ASM ADVISORY REPORT 1/2014

STRATEGIC PLAN FOR ADDRESSING THE IMPACTS OF CLIMATE CHANGE ON WATER-RELATED ISSUES IN MALAYSIA

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AKADEMI SAINS MALAYSIA

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FORE

I would like to convey my congratulations to the members of the ASM Task Force on Climate Change and Water Resources for producing the Advisory Report on the "Strategic Plan for Addressing the Impacts of Climate Change on Water-related Issues in Malaysia", yet another deliverable of the ASM Water Committee.

This Advisory Report is the output of an ASM-commissioned study to present a synthesised set of summary conclusions and recommendations Strategic Consultative Laboratories (SCL) on Climate Change and Water Resources. Each SCL focuses on one issue such as Information Management Capacity, Stakeholder Awareness and Participation, Climate Change Projections and R&D Capacity, Water Resource and Use Management Capacity, Governance and Institutional Capacity, Water-related Hazard and Risk Management Capacity and Water-related Land Management Capacity including the perusal of various documentations (both "hard-copy" and electronic media) of available information on past and current initiatives and programmes undertaken within Malaysia and in areas within the same climatic zone with regard to the impact of climate change on water-related issues.

Water underpins all social and economic activities. Climate change impacts although currently limited

WORD

to further exacerbate extreme variability in rainfall patterns, escalating flood and drought events, which are frequently accompanied by one or a combinations of river bank breaches, soil erosions, landslides, forest fires, anticipated water shortages, heat waves, rising sea levels and others.

These extreme events are expected to affect economic and social activities, health, ecosystem and biodiversity, which can then be translated into economic costs. In Malaysia, increase in extreme climate variability is already being felt in the form of shifting rainfall patterns, escalating floods and drought occurrences (accompanied by forest fires and haze), as well as an increase in their individual intensities.

This Advisory Report is yet another important deliverable of the Academy of Sciences Malaysia which is already receiving favorable comments. We are confident that the findings, recommendations and strategies contained therein would lead to the Government taking more concrete steps towards developing increase resilience through a possible plan of action for implementation over the short, medium and long terms, within the various Malaysian Plans, in line with sustainable development and the outcome of Rio + 20.

TAN SRI DATUK DR. AHMAD TAJUDDIN ALI F.A.Sc.
President
Academy of Sciences Malaysia

PREFACE

Impacts of climate change, a global phenomenon, are increasingly being felt with the current increase in global occurrences and increased intensities of extreme floods, droughts and cyclones.

These changes in the hydro-meteorological events will impact water resources management and will affect the function and operations of existing water systems and water infrastructure, including water supply, hydropower, structural flood defenses, navigation, drainage and irrigation systems, etc. Water underpins all socio-economic activities.

Thus, these changes will be of major concern because of the chain-reactions and the impact on multi-sectoral areas, such as the water-food-energy nexus, and hence it is an area of national security. The focus is not only on the most vulnerable, but also on the impacts on our socio-economics, for example, impacts on tourism, health, industries and agriculture, can be devastating, as had been seen from the major floods and droughts events in other countries as well as in various parts of Malaysia from the mid-2000s to the last few years. The Asia-Pacific region, where Malaysia is located, is expected to be the worst affected region.

In support of the Government's efforts to address the challenge of water-related impacts due to climate change, the Academy of Sciences Malaysia's Water Committee had

established the "Task Force (TF) on Climate Change and Water Resources" to prepare the ASM Strategic Advisory Report on Climate Change and Water Resources for the Government of Malaysia. This Strategic Advisory report was preceded by the development of a Position Paper, the "Study on the Status of Climate Change Impact on Water Related Issues", which identified issues into seven thematic focus areas. This was then followed by a series of strategic consultations with key stakeholders to solicit their views and additional inputs for the formulation of the strategies.

The Strategic Plan adopts the pragmatic approach recommended by the Asia Pacific Water Forum (APWF), as embodied in the APWF's "Five Principles Framework".

The successful completion of the Task Force's tasks would not have been possible without the guidance of Tan Sri Shahrizaila Abdullah, the first chair of the ASM Water Committee, Datuk Fateh Chand, our current chair, and the ASM Water Committee itself. Most certainly, the completion of the work of the Task force would not have been possible without the full cooperation, support and commitment of the Task Force members and the ASM Secretariat. I take this opportunity to convey my deepest appreciations and thanks to all of them.

IR. DR. SALMAH ZAKARIA F.A.Sc
Chairman,
ASM Task Force on Climate Change and Water.

EXECUTIVE SUMMARY

CONCERNS ON CLIMATE CHANGE

Climate change is expected to have potential impacts on the management of water bodies, water-related services and water-related hazards.

To support the Government to address the challenges of water-related impacts from potential climate changes, the Academy of Sciences Malaysia (ASM) has prepared this Strategic Advisory Report on Climate Change and Water Resources for Malaysia.

This Report is based on a combination of the outputs from a previous baseline study report entitled, "Climate Change and Water Resources in Malaysia", and from the outputs of a multi-stakeholders national forum, and seven follow-up thematic Strategic Stakeholders Consultation Workshops.

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

In response to this concern the UN has set up the Intergovernmental

Panel on Climate Change (IPCC) in 1988, to collate research findings from scientific studies to help assess and develop increased understanding, developed different potential global development scenarios and postulate potential impacts of projected future climate changes on human society, and in the process provide its recommendations.

IPCC has since released AR5 (Fifth Assessment Report 5) and the SPM (Summary for Policy Makers) can be accessed at: *https://www.ipcc.ch/report/ar5/wg1/docs/WG1AR5_SPM_FINAL.pdf.*

In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was set up to define and negotiate the actions each country needs to take, to address the issue. The future global climate is still very uncertain.

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

Natural Water Cycle and Climate Models

The natural water cycle is an integral part of the global climate system. Climate changes impact significantly the water cycle and all water-related events and activities, since ninety percent of climate impacts are water related. The current climate projection models are still continuously under development and testing, and thus their projections have a lot of uncertainties.

The climate models have projected the trend that climate change will result in increased rainfall intensities, resulting in larger floods with increased flood damages and loss of lives. Thus, there are needs to mitigate against such losses. However, the large uncertainties associated with climate-model projected flood risks (which can differ by a few hundred percent between models), makes the choice of investing in costly, hard, structural flood mitigation projects potentially very hazardous. This is related to the risk of investing in projects of low economic viability and thus wasting limited national financial resources.

A better approach is to use the projections of climate change model to support the selection of "No regrets" projects, i.e. projects that will yield benefits whether the climate change projections are accurate or not. In every 5-year Malaysia Plan, multi-billion ringgit have been budgeted for water infrastructure such as for flood mitigation, irrigation and drainage, hydropower, water supply, transport/tourism, etc (10th Malaysia Plan allocation amounted to RM982.40 million whereas the 9th MP allocation was RM17,998.6 million).

Thus, continuous investment in climate projection models is required to increase the reliability of the climate model projections so that the current retro-fittings and new water infrastructure that are to be built will have better economic viability. It will also ensure sustainability and protect the economic gains that have been made. Possibly 0.1% of the total cost budgeted for water infrastructure development should be spent on research, including climate change projections.

Impacts from Climate Change

The exposure of people and assets to hydro-meteorological hazards in Asia Pacific and Malaysia, has grown over the past few decades. Malaysia has seen rapid urbanization, (see Box 1a and 1b). With urbanization, economic growth, changes in local environmental conditions and the location of more assets and people in hazardous areas such as flood plains and coastal low land areas, the country will continue to be more exposed.

Climate change is anticipated to create extreme events, with some

projections including an increase in the frequency of years with above normal monsoon rainfall or extremely rainfall deficient. An increase in rainfall extremes of landfall cyclones in South and East Asia have been recently projected in the IPCC's AR5 (Fifth Assessment Report), along with enhanced monsoon precipitation and increased drought in some areas over the long term.

While much work has been done by our government, much more is still needed, to ensure national policies are implemented to provide social protection and to build resilience to the most vulnerable. There is a need towards better integrating disaster risk reduction into development initiatives in the 5-year Malaysia plans in each and every agency. No agency located in a river basin is immune from climate change impacts since everyone lives in a river basin.

The Malaysian landscape is one of short swift rivers flowing within 189 major river basins (see Box 2). Even before the concern on climate change emerged, Peninsular Malaysia, (the size of the Chao Phraya River Basin of around 330,000 hectares – which was hit by the unprecedented great floods of 2011), had an estimated 29,000 hectares of flood prone areas, that historically are susceptible to flooding.

The 2002 Institutional Study by Deloitte Kassim Chan for DID (see Box 2) estimated an annual flood damage loss of close to RM3 billion annually. The country is also surrounded by more than 3500km of coastlines (see Box 3) making it susceptible to any sea level rise.

TABLE 1A

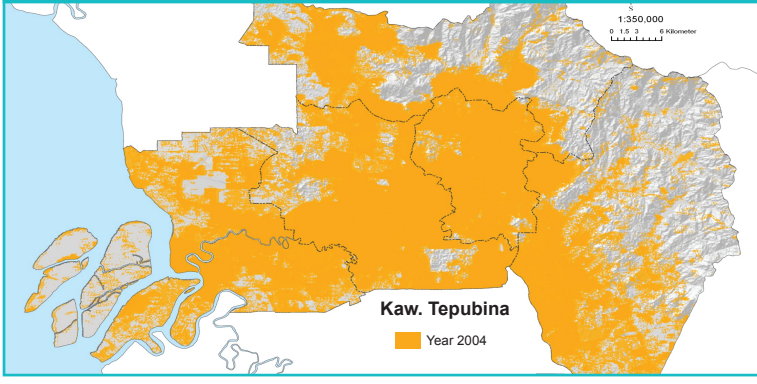
MALAYSIAN LANDSCAPE, BOTH THE PENINSULA AND THE EAST UNDESA POPULATION DIVISION FILE 2: PERCENTAGE OF POPULATION RESIDING IN URBAN AREAS BY MAJOR AREA, REGION AND COUNTRY, 1950-2050

United Nations Department of Economic and Social Affairs (UNDESA) Population Division World Urbanization Prospects : the 2009 Revision. Percentage of population residing in urban areas by major area, region and country, 1950-2050

Year	1950	1960	1970	1980	1990	2000	2010	2030	2050
World	28.83	33.00	36.08	38.92	42.62	46.40	50.46	58.97	**68.70**
More developed regions	52.58	58.80	64.69	68.32	70.75	72.74	75.16	80.88	86.24
Less developed regions	17.61	21.80	25.32	29.44	34.83	40.00	45.08	54.98	65.86
South-Eastern Asia	15.48	18.52	21.50	25.53	31.62	38.16	**41.84**	52.85	**65.44**
Brunei Darussalam	26.76	43.40	61.68	59.89	65.83	71.15	75.65	82.33	87.21
Cambodia	10.20	10.29	15.97	8.97	12.60	16.91	20.11	29.20	43.83
Indonesia	12.40	14.59	17.07	22.10	30.58	42.00	44.28	53.70	65.95
Lao People's Democratic Republic	7.24	7.95	9.63	12.38	15.44	21.98	33.18	53.07	68.03
Malaysia	**20.36**	**26.60**	**33.45**	**42.04**	**49.79**	**61.98**	**72.17**	**82.21**	**87.85**
Myanmar	16.16	19.23	22.83	23.97	24.71	27.80	33.65	48.09	62.87
Philippines	27.14	30.30	32.98	37.48	48.59	47.99	48.90	58.33	69.36
Singapore	99.45	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Thailand	16.48	19.67	20.89	26.79	29.42	31.14	33.96	45.77	59.96
Timor-Leste	9.89	10.09	12.89	16.48	20.84	24.26	28.12	39.89	54.92
South-Central Asia									
Bangladesh	4.28	5.14	7.59	14.85	19.81	23.59	28.07	41.04	56.41
Bhutan	2.10	3.60	6.09	10.13	16.39	25.42	34.71	49.97	64.17
India	17.04	17.92	19.76	23.10	25.55	27.67	30.01	39.75	54.23
Maldives	10.61	11.17	11.89	22.25	25.84	27.71	40.10	60.06	73.12
Nepal	2.68	3.48	3.96	6.09	8.85	13.43	18.62	31.74	47.56
Pakistan	17.52	22.10	24.82	28.07	30.58	33.14	35.90	45.62	59.37
Sri Lanka	15.33	17.88	21.89	21.58	18.61	15.83	14.31	19.55	31.34

TABLE 1B

URBAN FOOTPRINTS FOR KLANG VALLEY – AGIS WALK THE MALAYSIAN LANDSCAPE

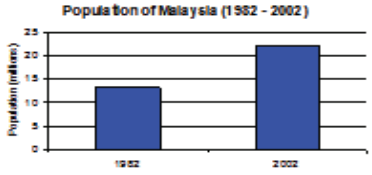


BOX 2

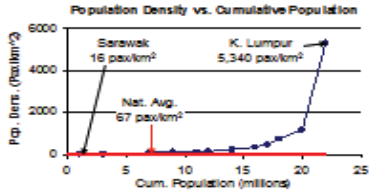
2002 INSTITUTIONAL STUDY BY DELOITTE KASSIM CHAN FOR DID ESTIMATED AN ANNUAL FLOOD DAMAGE LOSS OF CLOSE TO RM3 BILLION ANNUALLY.

The need to reposition DID arises from the need to ameliorate the significant water issues facing Malaysia

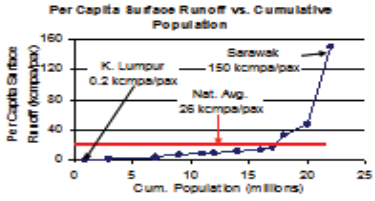
1) The rapidly increasing Malaysian population...



2) ...Combined with increasing population *concentration*, especially in urban areas...



3) ...Has led to certain areas suffering conditions of water stress...



4) ...Along with generalised water-related problems, flooding being the most evident

Estimated Costs of Flooding in 2000

- RM850 million in direct losses
- RM 1.8 billion in lost GDP arising from lower investment over the previous 20 years
- Significant *but difficult to measure* losses due to disruption of day-to-day operations as a result of flooding
- **Resulting in a probable total economic loss of ~ RM 3 bln. annually from flood effect[3]**

BOX 3

RIVER BASINS AND COASTAL LINES OF MALAYSIA

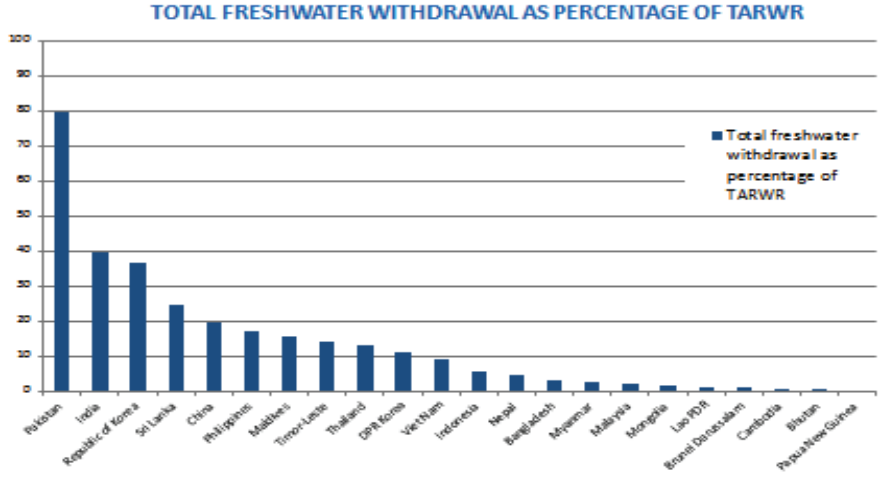
Malaysia - 330,000 km²
Average Annual Rainfall 1500mm to 4500 mm

189 River Basins Management Units (RBMU) in Malaysia

From the FAO Aquastat Survey of 2011 (Box 4), Malaysia has actually used less than 5% of its Total Actual Renewable Water Resources (or, TARWR). Although the average annual rainfall in Malaysia is around 2500 to 3500 mm, there are differences in the temporal and spatial distribution of rainfall in the country as indicated in Box 5. This requires management of the water resources in an integrated manner, managing each individual river basin holistically, to ensure equitable distribution over a sustainable period. For example, the 700-sq km Singapore Island is managing water for a population of 5.3 million. On the other hand, the 7.1 million population of the Selangor State, although served by at least 6 major river systems: the Rivers Bernam (3335 km2), Tengi (565 km2), Selangor (1820 km2), Buloh (560km2), Klang (1425 km2) and Langat (1815 km2), is currently facing a water crisis. The Inter-Basin Water Transfer Scheme from the Pahang River Basin to Selangor, under construction now, is expected to alleviate water supply problems up to 2025.

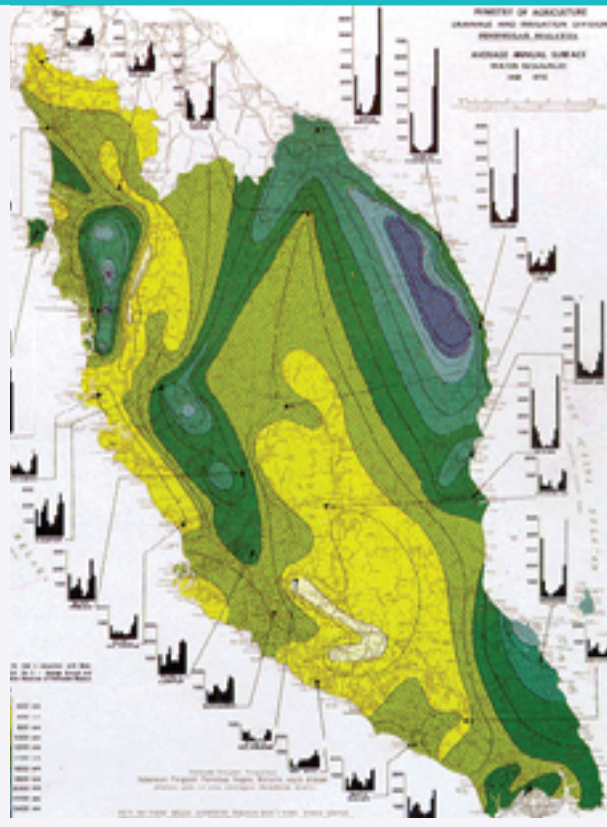
BOX 4

MALAYSIA WITHDRAWS LESS THAN 5 % OF ITS TARWR (TOTAL ACTUAL RENEWABLE WATER RESOURCES) DATA SOURCE: FAO IRRIGATION IN SOUTHERN AND EASTERN ASIA IN FIGURES, AQUASTAT SURVEY – 2011



BOX 5

TEMPORAL AND SPATIAL DISTRIBUTION OF RAINFALL IN PENINSULA MALAYSIA, DID MALAYSIA

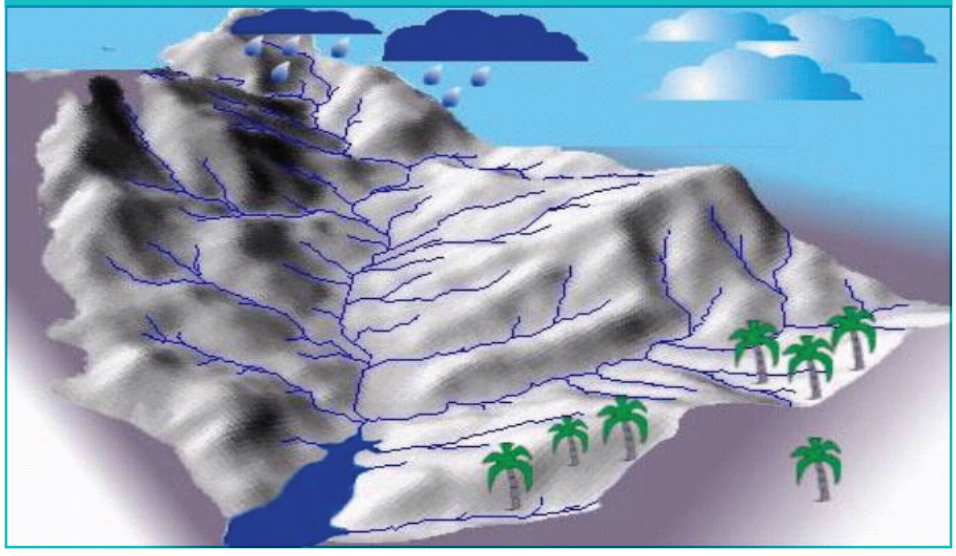


A typical river basin is indicated in Box 6. While the National Integrated Water Resources Management (IWRM) is a generic national policy directive, specific river basin management should be implemented through a river basin master plan. As such, IRBM (integrated River Basin Management) is a subset of IWRM.

Duly, the need for a river basin master plan for each river has been accepted unanimously by the MSAN at its meeting in July 2003 (Box 7).

