution • Water saving efforts in terms of reducing wastage in use and on-farm infrastructure improvements • Cooperation for efficient irrigation water management and water savings • Instil sense of system ownership and care
6.	**Wealth Creation**	• Increased and stable income for farmers • Mechanisation provided increased off-farm job and income opportunities • Development of new farm-support industries and services (rural jobs and income sources) – services and support services for land preparation, seeding, seed production and broadcasting, fertilizer and pesticide applications, transportation, harvesting • Ready for export of agriculture water services to cooperate with other developing countries in irrigation and drainage development (e.g. Nigeria and other African countries)	• Long-term existence, economies of scale and proven system performance encouraged investments in new business opportunities • Original investments in large-scale agriculture drainage and continuous systems management has allowed for rapid non-agriculture development and economic growth • Skills, knowledge and experience gained can be shared with other developing countries for their wealth creation

Table 19: Irrigation and Drainage Development and Management Attributes 1932 – 2004 (cont'd)

NO.	STRATEGIES	INSTRUMENTS / ENABLERS	IMPACT
7.	**Capacity Building and Enrichment**	• Systematic training programs by NWMTC for managers and farmers at the centre as well as on-site • DID Manual (DID, 1960) (updated 2012) • Hydrological Procedures (DID, 2010) • Planning and Design Procedures Publications • Specific training programs for system planners, designers and managers	• Skills and knowledge have ensured continuous rice production twice-a-year every year over the past 40 years in the Granaries and active non-Granary irrigation schemes
8.	**International Participation and Collaboration**	• International Commission on Irrigation and Drainage (ICID) • International Water Management Institute (IWMI) • Food and Agriculture Organisations (FAO) • Japan International Cooperation Agency (JICA)	• Long-term active participation has built recognition and respect for local expertise • Continuous exchange of knowledge and skills to address current and future issues. • Higher levels of contribution to local and international knowledge and skills

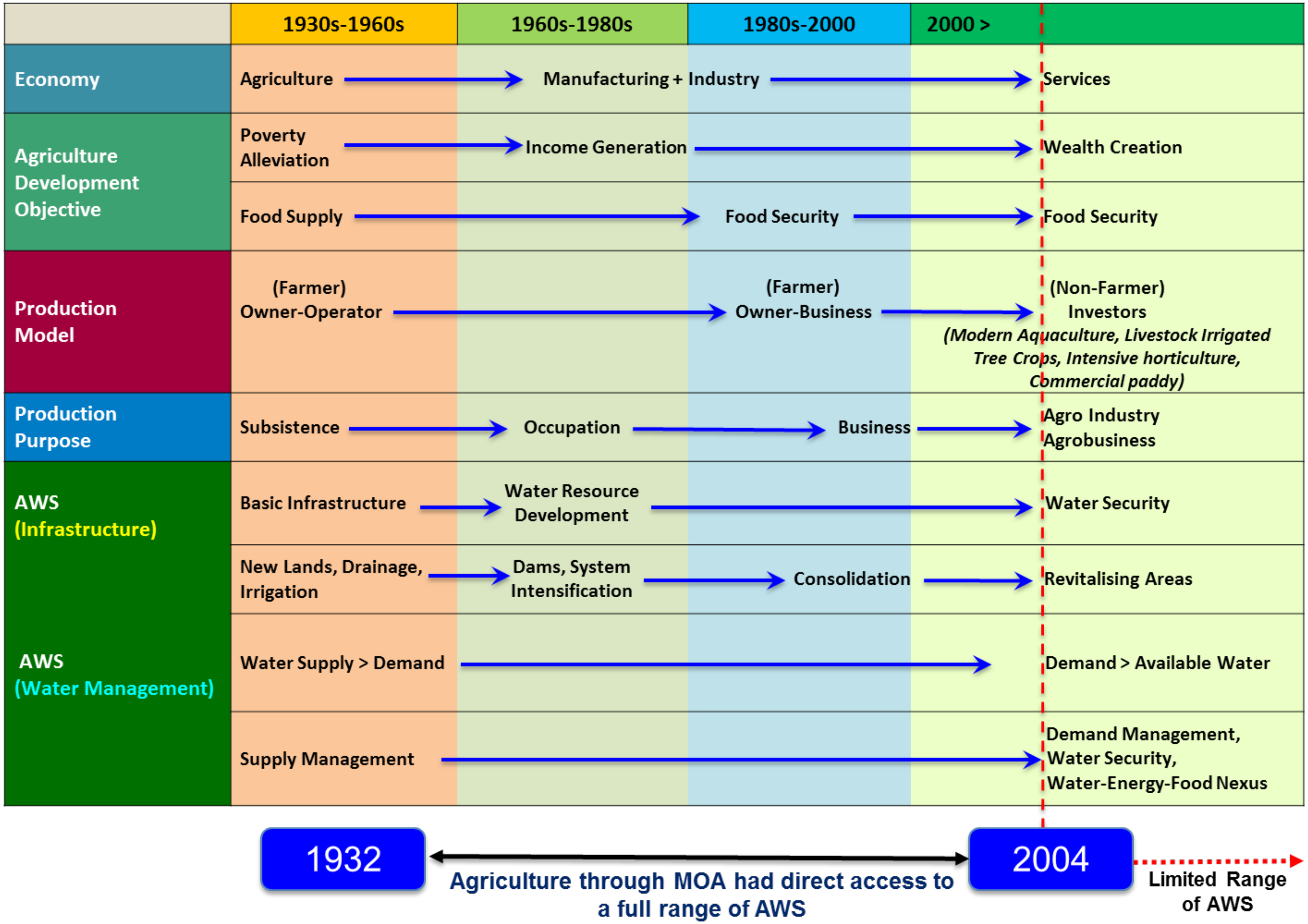


Figure 27: Agriculture through MOA (1932-2004)

The provisions of large-scale drainage and irrigation facilities and services were the principal strategies to achieve those policy objectives. These are necessary not only to increase production but ensuring the consistency and stability of production and therefore income.

Policies on food and income have remained consistent over the years. There is however a shift on emphasis from dependency on agriculture as the main source of income and job opportunities to a more diversified choice. The emphasis on local paddy production for food security remains especially in recognition of demands from an increasing population, limited availability in the international markets and, equally important, the socio-political sentiments and sensitivity attached to assured rice supply. This was demonstrated in the 2008 incidence of rice supply shortage in the market. Although it occurred over a relatively short period (less than a month) and only in a localised region (central Peninsular Malaysia; outside the Klang Valley), it caused panic-buying and general disquiet amongst the population. The policy response was increased investments in paddy irrigation systems upgrade as well as adding another four (4) new Granaries to the existing eight (8) matured Granaries. The four are the Pekan and Rompin Granaries in Pahang, Kota Belud Granary in Sabah and Batang Lupar in Sarawak (Figure 22).

The Granary Policy was introduced in the 1990s in response to wide scale abandonment of small paddy irrigation schemes that began in the mid-1980s. This was due to the success of the Government's economic diversification policy that began in the late 1960s that provided more attractive opportunities for the farmers. The small-scale irrigation and rainfed paddy areas were severely affected but the large contiguous irrigation schemes sustained on economies of scale. Following this the irrigation schemes with sizes above 4,000 ha were recognised as National Granaries to be given special attention and investments as well as management support to ensure and sustain rice production in the country. These Granaries are MADA, KADA, IADA Pulau Pinang, IADA Kerian-Sungai Manik, IADA Seberang Perak, IADA Barat Laut Selangor, IADA KETARA (Besut) and IADA Kemasin-Semerak. These eight (8) matured Granaries are now contributing 72% of the national paddy production. The Government continues to provide support for those active non-Granaries but the long-term policy is to allow these areas to be gradually converted to other non-paddy use.

In terms of support, the policy has always been for the Government to invest and operate and maintain the water resources and the main systems infrastructure up to tertiary level. Plans for farmers to eventually take over the tertiary systems management are being considered. Farmers are responsible for on-farm investment and water management. From time to time there are programs by the Government to provide financial support in the form of grants or cost sharing with farmers to undertake land levelling and on-farm infrastructure improvement works.

Dedicated Institutions for Paddy Irrigation and Agriculture Drainage

Prior to 1932, there were already attempts by the Government to develop paddy irrigation and agriculture drainage in several States mainly by the Public Works Department (JKR). However, this approach was found inadequate to meet increasing food demands and to address the poverty issues then. Following the policy to increase paddy production and rural income, the Drainage and Irrigation Department (later the Department of Irrigation and Drainage (JPS)) was formed in 1932. This is an institution dedicated to and focused on accelerating and sustaining the development and management of paddy irrigation schemes and drainage systems for other crops especially along the coastal plains. The JPS, under the Ministry of Agriculture then, provided the full range of agriculture water services covering land reclamation, flood protection, coastal protection, river management, water resources development (surface and groundwater) and irrigation (paddy) and drainage (non-paddy) systems network and research and training. The technical support and advisory and budgetary services were from the Federal JPS Headquarters and systems operations and maintenance were by the respective State JPS offices. On-farm water management remained to be the responsibility of the individual farmers or private sector landowners.

Two other dedicated institutions involved in agriculture water services are the MADA for the MADA Granary and the KADA for the KADA Granary. These were formed in the 1960s under the respective Acts.

Another form of dedicated institution that are involved in agriculture water development services are the Integrated Agriculture Development Project (IADP) offices. These are multi-disciplinary organisations formed by the MOA (Federal) at the project levels of each of the Granary and large-scale drainage Projects (e.g. the Western Johor Agriculture Development Project) and working closely with the respective State institutions such as the State Economic Planning Unit (UPEN), local authorities and State Government Departments (e.g. State local authorities and other departments such as JPS, DOA, JKR and Water Supply).

In 1984, the National Water Management Institute was established and dedicated solely to training system managers and farmers on water management. In 1994 the JPS Research Division was upgraded with the formation of an independent NAHRIM but still under the MOA. Its main function then was to undertake applied research in the planning and design of irrigation and drainage systems and their components not only for Government projects but also for the private sector.