BOX 6

A RIVER BASIN – FROM CARLOS TUCCI



BOX 7

REQUIREMENT FOR RIVER BASIN MASTER PLAN

NEW STRAITS TIMES NATI

Master plan for river basins

Monitoring land use for development

By Jaswinder Kaur
news@nstp.com.my

About 40 people representing government agencies, non-govern-

"DID sees rivers as a heritage we should care for. Rivers provide 98

BOX 8

DAMAGES AND LOSSES TO THE GREAT THAI FLOODS OF 2011 – SOURCE – RAPID ASSESSMENT FOR RESILIENT, RECOVERY AND PLANNING BY WB, ESCAP, EU, JICA AND GFDRR

Sub Sector	Total (in Mn THB)		
	Damage	Losses	Total
Infrastructure			
Water Resources Management	8,715	-	8,715
Transport	22,878	6,263	29,141
Telecommunication	1,290	2,020	3,309
Electricity	3,191	5,321	8,512
Water Supply and Sanitation	3,538	2,104	5,642
Cultural Heritage	2,562	3,061	5,622
Productive			
Agriculture, Livestock and Fishery	37,992	30,328	68,320
Manufacturing	513,881	417,025	930,906
Tourism	5,134	89,673	94,807
Finance & Banking	-	115,276	115,276
Social			
Health	1,684	2,128	3,812
Education	13,051	1,798	14,849
Housing	45,908	52,807	98,715
Cross Cutting			
Environment	375	176	551
TOTAL	660,199	727,980	1,388,179

Recommendations for Consideration

In view of the large uncertainties in the various climate change model projections, a Strategic Plan is required to address the issue. The proposed Plan shall adopt the pragmatic approach described in the "Five Principles Framework" recommended by the APWF/ADB Framework Document on Water and Climate Adaptation (see APWF/ADB Framework Document on Water and Climate Adaptation: For Leaders and Policy Decision Makers - http://www.apwf.org/doc/Framework.pdf).. The strategic actions recommended in the Plan were carefully selected to address three key limiting factors which are grouped under three "guiding policies". The thrusts of the 'Guiding policies' are as follows:

- Invest in 'no-regrets' development projects to increase the resilience of the community to adapt to an uncertain future climate;
- Invest in data collection, information management and R&D including continuous improvement of climate change model projections; and
- Use of these Climate Change model projections in new and retro-fitting investments in 'no-regrets' development projects to ensure optimum economic viability and to avoid "mal-investment/mal-adaptation".

Integrated Water Resources Management (IWRM) approach/ processes is "a no regret measure" in building up local resilience in climate change adaptation IWRM is based on the understanding that all water resources are an integral component of the ecosystem; a natural resource, and a social and economic good, the three requirement of sustainable development.

While the IWRM approach has been a Malaysian government policy since the 8th Malaysia Plan, there is a need to monitor its implementation, to ensure a coordinated development and management of water, land and related resources, to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment.

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

1. Adopt and implement the APWF five principles framework for Climate Change adaptation, as given below:

   (a) Usable Knowledge
      (i) Develop data infrastructure and networking for sharing data, information and knowledge to support decision-making and to raise public awareness;
      (ii) Accelerate scientific efforts to improve the use of climate projections for countries, river basins and cities as well as to quantify and reducem the related uncertainty;

   (b) No-regret Investments
      (i) Plan for incremental adaptation actions in tandem with improving climate projections;
      (ii) Use an appropriate mix of structural and non-structural measures;

   (c) Resilience
      (i) Strengthen the adaptation capacities of water managers, communities, and of society as a whole;
      (ii) Improve community-based water risk management capacities;

   (d) Mitigation and Adaptation
      (i) Promote IWRM in river basins as the appropriate process for planning and investments;
      (ii) Promote synergies in the planning and implementation of adaptation and mitigation measures;

   (e) Financing
      (i) Conduct economic impact assessments for various adaptation options; and
      (ii) Mobilise significant investments today (e.g., 1% of GDP) to prevent greater damages later (e.g. 5%,) as advised by the Stern report.

2. 'Climate-proofing' and selection of 'no-regrets' projects, to increase the resilience of the Malaysian community and reduce its vulnerability.

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

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

3. Key Climate Change adaptation actions are recommended in the management of water resource, services management and water-related hazards capacities as detailed below:

(a) water resources management capacity (such as in IWRM of water bodies of rivers, lakes and wetlands, groundwater and coastal area);

(b) water services management capacity (such as in agriculture/irrigation in the eight granary areas, potable water supply for domestic and industries including Water Demand Management especially for the anticipated floods and droughts, water for environment flow, etc); and

(c) water-related hazards management capacity (floods, droughts and forest fires, especially peat forest fires).

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

i. Governance and institutional capacity – developing a checklist of relevant CC-related policies/plans and process of updating;
ii. Climate Change Projections and R&D capacity – to improve baseline data collation and collection, set up early warning systems and monitoring and to adopt a systematic approach to include the uncertainty of climate change impacts in current design methodologies and standards for WRE projects;

iii. Information Management capacity – setting up a National Water and Climate Change Information Repository, and enhancing our National Climate Service;
iv. Land use Management capacity – IWRM is thecoordinated development and management of water, land and related resources; and
v. Stakeholder Awareness and Participation - create awareness and improve advocacy among all stakeholders: government agencies, disaster-relief agencies and communities.

The implementation and monitoring of the recommended key strategic actions should be incorporated within all existing proposed projects which should have their allocated budget. The retrofitting of existing project will need to be included in the allocation of operations and maintenance of the said projects.

The annual cost of floods for Malaysia, before climate change impact, was estimated to be around RM3 billion annually (Box 2). The 5-year budget than for floods was less than RM3 Billion. The current cost of damages is expected to even be very much higher due to higher exposure of assets and properties as well as more frequent occurrences of extreme events of floods.

The above have not included the costs of other damages to other water infrastructures such as irrigation systems, water supply systems, landslides and others. There may also not have been estimates on an annual average, but mostly event by event. Nevertheless, these costs are expected to be very high and may impact on previous economic gains. Box 8 indicates that the total losses and damages of the Great Thai Floods of 2011 were around USD45 Billion.

LIST OF **FIGURES** AND **TABLES**

LIST OF **ACRONYMS**

A

ADB	Asian Development Bank
ADP	Agricultural Development Program
APWF	Asia Pacific Water Forum
ASM	Academy of Sciences Malaysia
AWCI	Asian Water Cycle Initiative
AWS	Automatic Weather Stations

C

CC	Climate Change
CC & WR	Climate Change and Water Resources
CFS	Central Forest Spine
CO2	Carbon dioxide
COP	Conference of Parties

D

DID	Department of Irrigation and Drainage
DMG	Department of Mineral and Geosciences
DOE	Department of Environment

E

ESA	Environmentally Sensitive Areas

F

FAO	Food and Agriculture Organisation
FELDA	Federal Land Development Authority
FYMP	Five Year Malaysia Plan

G

GCM	Global Climate Model
GCOS	Global Climate Observation System
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GFCS	Global Framework for Climate Services
GTCCC	Green Technology and Climate Change Council
GTS	Global Telecommunication System
GW	Groundwater

H

HCM	Hydro Climatic Models
HRD	Human Resources Development

I

IADP	Integrated Agricultural Development Program
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technology
IFM	Integrated Flood Management
IMS	Information Management System
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
ISMP	Integrated Shoreline Management Plan
ISO	International Organization for Standardization
IWRM	Integrated Water Resources Management

J

JICA	Japan International Cooperation Agency
JPBD	Jabatan Perancangan Bandar dan Desa
JUPEM	Jabatan Ukur dan Pemetaan Malaysia

K

KA	Key Actions
KADA	Kemubu Agriculture Development Authority
KPI	Key Performance Indicators

M

MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MCT-IBIS	Multicentric Issue-Based Information System
MKN	Majlis Keselamatan Negara
MMD	Malaysian Meteorological Department
MSMA	Manual Saliran Mesra Alam
MW	Megawatts
MyWCC-IBIS	Malaysia Water and Climate Change IBIS

N

NAHRIM	National Hydraulic Research Institute of Malaysia
NBP	National Biodiversity Policy
NC2	Second National Communication
NCES	National Coastal Erosion Study
NCVI	National Coastal Vulnerability Index
NEM	New Economic Model
NGO	Non Governmental Organisations
NKRA	National Key Results Areas
NPP	National Physical Plan
NPCC	National Policy on Climate Change Environment
NWRS	National Water Resources Study
PAA	Prime Agricultural Areas

P

PPP	Public-Private Partnerships
PRECIS	Providing Regional Climates for Impacts Studies

R

R&D	Research and Development
RCM	Regional Climate Model
RE	Renewable Energy
RegHCM-PM	Regional Hydro-Climate Model for Peninsular Malaysia
RMK-10	Rancangan Malaysia Ke-10

S

SC	Strategic Consultation
SCL	Strategic Consultation Labs
SCORE	Sarawak Corridor Renewable Energy
SEA	South East Asia
SLR	Sea Level Rise
SPAN	Suruhanjaya Perkhidmatan Air Negara
SRES	Special Report on Emissions Scenarios
SWOC/T	Strengths, Weaknesses, Opportunities, Constraints/Threats

T

TF	Task Force

U

UTC	Coordinated Universal Time
UNFCCC	United Nations Framework Convention on Climate Change

W

WCC-IMU	Water and Climate Change Information Management Units
WDM	Water Demand Management
WMO	World Meteorological Organisation
WRE	Water Resources Engineering
WSIA	Water Services Industry Act 2006
WSP	Water Safety Plans

1 INTRODUCTION

1.1 The Issue - Climate Change and its Water-related Impacts

The issue of global climate change has been a major concern for world leaders and scientists ever since the 1990s when the hypothesis that "increased discharge of greenhouse gases into our atmosphere due to intensive human and industrial development activities over the past century have resulted in a trend towards a changed future global climate". In response to this concern the international scientific community has been working through the *Intergovernmental Panel on Climate Change (IPCC),* set up in 1988, to (a) develop an increased understanding of what is happening to our global climate, (b) visualise the future climate for different global development scenarios, (c) assess the potential impacts of the projected future climate change on human society, and (d) propose adaptation measures to the possible impacts. Similarly, the world leaders have responded by establishing an international environmental treaty, known as the *United Nations Framework Convention on Climate Change (UNFCCC)* in 1992, to discuss and agree on what each of them should do, in relation to their national development and economic activities, to help stabilise the atmospheric greenhouse gas concentrations to a level that will prevent dangerous anthropogenic interference to the global climate system.

While the scientists continue to debate on the causes of climate change, the reliabilities and accuracies of their models' projections for the future climate and their likely impacts, and how we should adapt to the future climate, the world leaders are arguing over what each nation should do to contribute their fair share in saving the planet's climate from a disastrous future climate change. Even though the future global climate is still very uncertain, and how it will evolve will depend very much on what the global community do collectively from now to the future, what is certain are the observed, abnormal climate-related events in recent years of increased variability and intensities of rainfall resulting in historic floods and droughts, and unusual climate-related events, in many places around the world.

In view of the above uncertainties in climate change what should a responsible and pro-active government do (apart from contributing its fair share of reducing its greenhouse gas emissions), to prepare for an uncertain, future climate that seems to be changing now? In particular, since the natural hydrological or water cycle is an integral part of the global climate system the changes to the hydrological cycle arising from climate change will have very significant impacts on all water-related activities that are related to the hydrological cycle.

For example, there are climate models simulation results showing that climate change will result in increased rainfall intensities, which will result in larger floods with increased flood damages and loss of lives. A responsible government will take actions to mitigate against such losses. However, unlike historical flood events, which have flood risks that can be statistically quantified, the large uncertainties associated with climate-model projected flood risks (*which can differ by a few hundred percent between models*), makes the choice of investing in hard, structural flood mitigation projects very hazardous. The outcome may be a mal-adaptation project, which creates a 'white elephant structure' and a waste of limited national financial resources.

In view of such large uncertainties in climate change model projections for a future global development scenario that is evolving, and also in view of the fact that our global climate seems to be changing now, the Asia Pacific Water Forum (APWF) has recommended to leaders and policy-makers in the Asia-Pacific Region to adopt a pragmatic approach to climate change adaptation for the water sector, using the strategic framework illustrated in **Figure 1**. The APWF framework, which is described in detail in **Appendix 1**, involves the application of the following five principles in end-to-end partnerships between four key stakeholders – (a) leaders and policy makers, (b) water managers, (c) community and civil society, and (d) scientists.

(a) Usable knowledge
(b) No-regret investments
(c) Resilience
(d) Mitigation and Adaptation
(e) Financing

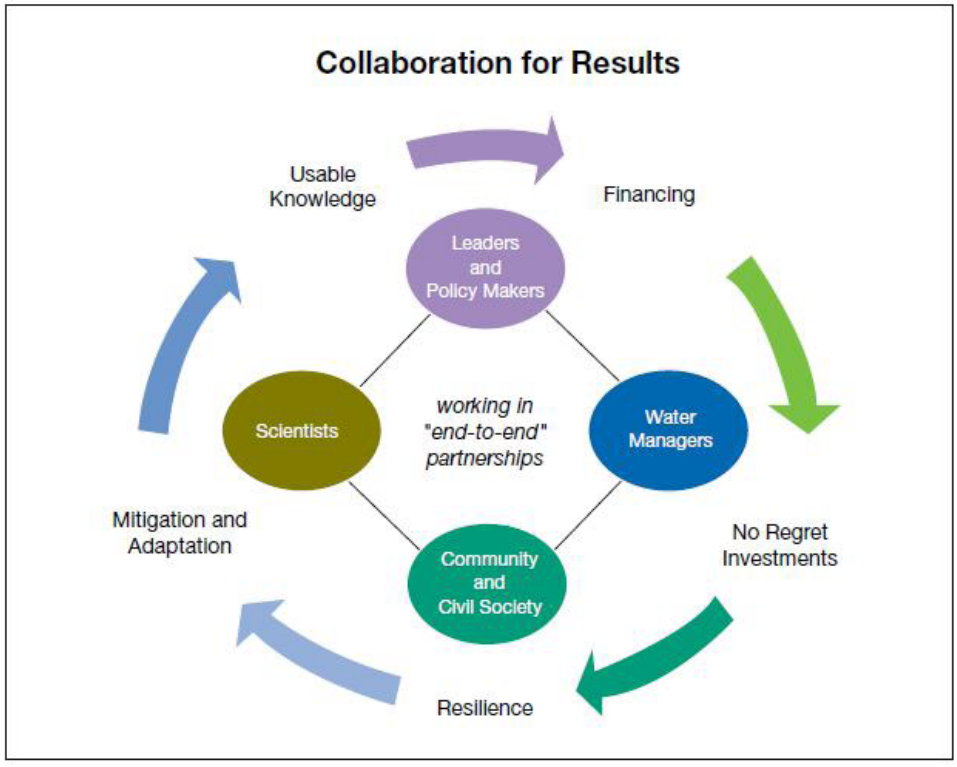


Figure 1 – The Asia Pacific Water Forum (APWF) Strategic Framework for Climate Change Adaptation for the Water Sector

Applying the APWF framework to the flood mitigation example described above, the decision-maker would start with low-cost 'soft approaches' before adopting higher cost 'hard solutions, such as, (a) identifying and investing in no-regrets flood mitigation options (those project options that will provide benefits whether there is climate change or not); (b) investing in project options that develop the resilience of the community and civil society to an uncertain future climate; and (c) investing in carefully selected and designed hard solutions to mitigate those impacts that cannot be avoided, only after the first two options have been explored.

The potential climate change water-related impacts due to a changed hydrological cycle can be grouped under the following three categories:

(a) Impacts on water bodies
(b) Impacts on water services
(c) Impacts on water-related hazards

To address the above water-related impacts due to climate change there is a need to assess the current weaknesses and gaps in the following governance, R&D and management areas:

(a) Governance and institutional capacity
(b) Climate Change Projections and R&D capacity
(c) Information Management capacity
(d) Land use Management capacity
(e) Stakeholder Awareness and Participation

Based on the results of the assessments of the impacts, weaknesses and gaps in the above three impact categories and 5 management areas, coherent strategies and action plans have to be developed for the above five management areas, including the management capacity to address the above three impact categories due to climate change.

1.2 ASM's Advisory Report on Water and Climate Change to the Government

In order to support the Government's efforts to address the challenge of water-related impacts due to climate change the Academy of Science Malaysia (ASM) has created a 'Task Force (TF) on Climate Change and Water Resources (CC & WR)' to prepare a Strategic Advisory Report on Climate Change and Water Resources for the Government of Malaysia. The work to prepare the report involves the following 3 stages:

(a) Preparation of a baseline, status report on CC & WR in Malaysia;
(b) Presentation of the report findings at a national forum; and
(c) Strategic Consultations (SC) with key stakeholders in a series of SC Labs (SCLs).

The TF has completed the baseline, status report, entitled "*Study on the Status of Climate Change Impact on Water Related Issues*" on 28 December 2010. Subsequently, the key findings from the status report were presented in a paper entitled, "*Position Paper on Malaysian Climate Change and Water Resources*" at the "National Conference on the impacts of climate change on water resources and their consequences to major economic sectors", in Putrajaya, on 25 July, 2011. This was then followed by a series of strategic consultations with key stakeholders on the study findings in seven thematic SCLs in 2012, so as to obtain their views and the additional inputs for the formulation of the strategies to address the climate change impact on water-related issues in Malaysia.

The following are the seven SCLs that were carried out:

1. SCL 1 (Information Management Capacity) – 3 September 2012
2. SCL 2 (Stakeholder Awareness and Participation) – 4 September 2012
3. SCL 3 (Climate Change Projections and R&D Capacity) – 9 October 2012
4. SCL 4 (Water Resources and Water Use Management Capacity) – 3 December 2012
5. SCL 5 (Governance and Institutional Capacity) – 4 December 2012
6. SCL 6 (Water-related Hazard and Risk Management Capacity) – 12 December 2012
7. SCL 7 (Water-related Landuse Management Capacity) – 13 December 2012

Note: SCL 3 was held in conjunction with the *"National Conference on Extreme Weather and Climate Change:Understanding Science and R&D Capacity Needs"*, 8-9 October 2012

To facilitate the TF in managing the huge amount of information arising from the baseline report and from the seven SCLs, the TF adopted the Multicentric Issues-based Information System (MCT-IBIS) to present and archive online the study findings and proceedings from the seven SCLs. The MCT-IBIS is an innovative, information management system that has been designed to support online deliberation of issues. It enables information to be organised and presented from numerous perspectives, in the form of linked, easily readable 'bite-sized' entries, grouped under a set of entry types (such as issues, facts, ideas, etc). It also provides a facility to get an overview of the linked entries in the form of a user-defined mind-map. The specific implementation of the MCT-IBIS containing the ASM TF study findings and proceedings from the SCLs deliberations is known as the *Malaysia Water and Climate Change IBIS (MyWCC-IBIS)* website.

The MyWCC-IBIS URL is http://mywccibis.mcthosting.net.

The TF recognises that there is a need for an on-going national dialogue on water and climate change even after ASM has submitted its Advisory Report to the Government. Thus, the TF has created the MyWCC-IBIS website as a web platform to support the on-going "National dialogue on the issues related to Water and Climate Change and the possible strategies to address them". The initial contents of the dialogue were based on the TF study findings in 2010 and the proceedings from the seven SCLs in 2012, together with the recommended strategies in this Advisory Report. ASM will hand over the MyWCC-IBIS web site to a designated, government implementing agency, for on-going maintenance and support for the National Dialogue on Water and Climate Change.

1.3 Report Structure

Appendix 1 describes the five principles of the Asia Pacific Water Forum (APWF) strategic framework to address the impacts of climate change in the water sector. It provides the basis and guidelines for the formulation of the recommended strategies in this Advisory Report to address the Climate Change (CC) impacts in the following eight focus areas:

1. Water bodies management capacity
2. Water services management capacity
3. Water-related hazards management capacity
4. Governance and institutional capacity
5. Climate Change Projections and R&D capacity
6. Information Management capacity
7. Land use Management capacity
8. Stakeholder Awareness and Participation

Chapters 2 to 9 describe the key issues, facts and ideas related to the above eight focus areas and the recommended strategies to address them.

Chapter 10 presents the "Strategic Plan for Water and Climate Change", which integrates the recommended strategies for the eight focus areas into a coherent strategic plan for implementation by the Government.

Appendix 2 provides a brief overview of the MyWCC-IBIS web site so that the reader will have an appreciation of the current content in the web site and how it can support the on-going National Dialogue on Water and Climate Change. All supporting references for this Advisory Report can be found in the MyWCC-IBIS web site and a PDF report on the MyWCC-IBIS website is also available for download from the website.

2 WATER BODIES MANAGEMENT CAPACITY

Water bodies, such as rivers, oceans/coastal areas, lakes and aquifers/ groundwater are an integral part of the hydrological cycle. The hydrological cycle will be affected by climate change, which will in turn affect the dynamics of water flow through the water bodies and their related characteristics. The capacity to manage the potential hydrological changes in the water bodies and their related impacts due to Climate Change (CC) is thus very important.

2.1 Rivers

The following are the potential impacts of CC on rivers:

(a) Increased variability of river flows due to increased variability of rainfalls.
(b) Increased salinity intrusion at river mouths due to sea level rise.