Laws, Rules and Regulations

As the area and number of paddy irrigation schemes and agriculture drainage areas increased, it was found necessary to promulgate laws, rules and regulations to manage them. Perak had an Irrigation Enactment as early 1899. With increasing Federal Government involvement in irrigation and drainage development (Irrigation and Drainage are in the Concurrent List of the Federal Constitution) two specific Acts were introduced. These were the Act 386, the Irrigation Areas Act 1953 (Revised 1989) Act 386 and Act 354, the Drainage Works Act 1954 (Revised 1989). Sabah has a combined drainage and irrigation law, Sabah Enactment No. 15, the Drainage and Irrigation Ordinance 1956.

These laws have essentially provided for long-term protection for Government investments in irrigation and drainage works. This was through the provision that specified and controlled the type of crops (paddy cultivation in irrigation schemes) and landuse in the gazetted irrigation and drainage areas. The Acts also provided management rules such as preventing water wastages, controlling pollution and illegal diversions and disruptions of irrigation water supply and drainage. Both Acts also provided for the payment of Water Rates (for Irrigation) and Drainage Rates (for Drainage Areas) by the end-users. These are not based on volume utilised but rather on the area owned. The rates are collected by the State Governments through the annual payment of land taxes. There are also provisions for penalties for non-compliance with the laws.

The Drainage Works Act also provided for the formation of Drainage Boards in gazetted drainage areas comprising representatives from the Government and the private sector. This allowed for smallholders as well as the large estate operators to participate in the scheme management. Also, this provided for a platform for Governance for the drainage system management.

Science, Technology and Innovations

Adequate water and reliable water management systems are key success factors for sustainable agriculture production. Drainage is a prerequisite for development in this country and irrigation has proven to be necessary even in a country with such high rainfall such as Malaysia. Reliable drainage systems too are necessary to ensure sustainable non-paddy production as well as for the security and comfort of surrounding settlement areas.

Many of the planning, design and construction criteria and techniques were developed locally since there were not many examples and experience elsewhere with similar climatic, geographical and socio-political conditions. These included engineering approaches to designs and construction of hydraulic structures (e.g. tidal gates, coastal bunds) in marine clays in the coastal estuaries, drainage for swamp land reclamation, construction in peat areas, the development of design criteria for irrigation and drainage systems, river training and coastal protection works. The hydrological and water resources assessment approaches were also modified based on local experience and this was later strengthened with the formation of the Hydrological Division in the JPS.

The tools and techniques developed over the years have led to a sound engineering approach and installation of complete and reliable irrigation and drainage systems in the country. By the late 1970s eight large schemes (the Granaries) and 928 non-Granary irrigation schemes were in operation throughout Malaysia. The major Granaries were also installed with computer-based irrigation management systems supported by a network of telemetric stations for hydrological data collection.

In the mid-1970s, the MADA Granary tertiary irrigation system and the Western Johor Integrated Agriculture Development drainage system planning and design criteria were developed by Malaysian expertise. These became the definitive reference models that have been replicated throughout the country. A canal, drain and farm road density and design for 1:5 years for irrigation and 1:20 years; 2-day flood for drainage are now the Malaysian standard criteria. For drainage of tree crops (e.g. oil palm), the design for 1:20 years, 7-day flood is now the standard criteria. The systems design were also developed locally and the Western Johor Agriculture Development Project in the 1970s and 1980s is now the reference model for drainage schemes in Malaysia.

MADA and IADA KETARA Granaries have also incorporated irrigation water re-use systems to enhance water availability and reduce freshwater demands.

STI development and applications are not the exclusive domain of systems managers and designers. A major shift in paddy production occurred in the 1980s. This was at the initiative of the farmers themselves. In response to issues of labour shortage, farmers took the initiative themselves to adopt and improve the direct seeding technique that replaced the labour intensive transplanting technique.

Adopting this technique induced farmers to invest in land-levelling and on-farm field channels (a challenging and often frustrating promotional effort by system managers for on-farm water saving strategy during the transplanting days) as the direct seeding requires higher precision in water management. The labour shortage situation also encouraged higher levels of farm mechanisation particularly for land preparation and harvesting. The irrigation system operations and selected structures were then adjusted and modified to support these changes.

Public Participation

Agriculture water services have long recognised the need for strong end-user participation for effective water management. The Drainage Works Act stipulated the need to form a Drainage Board with representations from the end-users. In paddy irrigation the culture and practice of system manager-farmer consultations in determining planting dates and irrigation schedules is still maintained. Farmers' consultations are still held at the planning stages of new tertiary irrigation system development for their views and feedback before finalising the proposed system layout. In the 1980s and 90s, WUGs were formed in irrigation schemes as a formal administrative platform in recognition that the end-users are important stakeholders integral in the total irrigation water management approach. One of the important underlying aims for this arrangement is for irrigation water savings. Efforts to save water by investments in increasing infrastructure efficiencies and systems operational skills would be meaningless if wastages still occur at the farm level due to farmers' non-adherence to irrigation schedules, wasteful on-farm practices and poor on-farm infrastructure. The system managers' response to these changes were structural adjustments to the farm roads and crossings to take the higher farm machinery loads as well as management adjustments to the systems operations and maintenance rather than major infrastructure investments in the irrigation and drainage facilities.