2.1.1 Current Status

To facilitate the management of rivers and also to support the integrated management of river basins in Malaysia the Department of Irrigation and Drainage (DID) has develop a register of all rivers and river basins in the country. It has also prepared maps delineating the river networks and river basin boundaries, and has also developed a number of river basin management plans based on the Integrated River Basin Management (IRBM) approach to facilitate river basin stakeholders' cooperation in achieving the IRBM vision for the basins. The IRBM approach for river basin management is also supported in RMK10 as part of the country's long-term strategy for water resource management to achieve water security.

The National Communication (NC2) Report submitted by the Government to the IPCC has highlighted that changing annual rainfall and seasonal rainfall patterns will affect river flow and river water quality. It noted the general

characteristics of Malaysian rivers, as small and short, with flooding occurring frequently in low-lying and coastal areas during short intense rainfall or during long, low intensity rainfall. It also noted that during periods of low rainfall, the river water quality is prone to deteriorate and that small forest streams are breeding grounds for one of the malaria vectors.

2.1.2 Issues

The following are the identified issues:

(a) Stability of river banks will be affected by the increased range between the high and low river flows. This will result in more frequent river bank failures and increased river erosion and sedimentation.
(b) The change in river flow regime will also affect the ecosystem functions of the river floodplains and estuarine wetlands.
(c) The change in river flow regime may also affect the breeding ground for the malaria vectors with potential future reintroduction or occurrence of malaria.
(d) Increased river mouth sedimentation due to the increased salinity intrusion at river mouths.

2.1.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Conduct CC impact assessments on river banks stability, erosion and sedimentation for important rivers based on hydrologically-simulated river flow regime with rainfall inputs derived from hydro-climatic models.
(b) Similarly, conduct CC impact assessments on important floodplains and wetlands ecosystems, and on the malaria vectors arising from the simulated river flow regime.
(c) Conduct CC impact assessment on sedimentation in important river mouths due to sea-level rise induced river mouth salinity intrusion.

2.2 Coastal Areas

The following are the potential impacts of CC on coastal areas:

(a) Increased inundation of coastal areas due to higher storm surge levels arising from Sea Level Rise (SLR);
(b) Increased salinity intrusion of coastal areas due to SLR; and
(c) Increased sea water temperature in the coastal areas.

2.2.1 Current Status

DID completed a National Coastal Erosion Study (NCES) in 1985 in which a thorough assessment of the conditions of the Malaysian coastline in 1985 was carried out. The conditions of the coastlines were grouped into 3 categories - Cat-1: Critical erosion, Cat-2: Significant erosion and Cat-3: Mild or acceptable erosion. Since uncontrolled developments along a reach of a coastline can affect that in another reach there is a need for coastal development plans that take into account the dynamic, physical nature of the coastline. In order to address that need DID conducted a pilot study in 2002 to develop an Integrated Shoreline Management Plan (ISMP) for the Northern Pahang coastline. The ISMP can assist local planning authorities in approving development proposals along coastal areas and complements the statutory Local Plan. Since then a number of ISMPs have been completed by DID for Southern Pahang, Negeri Sembilan, Labuan and Penang coastlines.

The NPP (2005) and the National Urbanisation Policy have also identified coastal areas where the sensitive coastal ecosystems within them need to be protected from coastal reclamation for urban expansion, except for the development of ports, marinas and jetties. It highlighted the need for the policy recommendations of the National Integrated Coastal Zone Management to be implemented.

2.2.2 Issues

The following are the identified issues:

(a) Increased coastal erosion due to increased wave actions from higher level storm surges;
(b) Increased socio-economic losses due to the increased frequency and extent of coastal inundation;
(c) Threats to coastal ecosystem, such as mangroves and related biodiversity, due to the increased extent of brackish areas caused by the salinity intrusion into the coastal areas; and
(d) Coral bleaching due to increased sea water temperature in the coastal areas.

2.2.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Increased coastal erosion
    1. Conduct long term wave measurement programmes for Malaysian coasts so as to support research on the impacts of storm surges and wave patterns on the coastlines;

2. Conduct long term observation of the natural coastal evolution caused by storm surges and wave patterns since they have significant impacts on the coastlines; and
3. Conduct research to find the best methods to implement coastal reforestation, such as finding the most optimal planting methods to develop robust coastal forests, as well as soft engineering application of structural and biological concepts to solve coastal erosion problems and reduce its erosive forces.

(b) Increased socio-economic losses

1. A policy on coastal management should be implemented to ensure that all coastline developments are guided by an *Integrated Shoreline Management Plans (ISMP)*. The "retreat, accommodate and protect" approach should be adopted as a step-by-step development of defensive options to address the threat of coastal SLR.
2. Identify financial resources to accelerate the formulation of ISMP for the rest of the country's coastlines.
3. Identify ways to ensure compliance with the ISMP recommendations, for example by adopting legal instruments, such as the Coastal Development Control Law, for consistency in the application of coastal development guidelines.
4. Conduct National Coastal Vulnerability Index (NCVI) studies for coastal areas that are likely to suffer from serious socio-economic impacts from SLR. The outputs from the studies will enable timely adaptation measures to be undertaken to reduce or eliminate the impacts from SLR. It is recommended that NCVI studies be conducted for the following coastal areas:

- East Coast: Pantai Sabak, Kelantan, Kuantan, Pahang, K. Terengganu, Terengganu;
- West Coast: Pelabuhan Klang, Selangor, P. Pinang, Batu Pahat, Johor;
- Sarawak: Bintulu, Miri, Kuching
- Sabah: Kota Kinabalu, Tawau, Sandakan

(c) Threats to coastal ecosystems - Conduct studies to assess the impacts on important, sensitive, coastal ecosystems. For example, a study should be carried out to assess the impacts on the Kuala Selangor firefly colonies arising from reduced river flow caused by prolonged dry periods. The reduced river flow would result in salt water intrusion which will impact on the sensitive Berembang trees upon which the fireflies rely on.

(d) Coral bleaching - Conduct detail studies on the effect of coral bleaching due to the increase of sea temperature.

2.3 Lakes

The International Panel on Climate Change (IPCC) Technical Paper on "Water and Climate Change" has highlighted the following possible CC impacts on lakes:

(a) Intensified stratification and nutrient loss from surface waters, decreased hypolimnetic oxygen (below the thermocline) in deep, stratified lakes, and expansion in range for many invasive aquatic weeds.
(b) Water levels in lakes at mid and low latitudes are projected to decline.
(c) Endorheic (terminal or closed) lakes are most vulnerable to a change in climate because of their sensitivity to changes in the balance of inflows and evaporation. Changes in inflows to such lakes can have very substantial effects and, under some climatic conditions, they may disappear entirely.
(d) A unit increase in temperature in tropical lakes causes a proportionately higher density differential as compared with colder temperate lakes. Thus, projected tropical temperatures will lead to strong thermal stratification, causing anoxia in deep layers of lakes and nutrient depletion in shallow lake waters. Reduced oxygen concentrations will generally reduce aquatic species diversity, especially in cases where water quality is impaired by eutrophication.
(e) Effects of warming on riverine systems may be strongest in humid regions, where flows are less variable and biological interactions control the abundance of organisms. Drying of stream-beds and lakes for extended periods could reduce ecosystem productivity because of the restriction on aquatic habitat, combined with lowered water quality via increased oxygen deficits and pollutant concentrations.

2.3.1 Current Status

NAHRIM completed a study on the status of eutrophication of 90 lakes in Malaysia in 2005. The study found that 60 lakes were eutrophic. Following the study, the Academy of Sciences Malaysia (ASM) and NAHRIM conducted a series of workshops to develop the strategies to manage the lakes in the country. NAHRIM has also developed a National Lake Inventory System, which is a component of the National Hydraulic Data Repository, to support the archiving and sharing of information on lakes in Malaysia.

2.3.2 Issues

The following are the identified issues:

(a) Increased lake eutrophication and decreased lake water quality;
(b) Increased variability in lake water levels, with potential drying-up of inland lakes; and
(c) Socio-economic losses arising from the decreased lake water quality and also lake water quantity and variability.

2.3.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) To adopt and implement the lake management strategies developed by ASM and NAHRIM in 2008;
(b) To identify lakes that have important socio-economic objectives and carry out preliminary, indicative studies on the potential impacts of climate change on the lakes, taking note of the potential climate change impact factors on lakes highlighted by the IPCC; and
(c) To conduct more monitoring and research on the major lakes in the country. The information is required as baseline data for CC impact assessments of lakes in the country. This is because apart from the extensive research on Putrajaya Lake and Tasik Chini there is not much information available on the major lakes in the country.

2.4 Aquifers/Groundwater

The International Panel on Climate Change (IPCC) Technical Paper on "Water and Climate Change" has highlighted the following possible CC impacts on groundwater:

(a) Climate change affects groundwater recharge rates (i.e., the renewable groundwater resources) and depths of groundwater tables. However, knowledge of current recharge and levels in both developed and developing countries is poor; and there has been very little research on the future impact of climate change on groundwater, or groundwater-surface water interactions.
(b) As much groundwater both change into and are recharged from surface water, the impacts of surface water flow regimes are expected to affect groundwater.
(c) Increased precipitation variability may decrease groundwater recharge in humid areas because of more frequent heavy precipitation.
(d) Where the depth of the water table increases and groundwater recharge declines, wetlands dependent on aquifers are jeopardised and the base flow runoff in rivers during dry seasons is reduced.
(e) In areas where water tables are already high, increased recharge might cause problems in towns and agricultural areas through soil salinisation and waterlogged soils.

2.4.1 Current Status

The technical management of aquifers or groundwater resources in Malaysia is under the responsibility of the Department of Mineral and Geosciences (DMG). The DMG keeps records of groundwater wells and prepares the hydrogeological maps for the country. The licensing of groundwater development lies with the respective State Government. Due to the abundance of surface water in the rivers the exploitation of groundwater as a source of water for both irrigation and potable use is not common, except in the state of Kelantan and some parts of Sabah where potable water supply are derived from groundwater sources. In the RMK8 period (2000-2005), a study on groundwater resources in the states of Johor, Kedah, Negeri Sembilan, Sabah, Sarawak and Selangor was completed in 2002. Furthermore, in the RMK9 period (2006-2010) the development of groundwater was promoted as an interim measure to address the anticipated shortage of water in Selangor, Kuala Lumpur and Putrajaya.

The National Physical Plan (NPP, 2005) has identified groundwater resource and recharge areas that need to be protected from activities that cause pollution and reduce their yield. It highlighted that Structure Plans and Local Plans shall delineate ground water resource areas (wellheads) and recharge areas as part of the integrated land use management plans and that buffer requirement shall be imposed to protect the recharge areas and wellheads. In addition, it highlighted the need for drainage controls to be imposed in the vicinity of important groundwater areas such as peat swamps and freshwater swamps to maintain the water table required in sustaining the ecosystems within them. In order to avoid over-extraction of groundwater resources it also highlighted the need for monitoring the groundwater extraction of all public wells catering for commercial, industrial and agricultural activities.

2.4.2 Issues

The following are the identified issues:

(a) Impacts on groundwater levels and availability due to CC-induced changes in the groundwater recharge rates. This will result in socio-economic losses.
(b) Impacts on wetlands dependent on a stable groundwater level.
(c) Increased salinisation of coastal aquifers due to SLR which will affect the availability of freshwater for coastal communities and also impacts on the coastal ecosystems.

2.4.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) To adopt and implement the groundwater management strategies developed by ASM in 2011.
(b) To identify aquifers that have important socio-economic objectives and carry out preliminary, indicative studies on the potential impacts of climate change on the aquifers, taking note of the potential climate change impact factors on groundwater highlighted by the IPCC.
(c) To increase the monitoring of groundwater tables levels of important aquifers, and also their recharge characteristics, so as to identify potential negative CC impacts on wetlands dependent on the aquifers and also on the possible increased in soil salinity arising from rising water tables; and
(d) To monitor and study the issue of saline encroachment of groundwater near coastal areas due to over-pumping of groundwater.

3 WATER SERVICES MANAGEMENT CAPACITY

Water is a limited resource and has both consumptive and non-consumptive uses/services. The major consumptive uses of water in Malaysia are for: (a) potable water supply for domestic and industrial use, and (b) irrigation water supply for agriculture. The major non-consumptive uses are for (a) hydropower generation, (b) river navigation, (c) fisheries, and (d) sustaining the water ecosystem.

Since there are numerous uses for water there will be competition and conflict among different stakeholders for use of the limited resource. Thus, the capacity to manage the numerous water uses among different stakeholders is important, especially in view of the potential impacts that climate change will have on the quantity, quality and reliability of the water resources.

3.1 Agriculture and Irrigation Water Supply

The following are the potential impacts of CC on agriculture and irrigation water supply:

(a) Increased variability of rainfalls can impact on the operations and effectiveness of irrigation facilities;
(b) Increased salinity intrusion at the coasts due to sea level rise will impact on coastal agricultural areas; and
(c) Higher temperatures and increased variability of rainfall will affect crop yields.

3.1.1 Current Status

The NPP (2005) has identified eight strategic granary areas comprising the Muda (MADA), Kemubu (KADA), ADP Kerian-Sungai Manik, IADP Barat Laut Selangor, IADP Pulau Pinang, IADP Seberang Perak, IADP Terengganu Utara

(KETARA) and IADP Kemasin-Semerak that are to be conserved. All of these granary areas are served by irrigation facilities. The NC2 has highlighted that the irrigation facilities and their efficacy can be impacted by excessive rainfall, reduced rainfall and extreme weather patterns. With excessive rainfall, failure to contain excess water is anticipated which could result in flooding and crop damage/loss of yield.

Projections made by the RegHCM-PM model were used in the NAHRIM (2009) study to identify vulnerabilities in three granary areas" the Muda Agriculture Development Authority (MADA), Kemubu Agriculture Development Authority (KADA) and the Barat Laut Selangor granary areas. The projections indicated that the MADA granary area could face excess water for 76% of the 240 months studied, while there are indications of extreme surplus of up to (+) 5,438 MCM in the KADA granary area. Insufficient rainfall is anticipated for 10 out of the 40 planting seasons considered at the MADA scheme possibly warranting the cancellation of paddy planting in some, or in the worst case scenario, all of the MADA area. Likewise, for the Barat Laut Selangor irrigation scheme where one of the deficit events is projected to be severe enough to disrupt planting in some parts. KADA is not expected to face severe deficits.

The NC2 has also highlighted that rain-fed agriculture is also vulnerable to climate change impacts. In terms of rice for example, a 15% increase in rainfall in the early growth stages could result in an 80% decrease in yield. Apart from food security being vulnerable, economic security is also vulnerable as yields of important crops to the economy like oil palm, rubber and cocoa will also be affected. These impacts will reduce the number of rubber tapping days and increase fungal incidence in cocoa. To add, frequent and severe landslides are anticipated as is an increase in tree mortality. The NC2 has also highlighted that coastal agricultural activities are also vulnerable to salt water intrusion arising from sea-level rise.

3.1.2 Issues

The following are the identified issues:

(a) The effectiveness of the irrigation facilities serving the eight strategic granary areas comprising the Muda (MADA), Kemubu (KADA), ADP Kerian-Sungai Manik, IADP Barat Laut Selangor, IADP Pulau Pinang, IADP Seberang Perak, IADP Terengganu Utara (KETARA) and IADP Kemasin-Semerak will be affected.
(b) The salt water intrusion will affect coastal agricultural activities.
(c) There will be a reduction in the quality and yield of cash crops such as oil palm (where a 10% decrease in mean annual rainfall results in 30% decrease in yield) and rubber (where the reduction below mean minimum and increase in temperature over 30 degrees centigrade will result in 10% yield decrease).

3.1.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Conduct a vulnerability study to assess the projected climate change impacts on the irrigation water supply for the eight granary areas, and how it will impact on the national rice supply arising from increased frequency of floods destroying crops, or prolonged droughts destroying or reducing the yield of the rice crops;
(b) Implement measures and strategies to improve irrigation efficiencies in the eight granary areas;
(c) Conduct a vulnerability study to assess the impacts of salt water intrusion on coastal agricultural activities arising from sea-level rise;
(d) Conduct a vulnerability study to assess the projected climate change impacts on the quality and yield of our national cash crops like oil palm and rubber due to the potential change in rainfall and temperature regime;
(e) Conduct a study to identify the types of low-cost, farm-level adaptation actions that can be taken to address the potential changes in climate due to shifting rainfall patterns and characteristics on the major agricultural cash crops and the irrigated rice crops in the eight granary areas;
(f) Specific measures like low intensity tapping system and rain gutters for the rubber industry should be used in a more widespread manner to address increased frequency of rainfall. Workers skills should also be enhanced to enable them to apply newer technologies such as low impact tapping;
(g) There is a need to establish an early warning system to monitor changes in rice and cash crop yield, promote farm-level rain-water harvesting, soil water management and drainage improvement to increase the resiliency of the agricultural system to cope with climate change;
(h) R&D should be enhanced to identify flood resistant crop varieties, while agricultural drainage system should be designed to efficiently regulate water tables and remove flood waters from agricultural land as quickly as possible; and
(i) R&D should be carried out to improve crop modelling projections, with better local data on the projected magnitude of climate change, together with crop parameters and soil properties; and
(j) R&D on crops that are more resistant to drought conditions.

3.2 Hydropower

The potential impact of CC on hydropower schemes is the increased variability of river flows flowing to hydropower schemes due to the increased variability of rainfalls.

3.2.1 Current Status

The National Policy on Climate Change (NPCC, 2009) has two Key Actions (KA19 and KA23) where hydropower has been identified as one of the Renewal Energy (RE) solutions to be promoted among small and independent developers, including local communities, especially in rural electrification with mini and micro hydroelectric schemes. RMK10 has identified the Central Region of Sarawak as the Sarawak Corridor Renewable Energy (SCORE) with its hydropower energy resources of 28,000 MW. It has also identified the development of hydropower as an alternative source of energy. The NPP (2005) has highlighted the need to reduce the use of fossil fuels, and to utilise RE solution and Energy Efficiency (EE). Thus, the development of hydropower as a renewable energy resource is considered as part of the solution.

3.2.2 Issues

The issue that was identified is that the change in the river runoff regime due to the variability of river flows will affect the operations of hydropower schemes. A reduction in runoff will affect the hydropower generation capacity and will have an impact on the national energy supply grid.

3.2.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Conduct vulnerability studies on the projected impacts of climate change on the existing hydropower schemes.
(b) Carry out medium and long term catchment management where the hydropower scheme is located to balance competing use of the limited runoff in times of reduced river runoff to ensure sufficient runoff for hydropower generation.
(c) Promote the national implementation of grid connected rooftop solar panels to reduce disruption risks and ease the hydropower capacity requirements.

3.3 River Navigation

The potential impact of CC on river navigation is the increased variability of river flows due to increased variability of rainfalls.

3.3.1 Current Status

River navigation is an important mode of human and cargo transport such as for timber in Sarawak. The NC2 recognises that changes in river flows due to more extreme rainfall patterns, as well as increased frequency of extreme weather such as storms, can reduced the navigability of water bodies such as

rivers and lakes. It also recognises that the increased sedimentation at river mouths will affect cargo transportation such as timber.

3.3.2 Issues

The following are the identified issues:

(a) Changes in river flows due to more extreme rainfall patterns, as well as increased frequency of extreme weather such as storms, can reduced the navigability of water bodies such as rivers and lakes.
(b) The possible increased sedimentation at river mouths will affect cargo transportation such as timber.

3.3.3 Proposed Ideas

The following idea was proposed to address the identified issues:

(a) The need to assess the projected impact of climate change on river navigation, and how it will affect the existing transport operations of human and timber cargo, especially in Sarawak.

3.4 Fisheries

The following are the potential impacts of CC on freshwater fisheries:

(a) Increased ambient water temperature; and
(b) Increased salinity intrusion in coastal areas due to sea level rise.

3.4.1 Current Status

The impacts of climate change on freshwater fisheries have not been considered in the NC2 report, apart from the potential impacts of climate change on coastal aquaculture activities. Coastal aquaculture activities are vulnerable to salt water intrusion, since coastal wetlands and mangrove areas are habitats for juveniles and changes in the water salinity may affect their population and sex ratio.

3.4.2 Issues

The following are the identified issues:

(a) Fisheries stress due to increased temperature and oxygen demand and decreased pH.
(b) Occurrence of increased frequencies of diseases and toxic events for fisheries.

(c) Coastal aquaculture activities are vulnerable to salt water intrusion, since coastal wetlands and mangrove areas are habitats for juveniles and changes in the water salinity may affect their population and sex ratio.

3.4.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Carry out a study to assess the projected impact of climate change on freshwater fisheries, including coastal aquaculture activities, for various possible rainfall regime, and to define the possible adaptation options.

3.5 Water Ecosystems

The International Panel on Climate Change (IPCC) Technical Paper on "Water and Climate Change" has highlighted the following possible CC impacts on water ecosystem:

(a) The change in temperature and moisture regimes, which are among the key variables that determine the distribution, growth and productivity, and reproduction of plants and animals.
(b) The changes in the hydrology can influence species in a variety of ways, but the most completely understood processes are those that link moisture availability with intrinsic thresholds that govern metabolic and reproductive processes.
(c) The changes in climate that are anticipated in the coming decades will have diverse effects on moisture availability, ranging from alterations in the timing and volume of streamflow to the lowering of water levels in many wetlands, and a decline in mist water availability in tropical mountain forests.

3.5.1 Current Status

The ecosystem is recognised as a national strategic resource in the New Economic Model (NEM, 2009) report. Its importance is also recognised in the NPCC (2009), RMK10, NPP (2005) and National Biodiversity Policy (NBP, 1998). The NPCC (2009) has three Key Actions (KA15, KA16, KA17 and KA23) where the importance of the natural ecosystem has been identified. It recognises that natural ecosystems are carbon pool sinks that needs to be conserve and that sensitive and degraded ecosystems are to be rehabilitated through sound management practices, and land use planning. Added to that, it highlighted the need for the value of ecosystem services to be identified and integrated into the development planning process, and that there is a need to carry out baseline studies on forest ecosystems as part of the development of a national carbon accounting system.

RMK10 recognises the need to value our nation's natural endowments and that healthy ecosystems are a key determinant of our physical and economic well-being. It highlighted the need to develop business models to compete sustainably in the global economy and that economic growth has to be decoupled from environmental degradation. It also emphasised the importance to continue with programs to conserve our forests, and that further initiatives will be undertaken to encourage States to gazette forests, especially water catchments, as protected areas. It also highlighted that the Government with the participation of the private sector, non-government organisations (NGOs) and the public at large will continue its efforts in planting more trees to green the country.

RMK10 also recognises the need to enhance the conservation of our forest's biodiversity and to protect its biodiversity and habitats. Thus, the Central Forest Spine of 4.32 million hectares in Peninsular Malaysia and the Heart of Borneo of 6.0 million hectares in Sabah and Sarawak have been classified as Environmentally Sensitive Areas (ESA), where limited or no development will be permitted. They will also serve as biodiversity reservoirs and watershed areas, with the potential to be developed for eco-tourism.

The NPP (2005) has identified and categorised three types of ESA in Peninsular Malaysia. The ESA will be affected by climate change and thus there is a need to include them in any climate change adaptation plans. The NBP (1998) highlighted the need to increase efforts to strengthen and integrate conservation programmes and that there is a need to ensure that all major sectoral planning and development activities incorporate considerations of biological diversity management.

3.5.2 Issues

The following are the identified issues:

(a) Inland freshwater wetlands will be affected through the altered rainfall and more frequent or intense disturbance events (droughts, storms, floods). Relatively small increases in precipitation variability can significantly affect wetland plants and animals at different stages of their life cycle.
(b) Generally, climatic warming is expected to start a drying trend in wetland ecosystems, which would be the main agent in wetland ecosystem change.
(c) Wetland processes that are dependent on catchment-level hydrology can be altered by changes in land use as well as surface water resource management practices.
(d) Changes in water recharge external to the wetland.
(e) Due, in part, to their limited capacity for adaptation, wetlands are considered to be among the ecosystems most vulnerable to climate change. Wetlands are often biodiversity hotspots and their loss could

lead to significant species extinctions, especially among amphibians and aquatic reptiles.

(f) The seasonal migration patterns and routes of many wetland species will have to change; otherwise some species will be threatened with extinction.

3.5.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) To setup a national inventory system for wetlands where basic information on the wetlands, including regular monitoring information can be archived.
(b) To conduct studies of important wetlands to identify the sensitive physical and biological parameters that will be affected by climate change.
(c) To setup monitoring programs to detect the impacts of climate change on the wetlands.

3.6 Competing Uses of Water

The International Panel on Climate Change (IPCC) Technical Paper on Water and Climate Change has highlighted that CC will also have impacts on non-climatic factors that affect the use of freshwater, such as increased competition for the scarce water resources.

The issue arising from the above CC impacts on the non-climatic factors is that it will increase the severity of the impacts of climate change and require adaptations measures that will need increased stakeholder awareness and participation to ensure acceptance of the measures.

The following are some of the non-climatic factors that have been identified by IPCC that need to be addressed:

(a) Both the quantity and quality of water resources are influenced by land-use change.
(b) Water use is driven by changes in population, food consumption, economy (including water pricing), technology, lifestyle and societal views regarding the value of freshwater ecosystems.
(c) The vulnerability of freshwater systems to climate change also depends on national and international water management, in which the Integrated Water Resources Management (IWRM) approach will be increasingly adopted around the world.
(d) Consideration of environmental flow requirements may lead to the modification of reservoir operations so that human use of the water resources may be restricted.

3.7 Potable Water Supply (Water Resources Management)

The potential impacts of CC on the water resources is that the increased variability of river flows due to increased variability of rainfalls will affect the availability of river water resources.

3.7.1 Current Status

The NWRS (2000) for Peninsular Malaysia highlighted the need to develop major water supply capacities to meet projected future water supply deficits, including the need for inter-basin water transfer from Pahang to Selangor across the Main Ranges of Peninsular Malaysia.
The NC2 Report has questioned the data used in the NWRS (2000) study to estimate the projected water supply demand to justify the development of the major water supply infrastructures to provide the required water supply capacities. The NWRS (2010) study has updated the NWRS (2000) study and has revised drastically downwards the water demand estimates in the NWRS (2000) study and also the number of recommended water supply infrastructures to be constructed.

RMK10 has highlighted that the major institutional restructuring of the water utilities sector that took place on 1 January 2008, with the implementation of the Water Services Industry Act 2006 (Act 655) or WSIA, will continue. The WSIA was created to allow the Federal Government to provide and regulate the treated water supply services and sewerage services which was formerly under the responsibility of the state authorities. It is to ensure uniformity of the laws and policies for the proper control and regulation of water supply services and sewerage services throughout Peninsular Malaysia and the Federal Territories of Kuala Lumpur, Putrajaya and Labuan.

3.7.2 Issues

The issue that was identified is that most of the potable water supplies used in Malaysia for domestic and industrial consumption are derived from river water resources.

3.7.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Need to protect the river water catchments providing the potable water supplies through the adoption of the IWRM and IRBM principles and approach in land use planning;
(b) Need to develop a long-term strategy for water resources management to achieve water security; and
(c) Need for the water-resources-rich states to protect their water catchments and develop them for the export to water-stressed states.

3.8 Potable Water Supply (Water Demand Management)

Since the water resources are limited the potential CC impact on water resources will increase the vulnerability of the potable water supply system. Thus, there is a need to manage the demand on the potable water supply.

3.8.1 Current Status

Both RMK10 and the NPP (2005) highlighted the need to implement water demand management measures through the reduction of water reticulation losses, recycling of water use and the incorporation of green design elements like rain water harvesting facilities and water conservation features into housing. With the restructuring of the water utilities sector in 2008 a major effort has been undertaken by the government to reduce the NRW losses through a series of measures. However, the planning paradigm and incentives given to the water supply providers have not changed since they are private sector entities and make profits from supplying water, not reducing the demand for it.

Currently, there is also a perceived loss in confidence of the consumers in the drinking quality of the potable water supply. This can be seen in the thriving bottled water industry and also increased sales of water filters. The reason for this is because of the increased incidences of murky water at the taps over the years due to the breakdown and poor maintenance of the water reticulation system over the years. Also, consumers are aware of the increased pollution of our rivers and with rising income is also increasingly health-consciousness.

3.8.2 Issues

The following are the identified issues:

(a) Lack of an effective institutional framework to support the implementation of IWRM and IRBM principles and approach in land use planning, water resources planning, management and use;
(b) Flawed paradigm of our water supply planners and consultants in planning our future water supply capacity based on meeting unlimited water demand, rather than planning with a targeted, sustainable per capita water demand;
(c) Lack of confidence of the consumers in the drinking quality of the potable water supply;
(d) Lack of an effective institutional, legal and financial framework to support water supply demand management through widespread adoption of rainwater harvesting, water conservation and water recycling measures by the consumers;
(e) Lack of a financial incentive structure to change the primary objective of water supply providers from selling more water to helping the consumers to reduce their consumption of water; and

(f) Lack of resiliency in our water supply system to cope with the projected increased in variability of our river runoff arising from climate change.

3.8.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Set-up national and state-level IWRM Secretariats to develop strategies, implement, monitor and report regularly on the progress in the implementation of IWRM principles, including integrated thematic sector-based approaches based on IWRM principles, such as IRBM, IFM, etc.
(b) Review the existing and future water supply infrastructure development plans recommended in the NWRS (2011) study, to anchor the plans on a targeted, sustainable per capita water consumption figure that is benchmarked with the contemporary figures achieved by other countries.
(c) Adopt a policy of water supply capacity planning based on a targeted, sustainable per capita water demand figure, and make water supply planners, operators and consultants aware of such a policy so that the planning and operations of water supply infrastructures will be based on a constrained demand.
(d) SPAN to impose requirement on water supply providers to develop and implement Water Safety Plans (WSP) to address the loss in confidence of the consumers in the drinking quality of our potable water supply.
(e) SPAN to setup a Water Demand Management Taskforce (WDM-TF) to develop strategies, implement, monitor and report on the country's progress towards achieving the targeted, sustainable per capita water demand figure.
(f) SPAN to develop financial incentive structures to make water supply providers earn their revenue from delivering water supply performance rather than selling more water to consumers to waste.
(g) Need to develop strategies to increase the resiliency of our water supply system to cope with the projected increased in variability of our river runoff arising from climate change.

4 WATER-RELATED HAZARDS MANAGEMENT CAPACITY

Water hazards due to too much (floods) and too little water (scarcity/droughts) are natural events that humans have managed to develop measures to adapt to their impacts. Climate change may increase the severity of these water hazards. Also, water-related diseases caused by water pollution, such as cholera, and mosquito vector-borne diseases such as dengue, are water-related hazards that may increase in severity due to climate change. Thus, the capacity to manage the water-related hazards is important.

4.1 Flood

The International Panel on Climate Change (IPCC) Technical Paper on "Water and Climate Change "has highlighted the following possible CC impacts on flood:

(a) Increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas. It highlighted that adaptation procedures and risk management practices that incorporate projected hydrological changes with related uncertainties are being developed in some countries and regions.
(b) Future flood damages will depend greatly on settlement patterns, land-use decisions, the quality of flood forecasting, warning and response systems, and the value of structures and other property located in vulnerable areas, as well as on climatic changes per se, such as changes in the frequency of tropical cyclones.
(c) The impact of climate change on flood damages can be projected based on modelled changes in the recurrence interval of current 20- or 100-year floods, and in conjunction with flood damages from current events as determined from stage-discharge relations and detailed property data.

4.1.1 Current Status

The DID completed a study in 2003 to update the condition of flooding in Malaysia up to the year 2000. The study encompasses all reported flood-affected areas in the states of Peninsular Malaysia, Sabah and Sarawak. The study concluded that the total flood affected area in Malaysia in 2000 is 29,799 sq. km, which is about 9% of the total 328,938 sq. km in the country compared to the 29,021 sq. km. of flood affected area reported in the JICA 1982 Study. The study also highlighted that the total number of people living in the flood affected areas is estimated to be 4.819 million, which is about 22 % of the total population of 22.2 million in Malaysia as at year 2000. This is an increase of 76% compared to the flood affected population reported in the JICA 1982 Study, which was 2.736 million, representing 20% of the population at that time. This increase is in tandem with the increase in the country's population since 1980. The study also computed the total Annual Average Flood Damage for Malaysia, which was estimated to be RM915 million (at 2000 prices), compared to the RM100 million (at 1980 prices) reported in the JICA 1982 Study.

4.1.2 Issues

The following are the identified issues:

(a) Need to update design rainfalls and flood peaks guidelines to include projected design rainfalls;
(a) Need to review designs of all major drainage, flood mitigation, dams and water-related projects; and
(b) Need to update flood maps to include projected design rainfalls.

4.1.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Update DID's Hydrological Procedures related to design rainfalls and flood peaks to include projected design rainfalls;
(b) Update the design rainfalls in the MSMA manual to include projected design rainfalls;
(c) Update DID 2003 Flood Study report and derive the latest flood maps, including indicative flood maps for the projected design rainfalls;
(d) Review designs of all major drainage and flood mitigation projects;
(e) Review design of all dams with updated and projected design rainfalls; and
(f) Develop flood disaster and dam-break mitigation plans for updated and projected design rainfalls.

4.2 Water Pollution

The International Panel on Climate Change (IPCC) Technical Paper on "Water and Climate Change" has highlighted the following possible CC impacts on water quality:

(a) Higher water temperatures, increased precipitation intensity, and longer periods of low flows are projected to exacerbate many forms of water pollution, including sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salt and thermal pollution. This will promote algal blooms and increase the bacterial and fungal content. This will, in turn, impact ecosystems, human health, and the reliability and operating costs of water systems.
(b) Rising temperatures are likely to lower water quality in lakes through increased thermal stability and altered mixing patterns, resulting in reduced oxygen concentrations and an increased release of phosphorus from the sediments.
(c) More intense rainfall will lead to an increase in suspended solids (turbidity) in lakes and reservoirs due to soil fluvial erosion and pollutants will be introduced.
(d) More frequent heavy rainfall events will overload the capacity of sewer systems and water and wastewater treatment plants more often.
(e) An increased occurrence of low flows will lead to decreased contaminant dilution capacity, and thus higher pollutant concentrations, including pathogens.

4.2.1 Current Status

The Department of Environment (DOE) conducts regular monitoring of water quality in major rivers which provides raw water for water supply treatment. The results of the monitoring are reported annually in DOE's Annual Environmental Quality report. RMK10 highlighted that the major sources of pollution in rivers include improper discharge from sewerage treatment plants, agro-based factories, livestock farming, land clearing activities and domestic sewage. It stated that during the RMK10 period measures will be taken to improve pollution control targeting the above identified sources through the following measures:

(a) Strengthening the enforcement on industrial effluents and sewage discharge in line with the revisions to the regulations under the Environmental Quality Act 1974;
(b) Assessing the Total Maximum Daily Load and carrying capacity of rivers to determine allowable discharge loads, for both point and non-point sources of pollution;

(c) Revising the current Water Quality Index to incorporate additional parameters, such as biological parameters, for more accurate river water classification;
(d) Developing the National Marine Water Quality Index to replace the current Marine Water Quality Criteria and Standard, which was developed in 2008; and
(e) Expanding outreach and awareness programmes targeting various segments of society, such as the Langkawi Award, Rakan Alam Sekitar, Malaysia Environment Week, Promotion of Cleaner Production to Industries and Environmental Debate amongst higher institutions.

The NPP (2005) highlighted that there is a need for a major commitment to sewerage treatment to create world class cities. The NC2 highlighted that water supply quality will deteriorate with climate change impacts such as floods, droughts and extreme weather patterns. This in turn will adversely affect public health and cause diseases like cholera to spread easily. It noted that improved sanitation coverage and safe water supply will reduce this impact.

4.2.2 Issues

The issue that was identified is the need to monitor the effects of temperature increase on lakes and rivers. This is due to the significant effects on the pollution of lakes and rivers arising from an increase in water temperature. There is a need to increase monitoring of the effects of temperature increase on lakes and river water quality.

4.2.3 Proposed Ideas

The proposed idea to address the above identified issue is to conduct increased monitoring studies on the effects of temperature increases on lake and river water quality.

4.3 Water Scarcity and Drought

Due to the increased temporal and spatial variability of rainfalls the impacts of CC on water scarcity and drought will increase.

4.3.1 Current Status

Currently some states suffer from water stress and are dependent on the water resources from adjacent states. Also, in times of a drought crisis situation, the current policy is always to sacrifice agriculture for water supply. However, this is only a short-duration strategy and is not a viable option for the long-term. For

such regions with stiff competition for water, there are a number of adaptation options but each poses serious challenges for the existing policies.

4.3.2 Issues

The following are the identified issues:

(a) Need to increase water use efficiency and productivity of water in each sector
(b) No integrated drought management system

4.3.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) To increase water use efficiency and productivity of water in each sector; and
(b) To develop an integrated drought management system based on the current procedure for drought management published by the National Security Council.

4.4 Human Health

The International Panel on Climate Change (IPCC) Technical Paper on Water and "Climate Change" has highlighted the following possible CC impacts on human health:

(a) Human health, incorporating physical, social and psychological well-being, depends on an adequate supply of potable water and a safe environment. Human beings are exposed to climate change directly through weather patterns (more intense and frequent extreme events), and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, livelihoods and infrastructure.
(b) Floods have a considerable impact on health both in terms of number of deaths and disease burden, and also in terms of damage to the health infrastructure. While the risk of infectious disease following flooding is generally low in high-income countries, populations with poor infrastructure and high burdens of infectious disease often experience increased rates of diarrhoeal diseases after flood events.
(c) There is increasing evidence of the impact that climate-related disasters have on mental health, with people who have suffered the effects of floods experiencing long-term anxiety and depression.
(d) Flooding and heavy rainfall may lead to contamination of water with chemicals, heavy metals or other hazardous substances, either from

storage or from chemicals already in the environment (e.g. pesticides). Increases in both population density and industrial development in areas subject to natural disasters increase both the probability of future disasters and the potential for mass human exposure to hazardous materials during these events.

(e) Climate influences the spatial distribution, intensity of transmission, and seasonality of diseases transmitted by vectors (e.g., malaria).

4.4.1 Current Status

The NC2 Report identified that climate sensitive health issues endemic in Malaysia are vector borne diseases (e.g. dengue and malaria), water borne diseases (e.g. cholera and typhoid), disaster-related health problems, and air pollution and temperature related mortality. Vectorial capacity modelling projected that the number of malaria cases may increase by about 15% to 20% with an increase of 1.5 degree C to 2 degree C in surface temperature in Peninsular Malaysia. The NC2 Report also highlighted that public health could be affected by the increased in areas of brackish water due to sea level rise in coastal areas, because of the increase in the coastal malaria vector population. The declining immunity as a result of effective control measures has rendered the rural population of all ages vulnerable to malaria. Lack of entomological data prevents an accurate assessment of the geographical extent of the vulnerability.

4.4.2 Issues

The following are the identified issues:

(a) Need for increased understanding and modelling of dengue transmission and mapping of malaria vector areas;
(b) No assessment has been made on the potential impacts of extreme weather and disaster on health; and
(c) Lack of capacity to conduct quantitative and qualitative vulnerability assessment in all areas of health impact due to climate change.

4.4.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Aedes-proof buildings to mitigate dengue epidemics; and
(b) Remote sensing mapping of malaria vector areas.

5 GOVERNANCE AND INSTITUTIONAL CAPACITY

"Governance is the act of governing. It relates to decisions that define expectations, grant power, or verify performance. It consists of either a separate process or part of management or leadership processes (Wikipedia)."

The government prepares policies that define the visions, expectations and goals that a society values and hopes to achieve. To implement the policies and translate them into practical actions there is a need for instruments, such as laws and institutional framework. Thus, the capacity of our Government to define a climate change policy, to legislate the required laws, create the institutional framework, train and equip its staff to implement, enforce and monitor the effectiveness in achieving the objectives of the policy is important.

5.1 Current Status

Climate change water-related impacts affect a broad range of sectors and activities, and pose a special issue concerning governance and institutional capacity. Traditionally, sectors involved in climate change analysis are governed individually and specific Ministries and agencies with specific sector related mandates have been established to do so. In Malaysia, climate change has generally been considered to be an environment issue and is anchored presently by the Ministry of Natural Resources and Environment (NRE). Prior to the establishment of NRE in 2004, climate change was under the purview of the then Ministry of Science, Technology and Environment.

A National Committee on Climate Change was established in 1994 after Malaysia became a signatory party to the UNFCCC. This national committee was chaired by the anchor Ministry and comprised of members from various ministries. However, with the rising escalation of attention and concern regarding climate change both at the global and domestic level, a Cabinet Committee on Climate Change was established in 2008 which was succeeded

in 2010 by the Green Technology and Climate Change Council (GTCCC). Both the Cabinet Committee and Council are chaired by the Prime Minister with members from numerous ministries. The NRE is a joint secretary of the GTCCC along with the Ministry of Energy, Green Technology and Water. Also, there is a National Water Council chaired by the Deputy Prime Minister and comprising of all the State Chief Ministers. This Council would be the appropriate avenue to discuss and determine water related issues nationwide and climate change water related measures can be implemented in a uniform manner using through the National Water Council.

The ADB Review on Economics of Climate Change study recommends the following:

"Put in place or enhance multi-ministerial coordination and planning mechanisms to promote multi-sector approaches to climate change adaptation, including linking climate change adaptation with disaster risk management. Given that climate change is an issue that cuts across all parts of government, it requires the attention of not just the ministries of the environment and the key agencies. Climate policy should be led by heads of State and the economics and finance ministries."

Through the establishment of the GTCC it can be seen that Malaysia has evolved its institutional framework on climate change to that recommended in the ADB study.