Overall, this formal and systematic arrangement for system manager engagement and consultations with the end-users has managed to inculcate a sense of system ownership by the farmers. In system maintenance, although the Irrigation and Drainage Acts are not any more enforced fully, the farmers have largely shown a high level of care for the system and assisted the system managers in such matters as vandalism, wilful damage and misuse of the infrastructure. This relationship is also conducive for the eventual taking over of the tertiary system operations and maintenance by the WUGs from the system manager.

Wealth Creation

The irrigation and drainage systems in the Granaries and agricultural drainage areas have been able to ensure performance consistency and reliability over many years. It has also been able to respond timely to the meet the changing social and economic needs of the end-users, transforming the role of agriculture from poverty alleviation to income generation whilst ensuring consistent levels of food security and SSL for a variety of crops. These are important attributes that has managed to build the confidence of farmers to not only continue farming over many years, thus sustaining production, but also to invest on their farms. More than that, these have encouraged other forms of business developments and investments and thereby other non-farming but industry related job opportunities. This progress has positioned agriculture in a state of readiness for the next phase of developing – transiting to agribusiness.

In the Granaries, these are the introduction of farm service providers as a distinct business for mechanised activities namely land preparation and harvesting. More and more farmers are also acquiring seeds for planting rather than self-prepared, outsourcing seed broadcasting for planting and also service contracting for fertiliser and pesticide applications. For many, farmers are now more farm managers rather than having to "toil the soil" any more.

Capacity Building and Enrichment

As a dedicated institution and with adequate and qualified human resources, the JPS was able to develop specific training and development programs for capacity building for systems planners, designers, system operations and maintenance team and also for the farmers.

The DID Manual (DID 1960) is a compilation of local technical experience and techniques in various aspects of irrigation and drainage and large volume water development and management. The Manual was updated in 2011 and with expanded topics as well as inclusion of new approaches (DID 2011).

The JPS also published a series of Hydrological Procedures (DID 2010) and Planning and Design Procedures based on local data and information for use by the professionals and available to the public.

Systematic and regular training programmes were also provided at the National Water Management Training Centre (NWMTC) for system managers and operator as well as the farmers. These programmes were not only implemented at the Institute but also on-site at the Granaries.

International Participation and Collaboration

The JPS, with the support of the Government, has been an active member of the ICID since 1958. The ICID is recognised by the United Nations and its organisation as the lead international stakeholder and resource partners on addressing global water matters and issues in water and agriculture. The worldwide maxim "*More Crop per Drop*" for efforts to increase agriculture water productivity could be attributed to ICID. This long-term active involvement has been beneficial to the country in terms of knowledge and experience sharing towards the development of water for agriculture. In fact, the long-term involvement was not just in terms of participation but has provided the opportunity and recognition for two Malaysians to be elected to lead the organisation as its President.

Over the years, there are other international participations that have benefitted the country and the world. These include collaborations with the International Irrigation Water Management Institute (IIMI) (now International Water Management Institute (IWMI)), the FAO, the JICA and ICID.

Through these international participations, the MADA Granary and the Malaysian Granary policy are now international reference models for irrigation development. The capability and expertise of Malaysian professionals in this field have also gained international recognition and prominence.

Summary of Lessons Learned and Experience Gained

From the above, the main lessons learned and need to be seriously considered in formulating future strategies for agriculture water services sustainability for the future can be summarised as follows:

(1) The need for definite and consistent policies and rapid policy responses to meet changing socio-economic situations.
(2) Reliable water resources and water management systems is a key success factor.
(3) The Granary Policy recognises the need for economies of scale for sustainability and continuous economic development. It also provides for more economic and efficient resource management not only for water but for other resource management (e.g. human resource, farm input and output management, support industries and financial institutions) necessary for agriculture production.
(4) Laws, rules and regulations are necessary to protect Government investments, inculcate uniform adoption of good practices and in the long-term could establish an imbedded culture for sustainable development and management even if these are not necessarily enforced in full any more.
(5) A dedicated institution (for development, capacity building and research) allows for focus, capacity building and thorough knowledge acquisition over a long-term.
(6) A long-term Institutional and end-user relationship establishes strong professional bonding and mutual respect. Coupled with a good track record for services and system performance, this instil a high sense of confidence for the farmers to be retained and continue production as well as encouraging the private sectors to invest in new business activities.
(7) A long-term existence of a dedicated institutions allow for local STI development. Farmers have also shown capability in STI development given the environment and technical support to accommodate their STI efforts.
(8) Public participation is an important aspect of agriculture water services. The formal platform allows for interaction in decision-making, accommodate a sense of ownership in the system management and long-term confidence building to invest and sustain production.
(9) Systematic and regular capacity building programs for all stakeholders are also important aspects for sustainable water management. A record and sharing of experience should also be a culture in water management.
(10) Active and long-term participation in international institutions and programs are important source of knowledge and ideas for addressing global and local issues for sustainable development.