5.2 Issues

The following are the identified issues:

(a) Lack of a CC decision-making process and framework

There is a need to develop the CC decision-making process and framework to ensure compliance with the decisions made at the Green Technology and Climate Change Council (GTCCC). There is a lack of procedures and risk management practices to incorporate the projected climate and hydrological changes, with its associated predictive uncertainties, from NAHRIM's fine grid regional Hydro-Climatic Models (HCMs) into the various sector analysis.

(b) Lack of coordination and compliance to existing national polices and plans

There are many existing national policies and plans that pertain to climate change and water issues in the country. However, generally only the Ministry formulating the policy/plan takes ownership for its implementation. For a cross-cutting issue like climate change and water however, such policies/plans require broader participation for their full implementation. Thus, the lack of coordination among the different ministries and agencies to ensure that their implementation decisions comply with existing policies or plans is an issue.

5.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Adopt the FAO 5-Step Approach to Coping with Climate Change

The FAO has proposed a 5-Step approach to coping with climate change in the context of food security. They are equally applicable in the context of water security. The 5-Step FAO approach is as follows:

1. Scenario planning;
2. Adopting a "resilient adaptation" approach;
3. Undertaking a SWOC/T analysis of proposed adaptation strategies;
4. Applying Commoner's Four Laws of Ecology in considering any adaptation strategy; and
5. Prioritising adaptation action to be implemented.

(b) Prepare a checklist of relevant CC-related policies/plans

A comprehensive checklist of relevant CC-related policies/plans shall be prepared, summarising key sections related to CC for quick reference by decision makers.

(c) Process for regular updating of CC-related policies and plans

A process to review new policies/plans to identify their relevance to the CC decision making process should be formulated. This will ensure that relevant future policies/plans are also considered in the CC decision-making process.

6 CLIMATE CHANGE PROJECTIONS AND R&D CAPACITY

No one can predict the consequences of climate change with complete certainty. However, by developing global circulation, regional scale hydro-climatic and hydrological computer simulation models it is possible to make projections on the potential changes to the global, regional and local hydrological cycles that may be affected by the potential change in the climate due to human factors?

Research and Development (R&D) to collect the required scientific data; to understand the processes that cause changes in observed phenomena; and to develop scientific and engineering tools based on the improved understanding, is necessary to reduce the uncertainty in the climate projections. Thus, our technical capacity to make climate change projections for Malaysia and to carry out the required R&D in reducing the uncertainty in the climate change projections and its related impacts in all sectors is important.

6.1 Climate Change Projections

6.1.1 Current Status

Two models are used to generate climate change projections in Malaysia, namely the PRECIS model, as used by the Malaysian Meteorological Department (MMD); and the RegHCM-PM model, as used by NAHRIM. Both the PRECIS and RegHCM-PM models' projections show a trend range of negative to positive for the rainfall in Malaysia, during the mid century (and late century for PRECIS), in the IPCC SRES A1FI and B1 scenarios; while a comparison with the climate change projections for the SEA region, as reported in the ADB Review report, for both scenarios, show positive rainfall trends.

The PRECIS and RegHCM-PM models' projections also correspondingly show a negative to positive rainfall trend range for Peninsular Malaysia. Nevertheless, the significant uncertainty in the current climate change projections is an area of concern that needs to be addressed.

6.1.2 Issues

In general, future CC vulnerability analysis depends on the dual aspects of availability of plausible climate projections and appropriate baseline data. The gaps identified in the NC2 Report with regards to climate change projections are as follows:

(a) inherent uncertainty in the downscaled projections, especially for Malaysia given the limited number of models used, as described below;
(b) a low level of understanding of uncertainties and limitations of climate change projections and scenarios for effective communication to decision makers and end users;
(c) lack of procedures and risk management practices in incorporating projected climate and hydrological changes, with related uncertainties from fine grid regional HCMs into sector analysis;
(d) lack of application of the projection results in sector vulnerability analysis; and
(e) lack of data in various aspects.

There is an inherent uncertainty in the downscaled CC projections for Malaysia due to the limited number of CC projections models used. Although there are climate change projections models for use in Malaysia, namely the RegHCM-PM and the PRECIS, questions on the degree of their accuracy remain. This affects the level of confidence in making recommendations and decisions. Simulation from the 9 km resolution RegHCM-PM was validated against a short duration of available observed data.

The simulations of the PRECIS model at the resolution of 50km allows simulation for a bigger region. However, greater computing resources need to be made available to enable higher resolution runs and to ensemble more scenarios in generating the required high resolution CC projections for climate change adaptation assessments with greater confidence. Confidence in these models has been carefully assessed and validated using longer and more types of observed data. One of the findings is that these models need to be further configured to reduce the uncertainties in future climate projections.

6.1.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Increase the number of GCM models and realisations used with the finer-scale and temporal resolutions river basin HCM models.
To reduce the uncertainties in CC projections, it is recommended that the number of GCM models and realisations, and the river basin HCM models with finer scale and temporal resolutions should be increased.

(b) Improve baseline data collection
Baseline data are keys to an improved understanding of the water-related impacts of a changing climate and of the rates of change at which those impacts appear. Slow rates of change, for example, provide time for preparation and response, whereas faster rates provide lesser time for such actions. Nevertheless, problems will always exist with data, statistics, lack of carbon-adjusted statistics and difficulties in modeling countries' "mitigation potentials". Filling the gaps in the baseline data collection, therefore, is an important aspect of CC adaptation. To achieve this, appropriate R&D capacity is required.

(c) Set-up early warning systems and improve the monitoring set-up
While there are inherent uncertainties in climate change future projections, proper monitoring and the setting-up of early warning systems in areas identified as being vulnerable can alert decision makers to climate changes that could result in potential adverse impacts.

6.2 Climate Change R&D Capacity

6.2.1 Current Status

Climate change projections are one of the key R&D achievements for Malaysia. The other key R&D areas related to climate change and water are as follows:

(a) Baselines
(b) Threshold change levels
(c) Monitoring threshold
(d) Analysing past events
(e) Vulnerability mapping
(f) Resilience mapping

The following is a list of some of the climate change and water-related R&D studies that have been undertaken in Malaysia:

(a) A National Coastal Vulnerability Index (NCVI) study has commenced with the pilot phase being completed;
(b) Forest CO2 flux observations and the importance of rainfall patterns on gas exchanges in tropical rainforests;
(c) Technology development to harness renewable energy from biomass, micro/pico hydro and oceans amongst others;
(d) Biofuels from palm oil;
(e) Relationship between rainfall and dengue transmission;
(f) Potential causes of coral bleaching; and
(g) Systematic observation through a network of climate and hydrological monitoring stations including three Global Atmospheric Watch stations.

Most of the research undertaken to date is on a sector basis apart from the NCVI which also includes socio-economic factors. This has enabled an enhanced understanding of the issues and impacts pertaining to the focus area of study.

6.2.2 Issues

The following are the identified issues:

(a) Limited long-term historical data for hydrological modelling and water resources assessment;
(b) Need for holistic assessment of the competition between different water uses;
(c) Lack of empirical data to assess the impact on agriculture due to the variability of climatic factors;
(d) Lack of long-term tidal records to support the development of local models on sea-level rise;
(e) Lack of research on the impacts of CC on coral beaching;
(f) Need for research on the impacts of increased brackish water ecosystems on the spatial distribution of malaria;
(g) Lack of a holistic, integrated, multi-sector approach to assess CC impacts;
(h) Lack of funding and incentives for natural science research;
(i) Lack of research to support vulnerability and resilience mapping
(j) Lack of monitoring of changes in the ecosystem and the water cycle;
(l) Lack of monitoring of changes in the ecosystem and the water cycle; and
(m) Need for updating of engineering design methodologies and design standards to account for climate change.

Climate change will affect the frequencies of hydrologic phenomena such as rainfall, which in turn will affect the frequencies of floods and droughts. This implies that the existing engineering design methodologies and design standards based on the assumption that the hydrologic frequencies of past hydrologic events are a good predictor of future hydrologic events are no longer valid.

The issue faced by the water resources design engineer is what hydrologic frequencies to use for the design of water-related infrastructures. There is a need to review the design methodologies and design standards which depends on hydrologic frequencies so that design engineers can design water infrastructures that takes into account the uncertainty of climate change. Since there are a lot of uncertainty in the results of climate change model projections, with results that can vary by more than 100%, project proponents and water resources engineers are advised to exercise great caution in using the results from climate change model projections so as to avoid maladaptation investments in costly water infrastructure projects ("white elephants projects").

The current best practice approach for adaptation to climate change in the water sector as advocated by the Asia Pacific Water Forum (APWF) is based on a framework of 5 principles as described in **Appendix 1**.

6.2.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Improve national hydrological data collection;
(b) Adopt the ecosystem approach to CC impact assessment;
(c) Develop integrated priority research programme on areas of CC concern;
(d) Carry out research on "Forecasting by Analogy";
(e) Include water-related impacts, cost and experts in all CC impact studies;
(f) Provide more funding for natural science research;
(g) Carry out vulnerability and resilience mappings;
(h) Develop CC risk management practices and procedures;
(i) Need for research on "Climate Change Warning Indicators"; and
(j) A systematic approach to include the uncertainty of climate change impacts in current design methodologies and standards for WRE projects.

A systematic approach to include the uncertainty of Climate Change (CC) impacts in the current design methodologies and standards for Water Resources Engineering (WRE) projects that takes into account the five APWF Framework principles for CC adaptation in the water sector can involve the following:

1. The review of WRE design methodologies in including an additional step - Accounting for the uncertainty of CC impacts, development, as well as evaluation and ranking of strategies to address them.
2. In view of the uncertainty in CC model projections, the use of "CC scenario hydrologic frequencies" generated by CC model should only be used to establish the potential quantitative upper and lower bounds impacts of CC on the WRE project.
3. The quantitative estimate of the potential CC impacts on the WRE project will allow a quantitative evaluation of the impacts, together with a statement of the uncertainty of the CC impacts.
4. The results from Step 3 will enable the designer to highlight the advantages of the "no regrets" investments in sustainable solutions, while increasing the CC resiliency factor of the project. It will also support the higher ranking of such strategies over the lower ranking hard-infrastructure strategies to adapt to the potential and uncertain CC impacts.
5. In support of Step 2, there is a need to update all the design standards/ procedures that are based on empirically-derived hydrologic parameters and design charts; as well as to include an additional, a similar set of "CC-scenario-derived hydrologic parameters and charts", so that designers will be able to carry out design calculations for both the historical climate and the uncertain future climate scenarios.

7 INFORMATION MANAGEMENT CAPACITY

Information is a key resource for management and as such the issue of information management capacity must be adequately addressed. A common objective of information management is to make information accessible, usable and exploitable.

The information management capacity should cover both the human capacity and the ICT infrastructure. The human capacity can include training and accreditation directly related to water, environment and climate change. The ICT infrastructure covers both hardware and software components. The software components include the tools, databases, repositories and data collection systems and procedures.

7.1 Current Status

The NC2 Report noted that, similar to most countries, the collection of environmental, biodiversity and socioeconomic data in Malaysia is largely ad hoc and not well organized and needs to be better coordinated. There are a limited number of standards developed so far for observation and archiving of such data. The Report also notes that there is currently a lack of data sharing amongst agencies, sectors and stakeholders, most probably due to insufficient means to do so. Furthermore, there are limited activities for increasing awareness of communities to climate variability and climate change issues.

To support the archiving and sharing of water-related data and information NAHRIM has also set-up a National Hydraulic Data Repository with the objective of *"Making water related digital information in Malaysia more accessible, usable and exploitable"*. The Repository contains both digital hydraulic data, digital copies of tables, figures, charts and chapters from key water-related study reports and archives of water-related news clippings from the major newspapers.

7.2 Issues

The following are the identified issues:

(a) Lack of information on the effectiveness of existing measures in preventing or reducing the impact of climate related disasters;
(b) Need to develop standardized approaches for reporting and archiving information; and
(c) Issues & Challenges in Climate Services.

The following is a list of issues related to the provision of climate services information:

1. Fees (*Perintah Fi*);
2. Services to all users, including future users;
3. Data structure must include all user applications;
4. Quality of data need to meet the demand of high quality;
5. Improved measurement and monitoring of climates;
6. Increased understanding of the causes and patterns of natural variability;
7. More reliable methods of predicting climate over seasons and years ahead;
8. Better understanding of the linkages between climate/atmospheric chemicals and a range of social and economic activities and ecological changes; and
9. Capacity building.

(d) Issues and challenges in meteorological data collection

The following is a list of issues related to the provision of meteorological data collection:

1. Late Delivery of Data - auxiliary stations from external agencies, such as from FELDA and *orang asli* settlements;
2. Interruption in Communication Lines:
   (a) Mobile network problem: causing late delivery of AWS data to IMS data server; and
   (b) *Streamyx* line problem: causing late delivery of data from principle stations to IMS data server.
3. Sensors breakdown/unserviceable - causing data from automatic stations to be incomplete;
4. Repeated transmission of identical Data from stations - need to quality check data;
5. Operational Cost: RM120,000.00 - RM140,000.00 per new AWS, maintenance twice per year, Communication Cost (Internet/mobile), Part Replacement Cost, Observer Cost and accessibility for auxiliary stations, especially remote areas;

6. Closing and moving of stations - causing interruption and inconsistency of data;
7. Strategic Location of stations:
   (a) Not able to meet the request of data for certain strategic locations, MARDI, need more station and staff for management;
   (b) Other than cost, the challenge of obtaining land for new stations; and
   (c) Stations in remote places such as *Orang Asli* settlements are difficult to reach and manage. At times, no data is available as the person in charge is on leave; away from the settlement. Furthermore, it takes time to replace the data if lost.
8. Lack of spare parts:
   (a) late replacement and recovery of instruments; and
   (b) quality of data collection affected.
9. Lack of staff:
   (a) maintenance work affected and delayed; and
   (b) repair of breakdown delayed.
10. Lack of transport - maintenance and repair works affected;
11. Data have to be transmitted and collected on time - This is because aviation data are shared internationally & world-wide according to agreement by ICAO & WMO. The UTC time is used for this purpose.
12. Data Standard:
   (a) Internationally, all MMD data used the WMO and ICAO standard; and
   (b) Locally, MMD station maintenance obtained MS ISO standard.
13. Managing Various Format of Data:
   (a) Historical Data : Pre war data, data from 1800;
   (b) In-situ Data in numerical value : Rainfall, Temperature, RH & etc.;
   (c) Data in Raster : Radar, Satellite & NWP; and
   (d) Coded Data : METAR, TAF, SYNOP & etc.

(e) Issues and challenges in meteorological data usage

The following is a list of issues related to meteorological data usage:

1. Publics awareness and understanding of meteorological terms lacking - a challenge for MMD to explain in simple terms;
2. Lack of use of the data available for studies and research, including micro and local climate;
3. Late Receipt and Provision of Incomplete Data:
   (a) cannot meet the request for data from clients; and
   (b) bad image if defective data is provided to clients.
4. Publication Interruption - late publication: not fulfilling Key Perfomance Indicators (KPI);
5. Interruption in Data Analysis - interruption in preparing reports to government, monthly weather reports etc.;

6. Interruption in Updating Web Page - not able to provide latest information for internal operational web page (e-cuaca) and department external public web page;
7. Data Sharing:
   (a) Internationally share through a WMO/ICAO platform called Global Telecommunication System (GTS);
   (b) Aviation Briefing Terminal; and
   (c) Locally shared through intranet (e-cuaca) and departmental external/ public web page to be used by disaster manager, government agencies and others.

(f) Issues and challenges in meteorological data organisation

The following is a list of issues related to meteorological data organisation:

1. The present data base management, e-cuaca, MAKLIM dan IMS, for real-time operation, data checking and extraction are still not sufficiently comprehensive.
2. Data Management needs additional staff from the aspects of station maintenance, data quality control and publication.
3. Quality Control of MMD data:
   (a) Data undergo Quality Control process. Non-retrievable and unavailable data is marked in the database.
   (b) Duplicate Data is removed.
   (c) The historical data is manually 'keyed in' in the database.
   (d) Missing values are 'push-in' the database once the data is received.
   (e) All data has to be complete, any incomplete data would not be used.
   (f) All the data is archived.

(g) Constraints in hydrological data collection

The following is a list of issues related to hydrological data collection:

1. Demand for more accountability - Every *ringgit* spent on hydrological monitoring programmes must have an impact and outcome on water resources development.
2. Development of new station network - Lack of funds to develop new hydrological station network.

(h) Issues related to groundwater data sharing

The following is a list of issues related to groundwater data sharing:

(g) JMG has produced reports, maps and technical papers for dissemination of GW knowledge.

(h) There is a need for some form of policies and procedures to collect all GW data in one databank and the need to manage sharing of these GW data to interested parties.
(i) There is a need to standardise what is collected, ways in collecting data in the field, and what to input in the GW databank.
(j) Issues related to the mapping and monitoring of groundwater resources

The following is a list of issues related to groundwater data sharing:

1. Groundwater data and information are not plenty, and many more groundwater regions should be investigated and developed so as to get background data and to understand the effect of climate change on the GW resource.
2. Long term monitoring needed to understand the groundwater behaviour and is crucial for the management to protect from the effects of climate change.

7.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Set-up a National Water and Climate Change Information Repository
It is recommended that a National Water and Climate Change Information Repository be set-up to store all studies and information relating to climate change and water for Malaysia. Such a central repository should also contain a complete archive of all water related incidents such as floods and droughts and record their socio-economic impact.

(b) Publicise and disseminate climate information
Apart from establishing a good and effective information management system, such information should also be regularly publicised and disseminated to relevant agencies, other stakeholders and the general public.

(c) Set-up Sector-specific Water and Climate Change Information Management Units (WCC-IMU)
In order to galvanise and focus each water-related sector agencies and departments effort to adapt to the impacts of climate change on water it is recommended that "Water and Climate Change Information Management Units (WCC-IMU)" be setup by each of the agencies and departments to systematically collect, compile and manage their relevant data related to climate change. The need for a dedicated WCC-IMU to facilitate systematic observation and monitoring systems need to encompass all relevant agencies, users, policy makers and stakeholders, as much as possible.

(d) Set-up a National Global Climate Observation System (GCOS) Committee
It is recommended that a national Global Climate Observation System (GCOS)

Committee be set-up to provide a means to enhance coordination between the different parties involved in observing and collecting information relating to climate change.

(e) Enhance our National Climate Service
It is recommended in the NC2 that our national climate services needs to be enhanced to strengthen the production, availability, delivery and application of science-based climate projections and services as well as coordinate climate information for the government and stakeholders. This enhancement should also include more coordinated climate research carried out among relevant agencies.

(f) Ideas to address the issues in climate services, data collection, organization and use

The following is a list of ideas to address the issues in climate services, data collection, organisation and use:

1. Mechanisms to ensure that the climate information and prediction needs of all users are recognised;
2. Extensive and systematic collection of climate observations, management of databases and the provision of data;
3. Coordination of meteorological, oceanographic, hydrological and related scientific research to improve climate services;
4. Multidisciplinary studies to determine national risk, sector and community vulnerability related to climate variability and change, to formulate appropriate response strategies, and to recommend national policies;
5. Development and provision of extensive climate information and accurate prediction services to meet user needs;
6. Linkages to other programmes with similar or related objectives to enhance services and to avoid unnecessary duplication of efforts;
7. To establish a single coordinating authority in data handling to ensure that there is no divergence among datasets; and
8. To enhance partnership and capacity.

(g) Ideas for hydrological data management

The following is a list of ideas for hydrological data management:

1. Create greater organisational flexibility for financial independence;
2. Corporatisation or privatisation especially if the RMK fund is unavailable;
3. Adopt Quality management - ISO 9000 and Environment management - ISO 14000 standards in the implementation of the hydrological network; and
4. Strengthen research and development, HRD & capacity building.

8 WATER-RELATED LAND USE MANAGEMENT CAPACITY

Water bodies like rivers, lakes, wetlands and coastal areas are at the receiving-end of the impacts of activities on the land that are connected to them. Thus, a significant number of issues related to the water bodies are associated with the land use within the catchments of the rivers, lakes, wetlands and coastal water bodies. For example, the pollution in water bodies are caused by the polluting land use activities within the catchments of the water bodies. Similarly, the increased threats posed by river floods are caused by the increased runoff that flows into rivers arising from the changed in the land use activities from forests to urban areas in the river catchments. Thus, the capacity to manage the land use within the catchments of water bodies is important to address the water-related issues associated with land use activities.

8.1 Current Status

The Federal Department of Town and Country Planning have developed the National Physical Plan in 2005 (NPP-2005) to provide a master plan framework for the land use in Peninsular Malaysia. The NPP-2005 is a plan that has to be updated every five years so that it is in line with the 5-year national development. Thus, the NPP-2005 was updated in 2010 as the National Physical Plan 2 (NPP-2). A brief description of the CC-related land use policies in both the NPP-2005 and NPP-2 is given below.