Emerging Issues and Current Efforts

National water security and specifically agricultural water security is emerging as a major issue. This needs to be addressed in a concerted manner and transforming the water management approach from sectorial to IWRM is imperative. Agriculture is in the position to support this and especially as it is still the biggest water user and consequently the biggest sector returning used water to the system. Improving agricultural water productivity would significantly contribute to water resources availability and security levels for all other sectors in the WEF Nexus.

However, the concern is that the present capacity of Agriculture with respect to AWS to support those efforts appears to be inadequate compared to other sectors namely the Water Supply and Energy (Hydroelectric).

Agriculture is water dependent and also exposed to water hazards. Thus, climate change impacts could be disastrous to production and therefore the jobs associated with it. At present there appears to be no affirmative action plans particularly by the individual farmers and private agriculture investors to address this issue although the projected climatic changes is expected to be as early as in 12 years time (refer Figure 12). This should be one of the major roles of AWS – to prepare and advise the sector on responses to climate change.

Efforts to address these are there such as water reuse in the Granaries, water recycling development by the Rubber sub-sector, water quality discharge management technology development in the Oil Palm industry and research by MARDI for higher agricultural water productivity. These efforts will need to be stepped up and directed towards national technology ownership.

There are many other issues threatening the sustainability of agriculture and some could constrict efforts to achieve the vision for transiting agriculture to agribusiness. These are outlined in Chapters 1 and 2 in this report.

3.3 Vision for the Future of Water and Agriculture

The vision for the future of water and agriculture is that a distinct AWS is able to support the vision for agriculture to be an agribusiness that contribute significantly to the GNI and provide opportunities for high-value jobs and wealth creation. The AWS shall be at par with water services of the Water Supply and Energy sector and by itself is an industry and together with the two sectors, contribute significantly to the national GDP and qualify as an NKEA.

This is necessary to develop a high-level capacity to address present and future agriculture water issues and attract as well as retain talent in the Agriculture sector.

3.4 The Strategies

Based on the proceeding discussions, the recommended strategies for revitalising AWS for agribusiness are summarised in Table 20. The total numbers may seem too numerous and some almost repetitive. However, AWS covers a very wide range of issues and also that agriculture is a sector with many subsectors and within each are numerous products.

As a summary and conforming to the standard applied in IWRM, the recommended strategies can be summarised as follows:

a. Enabling Environment:

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

The present policies related to agriculture are silent on agriculture water services. A distinct and dedicated AWS policy would encourage a systematic approach to support the development and sustaining agribusiness. The AWS policy is also necessary to ensure adequate water resources and water management needs for agriculture in relation to other sectors and for the WEF Nexus management and Water Security.

- ***Strategy 2 – Promulgate law, rules and regulations for AWS***

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

b. Institutional Framework:

- ***Strategy 3 – Form a dedicated government institution for AWS with adequate capacity to support agribusiness and allow for private sector involvement as AWS Providers***

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

- ***Strategy 4 – Formalise the formation of agriculture water user groups (for individuals and agribusinesses) with special platforms or forums for interaction with Government and private AWS providers and that these platforms are linked to the Federal and State Water Resource Councils***

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

- ***Strategy 5 – Replicate the Granary model for all other key production areas and commodities of each of the agriculture sub-sectors***

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

c. Management Instruments:

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

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

- ***Strategy 7 – Develop Water-Energy-Food Security Nexus and Water Security Management Tools***

This is another inter-sector effort and towards establishing a standard procedure for Water, Energy, Food and Water Resources security policy responses to prevailing and anticipated drivers and pressures.

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
A	**Governance**	**Strategy 1**	Form a dedicated Agriculture Water Services Governance Structure	• Individual and commercial agriculture would require a formal Agriculture Water Services Governance system for sustainable water and agriculture development
		Strategy 2	Develop and instal a comprehensive agriculture Water Accounting, Water Auditing and Feedback System	• This is the basis of all efforts for governance, transparency, integrity in efforts to improve sustainable water management • To harmonisation of technical terms and definitions with all other Water Sectors (Water Supply, Sewerage and Environment) for Integrated Water Resources Management • Regular and systematic water services performance assessment is necessary

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

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

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
				• To develop small reservoirs to increase agriculture water security • This approach would also allow for possible development of cross-sector financing models for infrastructure investments and management • This approach could also be a tool to resolve transboundary issues (as in the NCER inter-State interests and vis-à-vis National wealth and security interests) • Also in line with the NBOS
		Strategy 7	All STI development for agriculture water services to be towards National ownership of the technology	• Support STI policies for increased water productivity • Wealth creation