8.1.1 The National Physical Plan 2005

In April 2005 the National Physical Plan (NPP-2005) developed by the Federal Department of Town and Country Planning was approved for use to guide the land use planning in Peninsular Malaysia. The NPP-2005 has 36 policies (NPP1-NPP36) that addresses the following 8 thematic focus areas:

1. Setting a National Spatial Framework (NPP1)
2. Enhancing National Economic Competitiveness (NPP2-NPP5)
3. Modernising Agriculture (NPP6-NPP7)
4. Strengthening Tourism Development (NPP8)
5. Managing Changing Human Settlements (NPP9-NPP17)
6. Conserving Natural Resources and the Environment (NPP18-NPP22)
7. Integrating the National Transportation Network (NPP23-NPP28)
8. Providing Appropriate Infrastructure (NPP29-NPP36)

The NPP-2005 has also developed an implementation mechanism consisting of the following elements:

1. An Institutional Mechanism for NPP Implementation
2. An Implementation Plan
3. A Monitoring Plan

The following are the 14 CC-related NPP-2005 policies:

1. NPP1 - The NPP shall serve as framework to achieve integrated and sustainable land use planning in the country.
2. NPP6 - The support of agriculture shall take cognisance of the threats and opportunities of urbanisation.
3. NPP7 - The eight strategic granary areas shall be conserved.
4. NPP8 - Tourism development zones shall maximise their resource and locational advantages.
5. NPP17 - Designated central authority responsible for publishing information regularly on land use development.
6. NPP18 - Environmentally Sensitive Areas (ESA) shall be integrated in the planning and management of land use and natural resources.
7. NPP19 - A Central Forest Spine (CFS) shall form the backbone of the Environmentally Sensitive Area network.
8. NPP20 - Sensitive coastal ecosystems shall be protected and used in a sustainable manner.
9. NPP21 - Land development in highlands shall be strictly controlled to safeguard safety and environmental quality.
10. NPP22 - All surface and ground water resources are strategic assets to be safely used optimally.
11. NPP29 - The NPP shall provide the spatial framework for the efficient delivery of integrated infrastructure services at the national and regional level.
12. NPP30 - The supply and projected demand for water should guide the planning of water resource areas.
13. NPP31 - Ground water resource and recharge areas shall be identified and protected.
14. NPP34 - Land utilised for main drains, streams and rivers shall be designated as drainage or river reserves.

8.1.2 The National Physical Plan 2

In August 2010, the National Physical Plan-2 (NPP-2) that was developed by the Federal Department of Town and Country Planning was approved by the National Physical Planning Council for use as a guide to land use planning in Peninsular Malaysia from 2011 onwards. The NPP-2 is an update of the National Physical Plan 2005, based on a 5-year updating frequency cycle and is in accordance with the 5-Year Malaysia Development Plan.

The NPP-2 proposed a development strategy which consists of 41 policies. The policies are divided accordingly into the following eight development themes and supported by key implementation measures:

1. Setting a National Spatial Framework;
2. Enhancing National Economic Competitiveness;
3. Conserving Agriculture Resources and Promoting Rural Development;
4. Sustainable Tourism Development;
5. Managing Changing Human Settlements;
6. Conserving Natural Resources, Biodiversity and the Environment;
7. Integrating the National and Urban Transportation Network; and
8. Providing Appropriate Infrastructure.

The following are the 14 NPP-2005 policies that have been updated as NPP2 policies:

1. NPP1 – The NPP shall serve as framework to achieve integrated and sustainable land use planning in the country.
2. NPP6 - Prime Agricultural Areas (PAA) shall be conserved only for agriculture purposes.
3. NPP7 - The eight strategic granary areas shall be conserved.
4. NPP8 - Existing potential paddy land outside granary areas shall be provided with the proper infrastructure.
5. NPP11 - Natural tourism resources shall be conserved.
6. NPP21 - Designated central authority responsible for publishing information regularly on land use development.
7. NPP22 - Environmentally Sensitive Areas shall be integrated in the planning and management of land use and natural resources.
8. NPP23 - A Central Forest Spine shall form the backbone of the Environmentally Sensitive Area network.
9. NPP24 - Sensitive coastal and marine ecosystems shall be protected and managed in a sustainable manner.
10. NPP25 - Land development in the highlands shall be strictly controlled.
11. NPP26 - All surface and ground water resources shall be safeguarded and managed in a sustainable manner.
12. NP27 - The spatial planning framework shall incorporate mitigation and adaptation measures against the impacts of climate change.

13. NPP35 - Appropriate water supply infrastructure shall be provided to all settlements.
14. NPP38 - Drainage infrastructure shall be provided in all settlements to eliminate the incidence of major floods, minor floods and pollution.

8.2 Issues and Proposed Ideas

The following are the identified issues and proposed ideas to address them:

1. Are the Structured and Local plans reviewed by JPBD? If yes, are the policies complied?
2. The KL conurbation concept will result in the 'heat island' effect, water shortage and flash floods. It will promote rural to urban migration. There is a need for the monitoring of the population size and greater coordination between the KL conurbation and Greater KL.
3. There should be integration between the NPP and FYMP, with established procedures to assess whether or not the development projects comply with the NPP.
4. Promotion of the NPP Policy should be enhanced and its awareness impact must be monitored and evaluated.
5. There should be regular and continuous monitoring and evaluation of the implementation of development projects to assess the impacts of policies and strategies. If a major project that is not mentioned in the NPP is implemented then the NPP must be reviewed to take care of the cumulative impacts.
6. Land is a state matter, therefore, identification and gazettement of PAA is at the prerogative of state governments, except on land owned by Federal agencies. The encroachment of PAAs by non-agricultural activities should be addressed.
7. There must be adequate water supply for granary and non-granary agricultural areas. Thus, there is a need for the conservation of water catchment areas to ensure adequate water to agricultural areas.
8. Changes of crops outside granary areas are subject to water availability or commodity prices.
9. Conflicting requirement and use of water for agriculture and non-agriculture activities must be resolved by the relevant agencies.
10. Use of technology and crop varieties which are adaptable to extreme weather changes.
11. To support natural tourism the Government should put more efforts on conservation of natural tourism resources, especially for the coastal areas. All sensitive coral islands must be gazetted.
12. There is a need to harmonise the JPBD, JUPEM, MKN guidelines to avoid conflicts regarding data management and implementation of the guidelines. Thus, a clear mandate for information source, such as a central agency like the MKN, should be adopted.
13. Introduce a NKRA on environment/conservation (report card system).

14. Link the Federal financial allocation for states to the NKRA on environment/conservation to create effective communication tools/ strategies.
15. Create awareness among politician and decision makers about the ESA and promote biodiversity conservation among the community at the state level.

16. There is a need to monitor the loss of natural forest within the CFS by the CFS committee. There is a need to identify the regional importance and relationship between CFS stress eco-hydrology with forest. Private and Public partnership and social media as well as NGOs engagement need economic support in CFS project.
17. Ecosystem-based fisheries management should be enhanced.
18. Consider the introduction of service tax for eco-tourism site at state level to ensure financial sustainability for the management of eco-tourism.
19. Lack of approach to communicate how uncertainty of climate change can be incorporated into the planning and development of new infrastructures.
20. The raising of development platform level in one area may exacerbate flooding in another area.

9 STAKEHOLDER AWARENESS AND PARTICIPATION

Global human development activities are the main causes of the current climate change issue. In order to mitigate the impacts of the development activities on the rate and magnitude of global climate change there is a need for global cooperation and co-ordination to adopt and implement 'climate-friendly' development plans and living activities. This will require sacrifices and compromises to be made for the common good by all affected stakeholders, i.e. all the people living in this planet Earth. Moreover, the impacts of climate change will affect all sectors of human society. Thus, there is a need to mitigate the potential impacts on all stakeholders, in all sectors of human society, through the development of climate change adaptation plans to reduce the risks of the impacts, the vulnerability of affected stakeholders and to increase their resiliencies to cope with the potential climatic changes.

For effective implementation of 'climate-friendly' development plans and living activities there is a need to gain support from all affected stakeholders by increasing their awareness of the issues, and their participation in implementing the adopted plans and choices in their daily living activities. Furthermore, there is a need to increase the awareness of stakeholders on their risks and vulnerabilities to the impacts of climate change and to get their participation to adopt and implement plans to increase their resiliencies to the uncertain climatic impacts.

9.1 Current Status

Generally, most adaptation is expected to occur autonomously at the individual, household or community levels. The NC2 Report notes that while anecdotal evidence shows an increase in general public awareness and understanding, nevertheless, affected populations are still not adequately informed and hence are not prepared to adapt to the anticipated changes in climate including to its impacts on water resources. Apart from that, at the institutional level, gaps in technical understanding between the different agencies result in a time lag in decision-making.

9.2 Issues

The major issues identified in the NC2 report with regards to stakeholder awareness and participation is the lack of awareness and participation among the following stakeholders:

(a) Government agencies and departments
(b) Disaster-relief Agencies
(c) Community

9.3 Proposed Ideas

The following are the proposed ideas to address the identified issues:

(a) Increase climate change awareness and participation of government agencies and departments

There is a need to increase the awareness of climate change and its impacts on water among the staffs of water-related government agencies and departments. Some ministries like NRE have already commenced learning platforms where knowledge is shared between staff through short seminars or other events. Such initiatives can be further expanded to an inter-ministry basis to generate wider awareness. There is a need to also ensure that departments responsible for water resources planning and management undertake multidisciplinary studies involving natural and social sciences so as to develop practical adaptation measures taking considerations of the needs of various stakeholders into account.

(b) Increase climate change awareness and participation of disaster-relief agencies

There is a need to identify partners who can assist in the adaptation process. Key stakeholders who are involved in disaster-preparedness and risk reduction would be affected by climate change in their traditional role as emergency relief providers. They form natural partners for climate change adaptation implementation given their familiarity with issues on the ground and their inherent interest in reducing/averting disaster. They should be encouraged to participate in adaptation decision-making.

The National Security Council, National Red Crescent Society and Mercy Malaysia can provide effective communication channels to decision-makers on the issues faced on the ground. It is useful to note that the International Federation of the Red Cross and Red Crescent (IFRC) has already identified climate change adaptation as a key strategy in its recently launched Strategy 2020 document.

(c) Increase climate change awareness and participation of the community
Since adaptation measures may have implications on changing traditional practices or livelihoods, there will be behavioral resistance. Thus, it is important to have community-level engagement in developing and implementing adaptation measures best suited to issues on the ground. In many instances, the intimate knowledge of the land and its environment by those who occupy it would be indispensable in formulating adaptation strategies.

Assessment results should be presented visually, for example, by plotting them on risk maps. Risk assessment is important not only to visually show current vulnerabilities but also to show differences to be made after the introduction of adaptation measures, which help people understand how effective they can be in terms of risk management.

To facilitate this, establishing climate change awareness forums starting at the community-level, and then replicating them all the way up to district, state and national levels should be considered. This could be similar in operations to that of Tun Razak's Operations Room in addressing rural development in the 1970s.

10 THE STRATEGIC PLAN

To address the above CC issue ASM has developed a Strategic Plan that recognises the large uncertainties in climate change model projections for a future global development scenario that is evolving. Thus, ASM has adopted the pragmatic APWF approach, as embodied in the APWF's 'Five Principles Framework', to develop its Strategic Plan to address the challenges of climate change adaptation for the water sector. The Plan was developed to address three key limiting factors, and is thus guided by three overall 'guiding policies' that address the limiting factors. The proposed strategic actions in the Plan were culled from the list of proposed ideas, through eight thematic focus areas, after a systematic review process to ensure that they are coherent with the overall thrust of the three 'guiding policies'. The overall thrusts of the 'guiding policies' are as follows:

(a) Invest in 'no-regrets' development projects to increase the resilience of the community to adapt to an uncertain future climate;
(b) Invest in data collection, information management and R&D;
(c) Use the projections from CC models to support investments in 'no-regret' development projects; and
(d) Avoid 'malinvestment' in speculative CC-related impact studies and also development projects based on those studies.

10.1 Key Limiting Factors

The following are the key limiting factors that have been taken into account in the development of the strategic plan:

(a) Large uncertainties in the projection of the future climate change scenarios

There are large uncertainties in the projection of the future climate change scenarios. This is because the future global development scenario is evolving, and the projections of the different climate models can vary by more than 100%.

(b) Lack of a process to evaluate the potential damages arising from CC in order to support the development and selection of the 'No-Regrets' development options. Climate change will result in changes in the hydrological cycle, which in turn will have impacts in the following three impact categories:

1. Impacts on water bodies
1. Impacts on water services
2. Impacts on water-related hazards

In view of the large uncertainties in the projections of climate models, which are dependent on a future evolving global development scenario, the most pragmatic course of action is to adopt and implement the 'no-regrets' development options for the above three impact categories. There is currently no systematic process to evaluate and include the potential damages arising from CC for a given future global development scenario, within the assessment and option selection process for proposed development projects for the above three impact categories. The inclusion of the potential damages arising from the impacts of CC will support the development and selection of the 'no-regrets' development options as the most feasible option in most cases.

(c) Lack of a coherent implementation process to address the weaknesses and gaps in the governance, R&D and management capacities for adaptation to the impacts of CC on water-related activities

Malaysia had created the national apex CC governing body in 2010, with the formation of the Green Technology and Climate Change Council (GTCCC), with members from numerous ministries. Added to that, there is a National Water Council chaired by the Deputy Prime Minister and comprises of all the State Chief Ministers. Malaysia had also developed a CC policy in 2009. However, there are weaknesses and gaps in the implementation capacities for the following five areas to support adaptation to the impacts of CC on water-related activities:

1. Governance and institutional capacity
2. Climate Change Projections and R&D capacity
3. Information Management capacity
4. Land use Management capacity
5. Stakeholder Awareness and Participation

Thus, there is a need to develop an implementation process that can support the integrated and coherent implementation of action plans to address the identified capacity weaknesses and gaps.

10.2 Guiding Policies

The following are the 3 key guiding policies to address the above 3 key limiting factors:

(a) Guiding policy to address the "large uncertainties in the projection of the future climate change scenarios"

In view of the limiting factor of "large uncertainties in the projection of the future climate change scenarios", and with the increasing amount of empirical evidence that show that the climate seems to be changing now, the best guiding policy to prepare for the potential CC impacts is to adopt and implement the five principles of the Asia Pacific Water Forum (APWF) framework for CC adaptation, as described in **Appendix A**. The five principles are as follows:

1. Usable knowledge
2. 'No-regret' investments
3. Resilience
4. Mitigation and Adaptation
5. Financing

Thus, the focus of the strategic actions based on the above guiding policy will be on:

1. Improving data collection, processing and management of information so that they can become usable knowledge to support CC-related decision-making;
2. Investing in 'no-regret' projects that can increase the resilience of the community to adapt to an uncertain future climate;
3. Mitigation and adaptation actions taken which can help increase the resilience of the community to adapt to an uncertain future climate, and shall not be based on the 'certainty' of the projections of CC models. The CC models' projections shall be used as potential future climate scenarios for use in the development and selection of 'climate-proofed' projects, which in most cases will be 'no-regret' investment projects. Maladaptation and investments in 'white elephant' projects can be avoided if the projections of CC models are used properly for project option selection, and not as a 'given fact'; and
4. Appropriate level of financing for the implementation of strategic actions to achieve the above three objectives shall be provided.

(b) Guiding policy to include the assessment of the potential damages arising from CC in the development and selection of the 'No-Regrets' development options

To address the limiting factor of the "lack of a process to evaluate the potential damages arising from CC in order to support the development and selection of the 'no-Regrets development options'", there is a need to adopt an overall guiding policy that all development projects shall be subjected to a 'climate proofing' exercise, in which the potential damages arising from a given future climate scenario shall be estimated and used to support the selection of the 'no-regrets' development option. In this regard, NAHRIM's hydro-climatic model projections (based on 9km 2 grid size cells) for the uncertain future climate of peninsular Malaysia, Sabah and Sarawak, can be used as the basis for the CC damage assessment. Similarly, the MMD's regional PRECIS model projections for Malaysia can also be used for comparison purposes, if desired.

(c) Guiding policy to ensure integrated and coherent implementation of CC adaptation actions
To address the limiting factor of the "lack of a coherent implementation process to address the weaknesses and gaps in the governance, R&D and management capacities for adaptation to the impacts of CC on water-related activities", there is a need for a guiding policy to ensure that an integrated water and CC adaptation and implementation framework be developed and implemented to address the identified weaknesses.

10.3 Coherent Strategic Actions

The following are the proposed, coherent strategic actions based on the above three guiding policies to address the above three key limiting factors.

10.3.1 Implement the strategic actions recommended in the APWF framework for CC adaptation

The APWF framework for CC adaptation has recommended the following strategic actions to support its five adaptation principles (see **Appendix A** for details):

1. Usable Knowledge
   (a) Develop data infrastructure and networking for sharing data, information and knowledge to support decision-making and to raise public awareness; and
   (b) Accelerate scientific efforts to improve the use of climate projections for countries, river basins and cities as well as to quantify and reduce the related uncertainty.

2. 'No-regret' Investments
   (a) Plan for incremental adaptation actions in tandem with improving climate projections; and
   (b) Use an appropriate mix of structural and non-structural measures.

3. Resilience
   (a) Strengthen the adaptation capacities of water managers, communities, and of society as a whole; and
   (b) Improve community-based water risk management capacities.

4. Mitigation and Adaptation
   (a) Promote IWRM in river basins as the appropriate process for planning and investments; and
   (b) Promote synergies in the planning and implementation of adaptation and mitigation measures.

5. Financing
   (a) Conduct economic impact assessments for various adaptation options; and
   (b) Mobilise significant investments today (e.g., 1% of GDP) to prevent greater damages later (e.g. 5%), as advised by the Stern report.

10.3.2 'Climate-proofing' and selection of 'no-regrets' projects

To increase the resilience of the Malaysian community and reduce its vulnerability to an uncertain future climate there is a need to ensure that all development projects shall be subjected to a 'climate-proofing' exercise. This will ensure that the potential damages from a given uncertain future Malaysian climate can be taken into account in the evaluation and selection of 'no-regrets' development projects. Thus, it is recommended that "a policy directive shall be given to all water-related government agencies and departments to develop and implement guidelines to 'climate-proof' their projects, and to select the 'no-regrets' projects as the preferred option."

10.3.3 Integrated and coherent implementation of CC adaptation actions

The lists of proposed ideas highlighted in the preceding eight chapters to address the capacity weaknesses and gaps in the following eight focus areas have been reviewed for their relevance with the proposed integrated and coherent implementation plan as follows:

1. Water Bodies Management Capacity
2. Water services Management Capacity
3. Water-related Hazards Management Capacity
4. Governance and Institutional Capacity
5. Climate Change Projections and R&D Capacity
6. Information Management Capacity
7. Land use Management Capacity
8. Stakeholder Awareness and Participation

The proposed ideas that are coherent with the five principles of the APWF CC adaptation framework have been selected to be the key components of the proposed, integrated CC adaptation actions for the eight focus areas. The selected list of proposed ideas for each of the eight focus areas are given below:

10.3.3.1 Water bodies management capacity

The following proposed ideas for CC impact assessments for rivers should only be carried out as part of the option assessment and selection for any proposed projects involving rivers:

(a) Conduct CC impact assessments on river banks stability, erosion and sedimentation for important rivers based on hydrologically-simulated river flow regime with rainfall inputs derived from hydro-climatic models.
(b) Similarly, conduct CC impact assessments on important floodplains and wetlands ecosystems, and on the malaria vectors arising from the simulated river flow regime; and
(c) Conduct CC impact assessment on sedimentation in important river mouths due to sea-level rise induced river mouth salinity intrusion.

The following are the selected ideas for coastal areas to address the two highlighted issues:

1. Increased coastal erosion
   (a) Conduct long term wave measurement programmes for Malaysian coasts so as to support research on the impacts of storm surges and wave patterns on the coastlines;
   (b) Conduct long term observation of the natural coastal evolution caused by storm surges and wave patterns since they have significant impacts on the coastlines; and
   (c) Conduct research to find the best methods to implement coastal reforestation, such as finding the most optimal planting methods to develop robust coastal forests, as well as soft engineering application of structural and biological concepts to solve coastal erosion problems and reduce its erosive forces.

2. Increased socio-economic losses
   (a) A policy on coastal management should be implemented to ensure that all coastline developments are guided by an *Integrated Shoreline Management Plans (ISMP)*. The "retreat, accommodate and protect" approach should be adopted as a step-by-step development of defensive options to address the threat of coastal SLR.
   (b) Financial resources should be identified to accelerate the formulation of ISMP for the rest of the country's coastlines.

(c) Ways in ensuring compliance with the ISMP recommendations should be identified, for example by adopting legal instruments, such as the Coastal Development Control Law, for consistency in the application of coastal development guidelines.

The following are the selected ideas for lakes:

(a) To adopt and implement the lake management strategies developed by ASM and NAHRIM in 2008; and
(b) To conduct more monitoring and research on the major lakes in the country. The information is required as baseline data for CC impact assessments of lakes in the country.

The following are the selected ideas for aquifers/groundwater:

(a) To adopt and implement the groundwater management strategies developed by ASM in 2011; and
(b) To increase the monitoring of groundwater tables levels of important aquifers and also their recharge characteristics, so as to identify potential negative CC impacts on wetlands dependent on the aquifers, as well as on the possible increase in soil salinity arising from rising water tables.

10.3.3.2 Water services management capacity

The following are the selected ideas for agriculture and irrigation water supply:

(a) Implement measures and strategies to improve irrigation efficiencies in the eight granary areas;
(b) Specific measures like low intensity tapping system and rain gutters for the rubber industry should be used in a more widespread manner to address increased frequency of rainfall. Workers skills should also be enhanced to enable them to apply newer technologies such as low impact tapping;
(c) There is a need to establish an early warning system to monitor changes in rice and cash crop yield, promote farm-level rain-water harvesting, soil water management and drainage improvement to increase the resiliency of the agricultural system to cope with climate change;
(d) R&D should be enhanced to identify flood resistant crop varieties, while agricultural drainage system should be designed to efficiently regulate water tables and remove flood waters from agricultural land as quickly as possible;
(e) R&D should be carried out to improve crop modelling projections, with better local data on the projected magnitude of climate change, together with crop parameters and soil properties.

The following are the selected ideas for hydropower:

(a) Carry out medium and long term catchment management where the hydropower scheme is located to balance competing use of the limited runoff in times of reduced river runoff to ensure sufficient runoff for hydropower generation; and
(b) Promote the national implementation of grid connected rooftop solar panels to reduce disruption risks and ease the hydropower capacity requirements.

The following are the selected ideas for water ecosystems:

(a) To setup a national inventory system for wetlands where basic information on the wetlands, including regular monitoring information can be archived;
(b) To conduct studies of important wetlands to identify the sensitive physical and biological parameters that will be affected by climate change; and
(c) To setup monitoring programs to detect the impacts of climate change on the wetlands.

The following are the selected ideas for potable water supply (water resources management):

(a) Protect the river water catchments providing the potable water supplies through the adoption of the IWRM and IRBM principles and approach in land use planning;
(b) Need to develop a long-term strategy for water resources management to achieve water security; and
(c) Need for water-resources-rich states to protect their water catchments and develop them for export to water–stressed states.

The following are the selected ideas for potable water supply (water demand management):

(a) Set-up national and state-level IWRM Secretariats to develop strategies, implement, monitor and report regularly on the progress in the implementation of IWRM principles, including integrated thematic sector-based approaches based on IWRM principles, such as IRBM, IFM, etc.;
(b) Review the existing and future water supply infrastructure development plans recommended in the NWRS (2011) study, to anchor the plans

on a targeted, sustainable per capita water consumption figure that is benchmarked with the contemporary figures achieved by other countries;
(c) Adopt a policy of water supply capacity planning based on a targeted, sustainable per capita water demand figure, and make water supply planners, operators and consultants aware of such a policy so that the planning and operations of water supply infrastructures will be based on a constrained demand;
(d) SPAN to impose requirement on water supply providers to develop and implement Water Safety Plans (WSP) to address the loss in confidence of the consumers in the drinking quality of our potable water supply;
(e) SPAN to setup a Water Demand Management Taskforce (WDM-TF) to develop strategies, implement, monitor and report on the country's progress towards achieving the targeted, sustainable per capita water demand figure
(f) SPAN to develop financial incentive structures to make water supply providers earn their revenue from delivering water supply performance rather than selling more water to consumers to waste.; and
(g) Need to develop strategies to increase the resiliency of our water supply system to cope with the projected increased in variability of our river runoff arising from climate change.

10.3.3.3 Water-related hazards management capacity

The following are the selected ideas for flood:

(a) Update DID's Hydrological Procedures related to design rainfalls and flood peaks to include projected design rainfalls;
(b) Update the design rainfalls in the MSMA manual to include projected design rainfalls; and
(c) Update the DID 2003 Flood Study report and derive the latest flood maps, including indicative flood maps for the projected design rainfalls.

The following are the selected ideas for water scarcity and drought:

(a) To increase water use efficiency and productivity of water in each sector; and
(b) To develop an integrated drought management system.

The following are the selected ideas for human health:

(a) Aedes-proof buildings to mitigate dengue epidemics; and
(b) Remote sensing mapping of malaria vector areas.

10.3.3.4 Governance and institutional capacity

The following are the selected ideas:

(a) Checklist of relevant CC-related policies/plans shall be prepared
A comprehensive checklist of relevant CC-related policies/plans shall be prepared, summarising key sections related to CC for quick reference by decision makers.

(b) Process for regular updating of CC-related policies and plans
A process to review new policies/plans to identify their relevance to the CC decision making process should be formulated. This will ensure that relevant future policies/plans are also considered in the CC decision-making process.

10.3.3.5 Climate Change Projections and R&D capacity

The following are the selected ideas for climate change projections studies:

(a) Increase the number of GCM models and realisations used with the finer-scale and temporal resolutions river basin HCM models.
To reduce the uncertainties in CC projections, it is recommended that the number of GCM models and realisations, as well as the river basin HCM models with finer scale and temporal resolutions should be increased.

(b) Improve baseline data collection
Baseline data are keys to an improved understanding of the water-related impacts of a changing climate and of the rates of change at which those impacts appear. Filling the gaps in the baseline data collection, therefore, is an important aspect of CC adaptation. To achieve this, appropriate R&D capacity is required.

(c) Set-up early warning systems and improve the monitoring set-up
While there are inherent uncertainties in climate change future projections, proper monitoring and the setting-up of early warning systems in areas identified as vulnerable can alert decision makers to climate changes that could result in potential adverse impacts.

The following are the selected ideas for climate change R&D studies:

(a) Improve national hydrological data collection;
(b) Adopt the ecosystem approach to CC impact assessment;
(c) Develop integrated priority research programme on areas of CC concern;
(d) Carry out research on 'Forecasting by Analogy';
(e) Include water-related impacts, cost and experts in all CC impact studies;

(f) Provide more funding for natural science research;
(g) Carry out vulnerability and resilience mappings;
(h) Develop CC risk management practices and procedures;
(i) Need for research on 'Climate Change Warning Indicators'; and
(j) A systematic approach to include the uncertainty of climate change impacts in current design methodologies and standards for WRE projects.

A systematic approach to include the uncertainty of Climate Change (CC) impacts in the current design methodologies and standards for Water Resources Engineering (WRE) projects that takes into account the five APWF Framework principles for CC adaptation in the water sector can be as follows:

1. To review WRE design methodologies to include an additional step - accounting for the uncertainty of CC impacts, development, evaluation and ranking of strategies to address them.
2. In view of the uncertainty in CC model projections, the use of 'CC scenario hydrologic frequencies' generated by CC model should only be used to establish the potential quantitative upper and lower bounds impacts of CC on the WRE project;
3. The quantitative estimate of the potential CC impacts on the WRE project will allow a quantitative evaluation of the impacts together with a statement of the uncertainty of the CC impacts;
4. The results from Step 3 will allow the designer to highlight the advantages of the 'no regrets' investments in sustainable solutions and increasing the CC resiliency factor of the project. It will also support the higher ranking of such strategies over the lower ranking hard-infrastructure strategies to adapt to the potential and uncertain CC impacts; and
5. To support Step 2, there is a need to update all the design standards/ procedures that are based on empirically-derived hydrologic parameters and design charts, to include an additional, similar set of 'CC-scenario-derived hydrologic parameters and charts' so that designers will be able to carry out design calculations for both the historical climate and also the uncertain future climate scenarios.

10.3.3.6 Information Management capacity

The following are the selected ideas:

(a) Set-up a National Water and Climate Change Information Repository
It is recommended for a National Water and Climate Change Information Repository to be set-up to store all studies and information relating to climate change and water for Malaysia. Such a central repository should also contain a complete archive of all water related incidents such as floods and droughts, as well as record their socio-economic impact.

(b) Publicise and disseminate climate information
Apart from establishing a good and effective information management system, such information should also be regularly publicised and disseminated to relevant agencies, other stakeholders and the general public.

(c) Set-up a National Global Climate Observation System (GCOS) Committee
A national Global Climate Observation System (GCOS) Committee shall be set-up to provide a means to enhance coordination between the different parties involved in observing and collecting information relating to climate change.

(d) Enhance our National Climate Service
Our national climate services needs to be enhanced to strengthen the production, availability, delivery and application of science-based climate projections and services as well as coordinate climate information for the government and stakeholders. This enhancement should also include more coordinated climate research carried out among relevant agencies.

10.3.3.7 Land use Management capacity

The following are the selected ideas:

1. There should be integration between the NPP and FYMP with established procedures to assess whether or not the development projects comply with the NPP.
2. Promotion of the NPP Policy should be enhanced and its awareness impact must be monitored and evaluated.
3. There should be regular and continuous monitoring and evaluation of the implementation of development projects to assess the impacts of policies and strategies. If a major project that is not mentioned in the NPP is implemented, then the NPP must be reviewed to be circumspect for the cumulative impacts.
4. Encroachment of Prime Agricultural Areas (PAAs) by non-agricultural activities should be addressed.
5. There is a need for the conservation of water catchment areas to ensure adequate water to agricultural areas.
6. Conflicting requirement and use of water for agriculture as well as non-agriculture activities must be resolved by the relevant agencies.
7. To support natural tourism, the Government should put more efforts on conservation of natural tourism resources, especially for the coastal areas. All sensitive coral islands must be gazetted.
8. There is a need to harmonise the JPBD, JUPEM, MKN guidelines to avoid conflicts regarding data management and implementation of the guidelines. Thus, a clear mandate for information source, such as a central agency like the MKN, should be adopted.
9. There should be an NKRA on environment/conservation (report card system) introduced.

10. There should be a link to the Federal financial allocation for States to the NKRA on environment/conservation to create effective communication tools/ strategies.
11. There needs to be awareness among politician and decision makers about the ESA and promote biodiversity conservation among the community at the state level.
12. There is a need to monitor the loss of natural forest within the CFS by the CFS committee. There is a need to identify the regional importance and relationship between CFS stress eco-hydrology with forest. Private and Public partnership, the social media as well as NGOs engagement need economic support in CFS project.
13. Ecosystem based fisheries management should be enhanced.
14. The introduction of service tax for eco-tourism site at State level should be considered to ensure financial sustainability for the management of eco-tourism.

10.3.3.8 Stakeholder Awareness and Participation

The following are the selected ideas:

(a) Increase climate change awareness and participation of government agencies and departments
There is a need to increase the awareness of climate change and its impacts on water among the staffs of water-related government agencies and departments. Some ministries like NRE have already commenced learning platforms where knowledge is shared between staff through short seminars or other events.

(b) Increase climate change awareness and participation of disaster-relief agencies
There is a need to identify partners who can assist in the adaptation process. Key stakeholders who are involved in disaster-preparedness and risk reduction would be affected by climate change in their traditional role as emergency relief providers. They should be encouraged to participate in adaptation decision making. The National Security Council, National Red Crescent Society and Mercy Malaysia can provide effective communication channels to decision makers on the issues faced on the ground.

(c) Increase climate change awareness and participation of the community
Since adaptation measures may have implications on changing traditional practices or livelihoods, there will be behavioural resistance. Thus, it is important to have community-level engagement in developing and implementing adaptation measures best suited to issues on the ground. To facilitate this, establishing climate change awareness forums starting at the community-level, and then replicating them all the way up to district, State and national levels should be considered.

APPENDICES

Appendix A – The Apwf Strategic Framework for Water and Climate Change Adaptation

In view of the large uncertainties in climate change model projections for a future global development scenario that is evolving, and also in view of the fact that our global climate seems to be changing now, the Asia Pacific Water Forum (APWF) has recommended the adoption of a Five Principles Strategic framework for climate change adaptation for the water sector.

Figure 1 in Chapter 1 illustrates the application of the five principles in end-to-end partnerships between four key stakeholders – (a) leaders and policy makers, (b) water managers, (c) community and civil society, and (d) scientists. The five principles are as follows and they are described in detail below:

(a) Usable knowledge
(b) 'No-regret; investments
(c) Resilience
(d) Mitigation and Adaptation
(e) Financing

1. Usable Knowledge

The APWF recognises that there is still a 'disconnection' between the knowledge generated by the scientific community with the specific needs of practitioners, such as in water managers of river basins and cities. Thus, the following strategic actions were recommended to address this knowledge gap and to make the knowledge usable by decision-makers and practitioners:

"We must support scientists and practitioners to work together and develop knowledge that leads to effective actions and increased public awareness."

Action 1.1 - Develop data infrastructure and networking for sharing data, information and knowledge to support decision-making and to raise public awareness

1. Develop hard and soft data infrastructure supporting inter-operability, data standards and methods of quality control and validation, and protocols for institutional collaboration;
2. Increase the availability of historical observation data, to support the calibration and validation of model-generated climate projections, and to support local/regional impact assessments;
3. Develop and share knowledge bases of local-level data, information and best practices for directed action.
4. Encourage scientists to 'translate' their findings into a language that is comprehensible to decision-makers, planners and other non-scientists;

and encourage decision-makers and other non-specialists to increase their scientific literacy, with respect to climate change;
5. Promote the networking of educational institutes, especially the higher education sector, to share research and data related to climate change and its impacts; and
6. Facilitate regional demonstration activities in existing international frameworks, such as the Global Framework for Climate Services (GFCS) developed by the World Climate Conference-3, 2009 and the Asian Water Cycle Initiative (AWCI) by the Group on Earth Observations (GEO), 2005.

Action 1.2 - Accelerate scientific efforts to improve the use of climate projections for countries, river basins and cities as well as to quantify and reduce the related uncertainty

(a) Improving projections

1. Invest on improving use of climate projection capabilities, including impact model developments such as improved flood control situation;
2. Improve the resolution of GCMs, the representation of cloud microphysics and topography, and then the simulation capability of high-intensity precipitation events;
3. Improve the coupling of atmospheric and land surface processes including their heterogeneity and bio-geochemical cycles; and
4. Improve hydrological models to address the large diversity of the natural and socio-economical conditions in the Asia-Pacific region.

(b) Quantifying uncertainty

1. Improve the collection, archiving and analysis of historical instrument records with particular emphasis on identifying and extending relatively complete, long-term hydrologic datasets for improving the performance of models at basin scale.
2. Develop and improve the metrics used to evaluate the skill of GCMs and RCMs;
3. Increase the use of analysis based on multi-model and multi-projection ensembles; and
4. Reduce uncertainty in the statistical inference of risks of hydrologic extremes – a specific challenge here is to develop robust alternatives to currently used frequency analysis methods based on the stationarity assumption.

2. 'No-regret' Investments

The APWF recognises that an 'adaptation deficit' already exists under contemporary climate conditions. In particular, many countries currently struggle to address extreme events such as floods, droughts, and tropical

storms, and to manage the resultant disasters arising from them. Thus, any improvement in the current capacity to cope with the present extreme water-related events will enable a country to be better equipped to deal with possible future increases in their severity and frequency.

"*In view of the uncertainty in how the global climate will change in the future, and in the large degree of inaccuracy of climate projections, the most logical approach is to start now with the 'no-regrets', and 'low-regrets' investments, which yield benefits at minimal or low cost even in the absence of climate change.*"

Figure A1 shows how committing to the 'no-regret investments now' strategy, in synergy with the other four principles, will ensure that socio-economic benefits will keep accruing over time as adaptation takes hold. Thus, the APWF recommends that actions be taken now to identify, plan and implement adaptation actions through improved adaptation planning methods, and also through the use of an appropriate mix of structural and non-structural measures. The following are the APWF recommended strategic actions to address this issue:

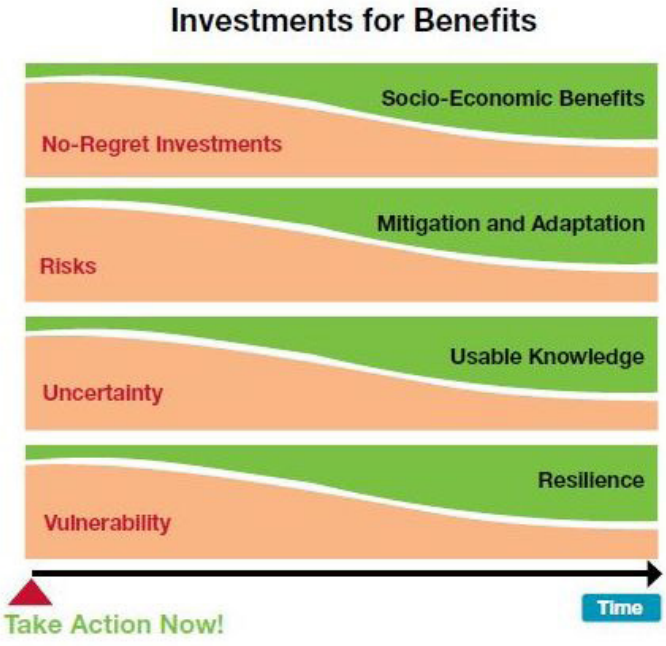


Figure A1. Implementing the 'Taking action now' strategy with the 'No-regret investments' strategy will ensure increased socio-economic benefits over time through the reduction of risks, vulnerability and uncertainty.

"We must identify and implement approaches that improve water security over a wide range of potential conditions, including current climate variability."

Action 2.1 - Plan for incremental adaptation actions in tandem with improving climate projections

(a) Planning adaptation actions

1. Mainstream adaptation in the national development planning cycle;
2. Manage disaster risks with focus on society's vulnerabilities;
3. Conduct comprehensive, credible assessment of basin-wide potential under current conditions for water resources development through watershed development, groundwater recharge, and local water systems;
4. Incrementally develop and frequently adjust adaptation actions through use of enhanced instrumental records, updated projections, emerging technologies, and monitoring and evaluating of these actions;
5. Limit, to a possible extent, the scope of critical decisions to a lead time of 20–30 years, over which uncertainty is both relatively low and, to an extent, quantifiable; and
6. Study and document the circumstances and existing coping strategies of communities and societies from which lessons can be learned and utilised for adaptation actions.

(b) Improving planning methods of adaptation

1. Establish risk assessment methods based on outputs of high-resolution GCMs and multi-model ensembles; which improves downscaling methods; and
2. Develop planning methods to identify robust infrastructure designs, which may be justified, even if they are not of the 'no-regret' kind.

Action 2.2 - Use an appropriate mix of structural and non-structural measures

1. Expand beyond engineering-oriented approaches to those that integrate structural and non-structural measures in various sectors.
2. Strengthen governing mechanisms involving a wide range of stakeholders at river basin level.
3. Link flood risk management to the livelihoods of riparian communities - "living with floods", and urban storm water management, including rainwater harvesting, use of wetlands, use of modular structures to treat waste water.
4. Focus on urban water planning and management through measures including harnessing local sources and treatment and reuse of wastewater, as they reduce the dependence on external sources.
5. Improve mechanisms for groundwater management in the context of integrated water resources management (IWRM), including sustaining existing recharge systems, creating new ones, and promoting legally enforced community groundwater regulation.

3. Resilience

'Resilience' is the ability to recover quickly from a change or misfortune. In view of the increased vulnerability of society to the threats of climate change the APWF recognises that there is a need to build increased resilience of society to cope with potential extreme changes in the weather and climate. Since resilience like vulnerability, is local, there is a need for improved governance systems and increased capacity, coupled with the necessary policy reforms, to allow local stakeholders to take steps to increase their resilience and sustainably manage their resources. The following are the APWF recommended strategic actions to address this issue:

"We must build societies' capacity to develop communities' resilience in the face of a changing climate."

Action 3.1 - Strengthen the adaptation capacities of water managers, communities, and of society as a whole

1. Identify the gaps in the current governance structure and the adaptive capacity of communities, and develop systems to fill these gaps.
2. Focus on capacity development programs and strengthening, including the localising of climate projections and impact assessment. A local governance structure that will support the transfer of information to communities must be in place. These capacity development programs will require financing that can be sourced through or from national levels.
3. Identify, utilise and adapt local methods, solutions and material, suited to local conditions. Some of these may already be available and in use while others may need to be identified.
4. Build networks between local communities and experts to facilitate efficient sharing of information and best practices.

Action 3.2 - Improve community-based water risk management capacities

1. Take up holistic and integrated land and water management planning as a comprehensive risk management strategy. The plan should be developed and implemented with a participatory approach involving all stakeholders. This includes adaptation planning and implementation encompassing communities at village/watershed level, through the sub-basin to river basin management organisations, to the national level;
2. Study and understand institutional structures, their capacities and the skills needed for community-based risk management;
3. Strengthen the capacity of academia, governmental institutions, communities and other stakeholders to collectively support community climate risk management efforts as communities typically face limitations

in many areas, including budget, technology, and human resources;
4. Share knowledge, experience and success stories on adaptation measures in water risk management emerging from community-based projects. A scaling up and disseminating of these practices should be established. Such best practices should include those that address sea level rise, flood mitigation, cropping calendars and agricultural practices, and related. Since these practices must ultimately be implemented at the local level, guidelines for tailoring them to particular local circumstances must be developed. A useful approach may be to produce simple booklets, instructional materials and directives, translated into local languages; and
5. Develop risk management approaches based on agricultural diversification. Many vulnerable local communities are involved in agricultural activities. Agricultural production is particularly sensitive to changes in hydro-climatic conditions, including temperature, water balance, and the occurrence of extreme events. Risk management approaches based on agricultural diversification can help build resilience to changes in these conditions, for example through development of drought and/or salinity resistant crops, altered cropping patterns and rotations, and so on.