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
C	**Laws, Rules and Regulations**	**Strategy 8**	Promulgate an Agriculture Water Services Act	• To ensure focused and high level water services for commercial agriculture • To protect Government investments in agriculture water services infrastructure and ensure long-term commitment to production in line with Government Policies • To instil discipline of end-users to care and protect the system, practice water savings and water quality management through rules and regulations that include penalties for non-compliance • To provide for the need to form Water User Group organisations and platform for end user participation and communication • Should include the review and update of the principles and provisions of the Irrigation Areas Act and the Drainage Works Act. These Acts to be repealed subsequently • To allow and facilitate for PPP financing and management approach for Agriculture Water Services such as provision for Agriculture Water Services Operators similar to that of the Water Supply Services Industry and Energy Services • To consider for the formation of the Agriculture Water Services Commission with allowance for private sector end-user representation • Should provide for the registration of all Farm Investors (Farmers) and Agriculture Services Providers and related rules and regulations for providing the services (e.g. mechanisation services, fertiliser and pesticide application services, water management services)

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

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

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
F	**Data and Information**	**Strategy 13**	Integrate data and information collection and sharing system with all other Water Sector managers and end-users	• All sector water managers require common set of data for planning, design and management such as hydrology, water resources, river flow, water quality • Integrating and sharing data and information can be a cost efficient management of resources • To support the Governance system
G	**STI**	**Strategy 14**	Develop agriculture water accounting, water auditing and performance feedback tools and systems	• Technology ownership is one of the most important characteristics of a developed high income Nation • This should also be part of a broader strategy to create an environment that nurtures advance STI ownership for the country • Green technology is an important characteristic of Green Growth Economy • Applications of Reduce, Reuse, Recycle and WDM approaches for sustainable water management
		Strategy 15	Develop agriculture water development and management sustainability tools	
		Strategy 16	Develop advance software for agriculture water services planning, design and management tools	
		Strategy 17	Develop and instal water quantity and quality measurement and control devices for all sub-sectors of agriculture	• Agriculture practices could impact non-point sources of pollution
		Strategy 18	Develop WEF Nexus assessment tools	• The WEF Nexus approach for sustainable water resources and water management is necessary to develop strategies for a balanced and sustainable growth at local and regional levels that ultimately contribute to National objectives and visions
		Strategy 19	Develop Water Footprint Tools for all agricultural sectors to support the WEF Nexus Assessment tools	• Water use policies of the future will need to be based on precise categorisation of water – Green, Blue, Grey; to allocate water sources, water use and water quality 3R specifications for each sector. This is one of the tools for the WEF Nexus approach

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
		Strategy 20	Redesign existing and new Granary Irrigation Systems and components to strengthen the gravity system and to incorporate climate change adaptation needs	• Existing large-scale irrigation (paddy) and drainage system (non-paddy) were not designed for Green Growth Economy and climate change management criteria
		Strategy 21	Develop planning and design criteria for non-paddy crops, livestock and aquaculture to increase yields, stabilise production, flood resilience and sustainable development	• As part of risk management in commercial farming • Climate change mitigation and adaptation measures
		Strategy 22	Develop irrigation and drainage planning and design criteria for large-scale agricultural services system for oil palm, rubber, fruits and other food crops, industrial and commodity crops, livestock and aquaculture	• Non-paddy agriculture is mainly rain-fed. For commercial enterprises, water management facilities and services are necessary for increased and stable production (risk management) • On-farm irrigation and drainage system development and installation of new irrigation technology are now on the initiatives of individual investors. There is a need of systematic agricultural services to integrate these individual systems for sustainability
		Strategy 23	Development of Waste-to-Energy plants in the Oil Palm, Rubber and Livestock industry	• Green Technology for Green Growth Economy • For climate change mitigation and adaptation • For higher yields and environmental management • To increase water availability to within agriculture sector and other sectors
		Strategy 24	Development of Zero Discharge technologies for the Oil Palm, Rubber and Livestock industries	
		Strategy 25	Development of Water Recycling Plants in the Paddy Granaries and Rubber Industry	
		Strategy 26	Development of surface water-groundwater conjunctive use of water technologies for agriculture water management	

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
		Strategy 27	Develop existing Granary irrigation and drainage system network for multi-use to service all sectors and ultimately plan for this as a regional and national water management grid. All new agricultural water services system should also be planned for this	• For efficient use of existing facilities and cost and resource savings for new infrastructures • In line with the NBOS • To ensure stability of supply over a wider region
		Strategy 28	Develop planning and design criteria for agriculture area to be part of the local, regional and national integrated flood system	• This is to be a component of the Integrated Flood Management approach for the country
H	**Financing**	**Strategy 29**	Develop and implement PPP financing models for Agricultural Water Infrastructure and Services	• There are already Malaysian financial models in other sectors e.g. the Water Supply Services Industry, Highways, Flood Mitigation, Federal Road Maintenance, Federal Building Maintenance • PPP in Agriculture Water Services models are also in France and certain developing countries • The World Bank has developed principles and frameworks for Governance and risk sharing for PPPs
		Strategy 30	Develop cross-sector Financing Models as part of the WEF Nexus management and multi-use of existing and new infrastructure	• Water savings efforts by the Agriculture Sector are for the benefit of the Water Supply Sector else the Water Supply Sector would have to develop new resources. Thus the cost of improved irrigation system could be finance by the Water Supply Sector • New sectorial infrastructure investments including dams and adjustments to existing infrastructure would need to account or accommodate the needs by other sector water requirements (including flood management) thus the benefiting sectors could also contribute to the financing (e.g. multi-purpose dams) • This is also in line with the NBOS

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
I	**Wealth Creation**	**Strategy 31**	Facilitate WUG to increase non-farm income sources within and outside of the Agriculture Water Service Areas	• To ensure certain categories of farmers are not marginalise in economic growth • To increase GNI and job opportunities • To retain talent in Agriculture Water Services and Agriculture as a whole
		Strategy 32	Identify and encourage the development of Agriculture Water Services Providers industry and new business opportunities	
		Strategy 33	Export Agriculture Water Services industry to cooperate with countries still in the development stages of large-scale irrigation and drainage system for paddy and other non-paddy agriculture activities	• One of the characteristics of a developed nation is to share knowledge and technology with other nations to support wealth creation and improve wealth creation opportunities including increasing food, energy and water security levels in developing nations
J	**Public Participation**	**Strategy 34**	Encourage the formation of WUG in Agriculture Water Services Areas with formal linkages to Policy Makers and Water Managers	• Higher levels of public participation is a characteristic of develop nations and civil society for good governance • For support in addressing water issues • For development of self-governance by end-users • To prepare end-users to share cost and management of agriculture water services and facilities • Facilitate Capacity Building Programs
		Strategy 35	Planned handover of tertiary systems operations and management to WUGs	

Table 20: Proposed Strategies for the Development of Agriculture Water Services for a Developed Nation (cont'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	NOTES
K	**Capacity Building**	**Strategy 36**	Develop comprehensive capacity building programs for agriculture water managers and agriculture water services providers	• Capacity including skills and knowledge are critical for sustainable water management • To include integrity and transparency advocacy
		Strategy 37	Develop comprehensive capacity building programs for WUG and Service Providers related or have impact on agriculture water management	• Unregulated agricultural service providers could impact AWS and soil
L	**International Participation and Collaboration**	**Strategy 38**	Long-term membership and active participation in Internationally renowned organisation	• Participation in Internationally renowned organisations (e.g. ICID, FAO, IWMI) has proven mutually beneficial, to other nations and organisations and the country as a whole • Local experts have gained international recognition and reputation through active and long-term international participation and collaboration and therefore ready to export services worldwide

CHAPTER 4:
IMPLEMENTING THE PROPOSED STRATEGIES FOR AGRICULTURE WATER SERVICES

CHAPTER 4: IMPLEMENTING THE PROPOSED STRATEGIES FOR AGRICULTURE WATER SERVICES

4.1 The Time Frame

The year 2020 is the target for Malaysia to realise the vision to be a developed nation with high-income status. The National Physical Plan (NPP) 2010-2020, RMK-11 and the ETP are all designed to towards achieving that Vision 2020.

The remaining period to achieve that is only 5 years away and therefore not practical to implement all the strategies over this relatively short time. Instead, the practical approach would be to target 2030 the year for full implementation of the AWS proposal. The year 2030 is also the target date for achieving UN Post-2015 Sustainable Development Goals and implementing the AWS should be in tandem with this timeline. In the National development plan context, this would need to be phased within the current RMK-11 (2016-2020) and on to RMK-12 (2021-2025) and on to RMK-13 (2026-2030).

4.2 The Plan

The plan within the RMK-11 time frame would be to focus on the soft aspects of AWS implementation. The main enabling activity would be installing the AWS policy and establishing a dedicated institution for AWS with the existing BPSP as the nucleus but for a more multi-disciplinary organisation. This institution would then be responsible to drive the Agriculture sector in implementing the rest of the proposed strategies. The key activity could be in developing a new model for AWS for Agribusiness. This will be followed by undertaking studies to implement the model and preparing plans for enhanced agriculture scheme development and agriculture water security improvements. The target is that by 2020, the AWS is ready to be implemented effectively.

Following that, RMK-12 and RMK-13 would be for refining the AWS model as well as implementing the proposed strategies is phases.

4.3 The Stakeholders

The MOA should be the lead stakeholder in establishing the AWS for Agribusiness and closely supported by the MPIC. All the Departments and Agencies under both the Ministries are stakeholders too and will need to actively participate in this development. In addition the NRE and KeTTHA and their respective Departments and Agencies will need to be involved as both are water-related Ministries. As land and water are under the purview of the States, their representation is critical. Completing the representation would be the farmers and agriculture investors as well as from the water industry players.

4.4 The General Program

The general program based on the proposed strategies is shown in Table 21.

Table 21: General Program for Implementing the AWS Strategies

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
A	Governance	**Strategy 1**	Form a dedicated Agriculture Water Services Governance Structure			
		Strategy 2	Develop and instal a comprehensive agriculture Water Accounting, Water Auditing and Feedback System			
B	Policy	**Strategy 3**	To incorporate Agriculture Water Services Policy in Agriculture Policy and key development plans			
		Strategy 4	All Agriculture and Agriculture Water Services development shall be based on the principals of Integrated River Basin Management approach			
		Strategy 5	To designate focused production areas and for all sub-sectors (non-paddy food crops, industrial and commodity crops, aquaculture and livestock)			
		Strategy 6	Develop and apply the WEF Nexus Approach for medium and long-term decision making in relation to Agriculture Water Services and water resources needs for agriculture development			
		Strategy 7	All STI development for agriculture water services to be towards National ownership of the technology			
C	Laws, Rules and Regulations	**Strategy 8**	Promulgate an Agriculture Water Services Act			

Table 21: General Program for Implementing the AWS Strategies (cnt'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
D	**Institution**	**Strategy 9**	Form a dedicated Department for Agriculture Water Services to develop and manage large-scale irrigation and drainage areas for all crops (food, industrial and commodity crops) and, aquaculture and livestock. Able to implement the Governance system			
		Strategy 10	Establish a CoE for Agriculture Water Services for all Crops for applied research on water and agriculture and including training and capacity programs for farmers and managers			
		Strategy 11	Establish WUG Dialogue Platform, Water User-Water Manager Integrated Dialogue Platform and extend this to all areas with Agriculture Water Services and establish formal linkages with the MOA and other Ministries and with State and National Water Resources Councils			
E	**Operations and Maintenance Service Levels and Performance Assessments**	**Strategy 12**	Develop Operations and Maintenance system based on service level delivery for end-users that include measurement indicators for cost of service with a view of remuneration for water services in the future			
F	**Data and Information**	**Strategy 13**	Integrate data and information collection and sharing system with all other Water Sector managers and end-users			
G	**Science, Technology and Innovations (STI)**	**Strategy 14**	Develop agriculture water accounting, water auditing and performance feedback tools and systems			

Table 21: General Program for Implementing the AWS Strategies (cnt'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 15	Develop agriculture water development and management sustainability tools			
		Strategy 16	Develop advance software for agriculture water services planning, design and management tools			
		Strategy 17	Develop and instal water quantity and quality measurement and control devices for all sub-sectors of agriculture			
		Strategy 18	Develop WEF Nexus assessment tools			
		Strategy 19	Develop Water Footprint Tools for all agricultural sectors to support the WEF Nexus Assessment tools			
		Strategy 20	Redesign existing and new Granary Irrigation Systems and components to strengthen the gravity system and to incorporate climate change adaptation needs			
		Strategy 21	Develop planning and design criteria for non-paddy crops, livestock and aquaculture to increase yields, stabilise production, flood resilience and sustainable development			
		Strategy 22	Develop irrigation and drainage planning and design criteria for large-scale agricultural services system for oil palm, rubber, fruits and other food crops, industrial and commodity crops, livestock and aquaculture			

Table 21: General Program for Implementing the AWS Strategies (cnt'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 23	Development of Waste-to-Energy plants in the Oil Palm, Rubber and Livestock industry			
		Strategy 24	Development of Zero Discharge technologies for the Oil Palm, Rubber and Livestock industries			
		Strategy 25	Development of Water Recycling Plants in the Paddy Granaries and Rubber Industry			
		Strategy 26	Development of surface water-groundwater conjunctive use of water technologies for agriculture water management			
		Strategy 27	Develop existing Granary irrigation and drainage system network for multi-use to service all sectors and ultimately plan for this as a regional and national water management grid. All new agricultural water services system should also be planned for this			
		Strategy 28	Develop planning and design criteria for agriculture area to be part of the local, regional and national integrated flood system			
H	**Financing**	**Strategy 29**	Develop and implement PPP financing models for Agricultural Water Infrastructure and Services			
		Strategy 30	Develop cross-sector Financing Models as part of the WEF Nexus management and multi-use of existing and new infrastructure			
I	**Wealth Creation**	**Strategy 31**	Facilitate WUG to increase non-farm income sources within and outside of the Agriculture Water Service Areas			

Table 21: General Program for Implementing the AWS Strategies (cnt'd)

NO.	CATEGORY	STRATEGY	DESCRIPTION	RMK-11 (2016-2020)	RMK-12 (2021-2025)	RMK-13 (2026-2030)
		Strategy 32	Identify and encourage the development of Agriculture Water Services Providers industry and new business opportunities			
		Strategy 33	Export Agriculture Water Services industry to cooperate with countries still in the development stages of large-scale irrigation and drainage system for paddy and other non-paddy agriculture activities			
J	**Public Participation**	**Strategy 34**	Encourage the formation of WUG in Agriculture Water Services Areas with formal linkages to Policy Makers and Water Managers			
		Strategy 35	Planned handover of tertiary systems operations and management to WUGs			
K	**Capacity Building**	**Strategy 36**	Develop comprehensive capacity building programs for agriculture water managers and agriculture water services providers			
		Strategy 37	Develop comprehensive capacity building programs for WUG and Service Providers related or have impact on agriculture water management			
L	**International Participation and Collaboration**	**Strategy 38**	Long-term membership and active participation in Internationally renowned organisation			

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