4. Mitigation and Adaptation

In view of the uncertainties of climate change, there is a need to implement a diverse set of measures, encompassing both mitigation and adaptation, to deal effectively with it. The *Integrated Water Resources Management (IWRM)* approach is an adaptive management process by which economic, social and environmental benefits of water resources among a range of water uses and users are increased and balanced in river basins. Since climate change effects all sectors of society, mainly through the land and water system, the IWRM approach should be adopted to enable both the horizontal and vertical integration of management approaches.

The use of water by different sectors (agriculture, energy, domestic, industry etc.), and the way in which the uses affect each other, require cross-sectoral IWRM approaches, not least to address adaptation (horizontal integration). Similarly, in the river basin context, IWRM bridges from the community/ watershed level through the basin, across boundaries within and between countries (vertical integration). Although "land and water integration" is inherent in the IWRM concept, the importance of this linkage needs to be stressed in adaptation planning. The following are the APWF recommended strategic actions to address this issue.

"We must adopt optimal combinations of measures."

Action 4.1 - Promote IWRM in river basins as the appropriate process for planning and investments

1. Recognise the river basin as the logical framework within which hydrologic and environmental processes are quantified, and hence as the fundamental geographical setting for IWRM and adaptation planning. River basins may be defined at many levels, from local watersheds to transboundary basins extending over several countries or states (e.g. Mekong, Indus). IWRM should extend to the entire river basin, as one integrated unit, in order to achieve optimal operation policies;
2. Ensure cross-sectoral dialogue on adaptation planning at both national and river basin levels, including government and relevant stakeholder groups;
3. Promote adaptation dialogue and consensus building by coordinating across different geographical zones, including upstream and downstream zones, inundation and non-flooding areas, areas of groundwater recharge and use, and urbanised and agricultural areas; and across different priorities including flood control, water utilisation, and environmental conservation. This requires an understanding of the respective adaptation needs of each zone;
4. Strengthen institutions for land and water management for effective adaptation and mitigation actions, building on the principles of participation of civil society, gender equality, subsidiarity and decentralisation;
5. Develop different approaches for effective adaptation for land and water within a comprehensive, integrated framework, where bottom-up meets top-down - from community based adaptation in the villages to the basin, national and regional/transboundary levels;
6. Develop a comprehensive information base for effective IWRM, including information on important hydrologic, hydraulic and environmental processes (e.g. river discharge, snow and ice-melt rates, groundwater levels, infiltration, evapotranspiration, sediment, nutrient and heavy metal loads etc.). Improved hydro-climate system modelling capabilities are required in order to provide this information, and to link river basin planning and management processes to climate projections; and
7. Ensure that IWRM policies and plans reflect both historical records and future (projected) hydro-climatic conditions.

Action 4.2 - Promote synergies in the planning and implementation of adaptation and mitigation measures

1. Pursue low-energy water development and low-water-consumption energy development (measured e.g. through energy footprints for water, and water footprints for energy). Energy production (primarily cooling of

thermoelectric generation) accounts for the majority of water abstractions in the US and Europe (35–50% of all abstractions), thus making energy production very vulnerable to increased variability and to changes in the hydrological regime, including changes in water temperature;
2. Examine the water-energy synergy in the context of multi-purpose water infrastructure, which provides e.g. hydropower generation, flood control, irrigation and/or domestic water supply;
3. Promote land and water management activities which at the same time contribute to adaptation through watershed management, and to mitigation (CO2 removal) through carbon sequestration ("re-carbonising the landscape" as the World Bank expresses it);
4. Coordinate mitigation and adaptation efforts by sharing knowledge between the human and natural systems, including water, energy, health, agriculture, and ecosystems, and by promoting inter-operability of knowledge and management systems for successful joint implementation. This will require coordination between different agencies and institutions, and a convergence of mitigation and adaptation programs and activities; and
5. Document and disseminate effective ("best") mitigation and adaptation practices already developed and utilized within the region. Many of these examples will be locally generated, and many of these will be cost-effective as community-level practitioners are skilled in using locally available resources and innovations.

5. Financing

Currently, climate adaptation finance embodies a 'top-down' perspective emphasising internationally negotiated agreements, protocols and funding vehicles. By contrast, 'adaptation is local,' and effective strategies for adaptation finance cannot be formulated without the explicit input and participation of the communities most likely to be affected adversely by climate change. The right balance must be struck between centralised and decentralised solutions.

Thus, there is a need to improve our understanding of the likely costs of climate change impacts in the water sector and in closely linked sectors including agriculture, energy and health; and the costs and benefits of specific adaptation options at a level of detail that supports effective planning and implementation. Without this information, there will be a risk of a serious misallocation of adaptation resources. Furthermore, there is a need to mobilise to secure the necessary funding and ensure that it is utilised efficiently, transparently and democratically. The following are the APWF recommended strategic actions to address this issue:

"We must increase dedicated climate financing substantially."

Action 5.1 - Conduct economic impact assessments for various adaptation options

1. Improve assessment methods to reflect the fundamental uncertainty in climate and hydrologic projections, as well as to allow the evaluation/identification of robust solutions that are effective across a range of scenarios, as distinct from 'optimal' solutions developed under a specific set of assumptions;
2. Develop economic impact assessments of proposed climate disaster risk-reducing measures, reflecting the often enormous costs of disaster relief financing and the long term negative impacts on economic growth of such disasters where resilience is low;
3. In developing, presenting and utilising economic impact assessments, emphasise studies that examine current, quantifiable risks (e.g. flood and drought), where you can demonstrate benefits from investments. If economic impact assessment focuses exclusively on future, hypothetical risks associated with climate change, the cascade of uncertainty (in both climatic and non-climatic factors including prices and technology) can call into question the soundness of conclusions, and lessons drawn. Identify, document and share good contemporary studies that provide guidance with respect to future conditions;
4. Apply economic assessments comprehensively in the context of IWRM processes in river basins and cities, encompassing the life cycles of infrastructure, emphasizing adaptation for water security in the long term, and recognising the public goods generated by many water sector investments; and
5. Use the concept of a 'triple bottom line' to optimise economic performance, social equity and environmental sustainability in a balanced manner, and thereby increase water security through the process of IWRM.

Action 5.2 - Mobilise significant investments today (e.g. 1% of GDP) to prevent greater damages later (e.g. 5%) as advised through the Stern report

1. Establish national and sub-national 'road maps' to guide financing priorities and strategies, prioritising the interests of the most vulnerable, and recognising and supporting climate change adaptation as an important dimension of the IWRM process;
2. International/multilateral funding must be focused on the creation of public goods. For example, develop funding arrangements that enable adaptation on a basin-wide scale, across boundaries within and between countries;
3. Ensure that new (e.g., Green Climate Fund) funding streams for adaptation are channelled through existing institutions that have proven to be effective; and directed sufficiently toward the water sector. As countries increasingly seek direct access to multilateral

climate funds through National Implementing Entities (NIE), care should be taken to ensure that funding for water sector adaptation activities is channelled to effective agencies at central, river basin and local levels;

4. Maintain flexibility by avoiding financing arrangements for special purposes and narrow interests; and align adaptation financing with disaster risk reduction and overall development objectives.
5. Demonstrate the commonality of purpose between building climate resilience and overall development activities, so that the (much larger) funding streams currently available in national development budgets can be made available for climate change adaptation;
6. Inform support and assist decision-makers and other parties in developing countries in preparing applications for grants, loans and technical assistance to gain access to the increasing funding opportunities anticipated post COP15;
7. Provide financial and technical support for R&D of promising (but unproven) mitigation and adaptation technologies early in the development cycle (note: we currently tend to finance proven technologies) – and be prepared to take some risks in their application;
8. Promote investment in existing infrastructure (including knowledge infrastructure) that generates benefits today as well as potential additional benefits under climate change. For example, encourage international funding for collaborative climate research;
9. Identify opportunities for Public-Private Partnerships (PPP) to leverage private investments and innovations, particularly when it makes advanced technologies or practices available in developing economies and offers opportunities for leapfrogging. When utilising PPPs to address climate adaptation, ensure that there is transparency, public oversight and participation in the allocation and administration of funds. Partner with the private sector locally to facilitate the financing of adaptation-oriented infrastructure and services, particularly where local firms have limited access to capital;
10. Provide start-up financing and technical assistance to introduce and to increase the coverage of disaster insurance pools (household, agricultural, other); and
11. Finance long-term capacity building for adaptation as part of IWRM processes in river basins and cities, including education and water governance institutions.

Appendix B - Overview of The Mywcc-Ibis Website

1. The MyWCC-IBIS Home Page

Figure B1 shows a snap-shot of the top part of the MyWCC-IBIS Home Page. The objective of the National Dialogue is briefly described in the 'Dialogue Box' which appears on every page of the web-site as a reminder to contributors/readers on the objective of the Dialogue. The web-links to the 'Key Documents' and also 'Presentation Files' related to the Dialogue are also given in the Dialogue Box. The 'Key Documents' link will provide access to a web page listing the key documents, which includes a copy of this Advisory Report and a Report on the MyWCC-IBIS website.

The 'Dialogue Entries/web pages' are organised and presented in three Tabs to facilitate access by users. Namely, they are the 'Focus Area' Tab, the 'Chronological entries' Tab and the 'Recent entries' Tab. The entries are also grouped under 8 key types of entries: *Issues*, *Facts*, *Positions*, *Questions*, *Ideas*, *Solutions*, *Support* and *Oppose*. The number in brackets, next to the entry types, indicate the number of entries in the website that are of that type

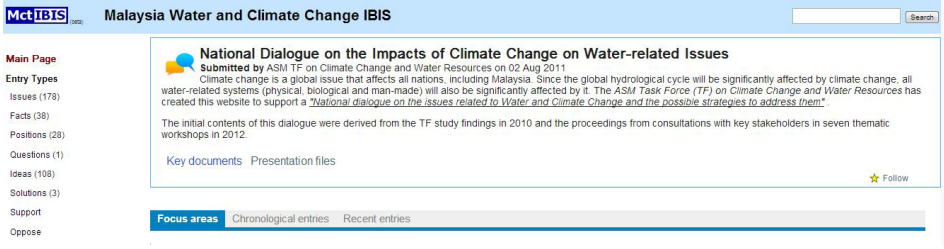


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Figure B1. A snap shot of the top part of the MyWCC-IBIS Home Page

Figure B2 shows a snap-shot of the middle part of the MyWCC-IBIS Home Page. It shows a brief write-up of the Issue Entries related to 3 of the 8 key Focus Areas of the Dialogue, which are listed in **Section 1.3**.

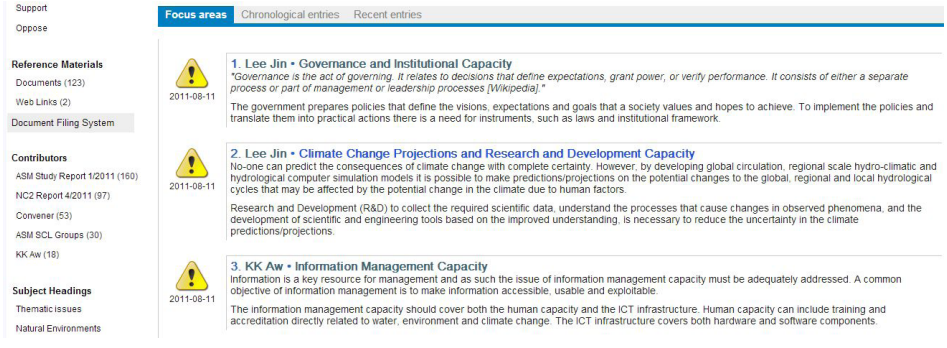

Figure B2. A Snap Shot of the Middle Part of the MyWCC-IBIS Home Page

Figure B2 also shows the links to the available Reference Materials to support

the Dialogue deliberations. There are 123 reference documents that are available for download from the website and also two web-links for reference. **Figure B3** shows a snap shot of the top part of the "Reference Documents" web page.

Figure B2 also shows the list of the top 5 Contributors to the Dialogue, which includes the names of people who made entries and also sources of entries from SCL Groups and relevant reports.

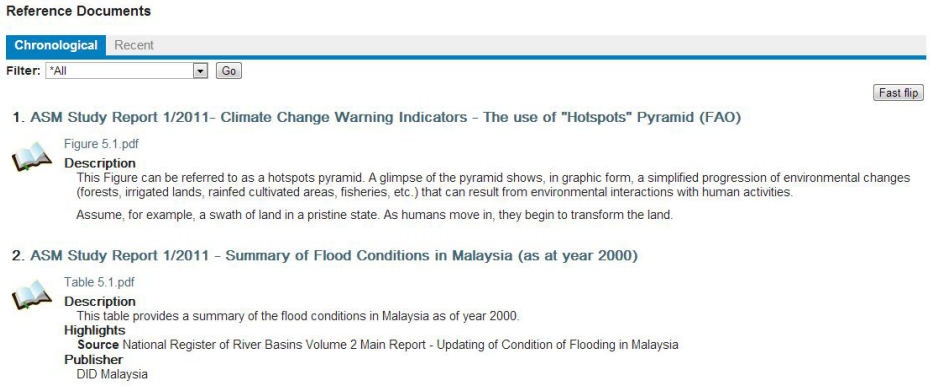

Figure B3. A Snap Shot of the Top Part of the 'Reference Documents' web page

Figure B4 shows the list of all the contributors to the MyWCC-IBIS, as of 28 March 2013. The numbers in brackets show the number of entries made by each of the contributors.

Figure B4. The List of Contributors to the MyWCC-IBIS (as of 28 March 2013)

Figure B5 shows a snap shot of the bottom part of the MyWCC-IBIS. It shows

the 7 'Subject Headings' Categories that have been used to group the entries in MyWCC-IBIS, by their topical subject contents. The subjects in each of the 7 subject headings categories and the number of entries grouped under them are shown in **Figure A6**.

Figure B5 also gives the links to reference materials 'About IBIS' and 'About MctIBIS'. It also provides a link to a User's Feedback Form, as follows:

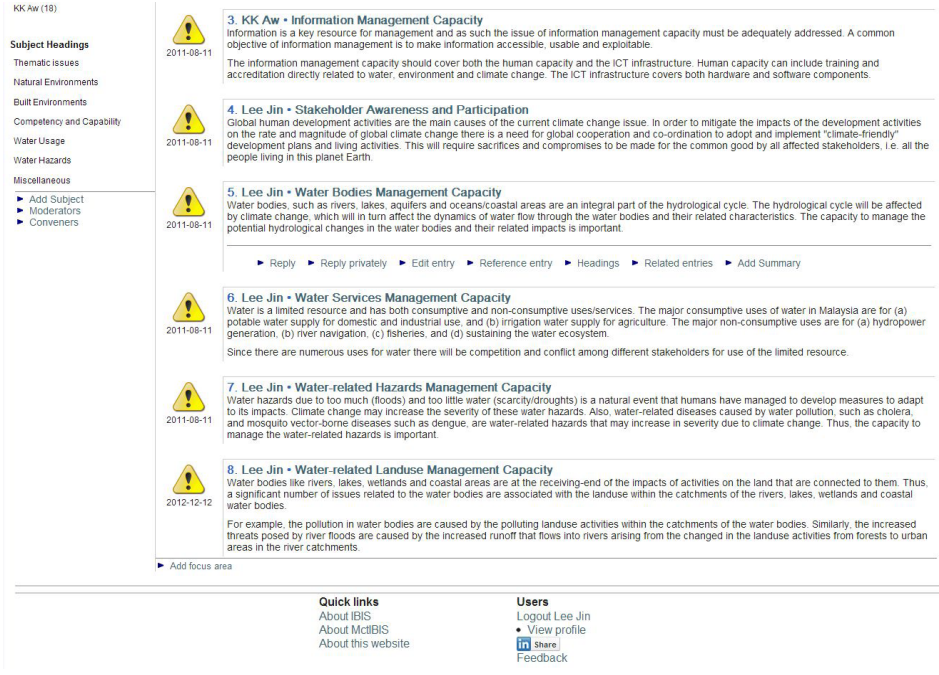

Figure B5. A Snap Shot of the Bottom Part of the MyWCC-IBIS Home Page

Figure B6. The Subjects Under the Respective Subject Headings Categories

2. The '*Governance and Institutional Capacity*' Focus Area Entry/Page

Figure B7 shows the top part of the 'Governance and Institutional Capacity' Focus Area entry/page, **Selected** as the 'Focused entry' web page. The complete webpage shows a tree-like structure of all the entries grouped under the focused entry. Only a part of each entry in the Tree is shown. To view the complete entry the user needs to click on the 'Blue Arrow' button on the RHS, which is visible when the cursor is placed over a given entry (e.g. the "*Status of Climate Change Governance in Malaysia*" entry, as shown below).

Figure B7 also shows at its top RHS the following 3 links:

(a) View in 'FreeMind'
(b) Export as 'MindMap'
(c) 'Print tree'

The 'View in FreeMind' link enables the user to get an overview of the tree-like structure of the selected "Focused Entry" web page in a "Mind Map" view as shown in **Figure B8** below. The 'Export as MindMap' link allows a 'FreeMind' file to be generated for use with the 'FreeMind' program. The 'Print tree' link allows the complete tree structure of all the entries in the selected web page to be printed and saved as a single document. This facility allows the extraction of all the tree-like entries in any selected 'Focused entry' web page to be compiled into a single document for sharing with any user, and is very useful for producing hard copies for use in any workshops.

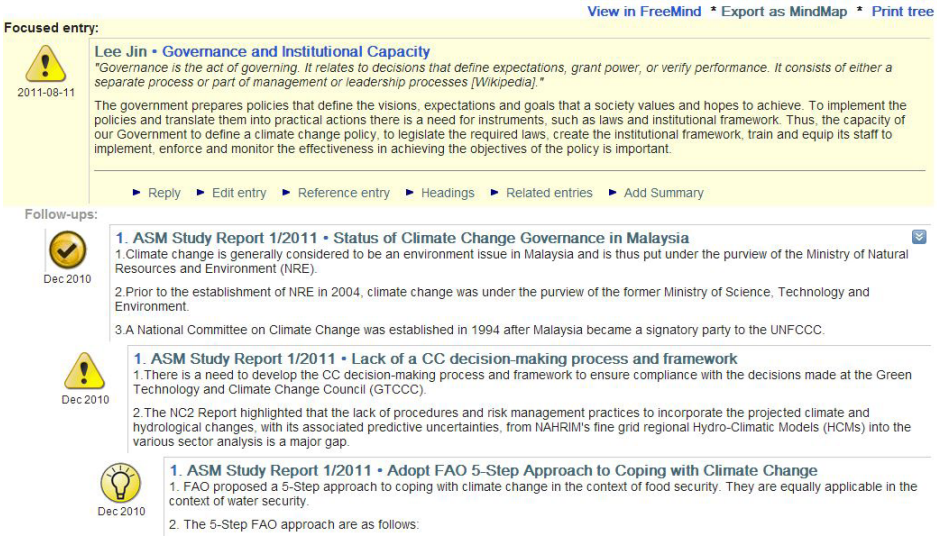

Figure B7 – The Top Part of the 'Governance and Institutional Capacity', 'Focused Entry' web page

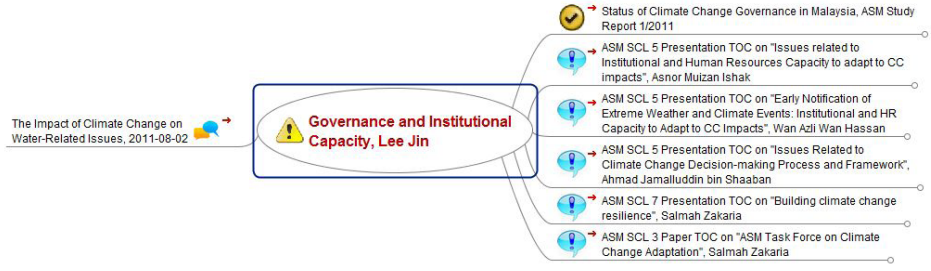

Figure B8. The 'FreeMind' 'Mind Map' view of the 'Governance andInstitutional Capacity','Focused Entry' web page

3. The "*Climate Change R&D Capacity – Current Status*" Entry/Page

Figure B9 is another example of a FreeMind "Mind Map" for the selected 'Focused Entry' web page of "*Climate Change R&D Capacity – Current Status*", which is under the *Climate Change Projections and Research and Development Capacity* Focus Area. It shows an example of how the 'white circle' at the end of each link can be expanded to show the 'child links' below it by 'clicking on it' (blue boxed item below).

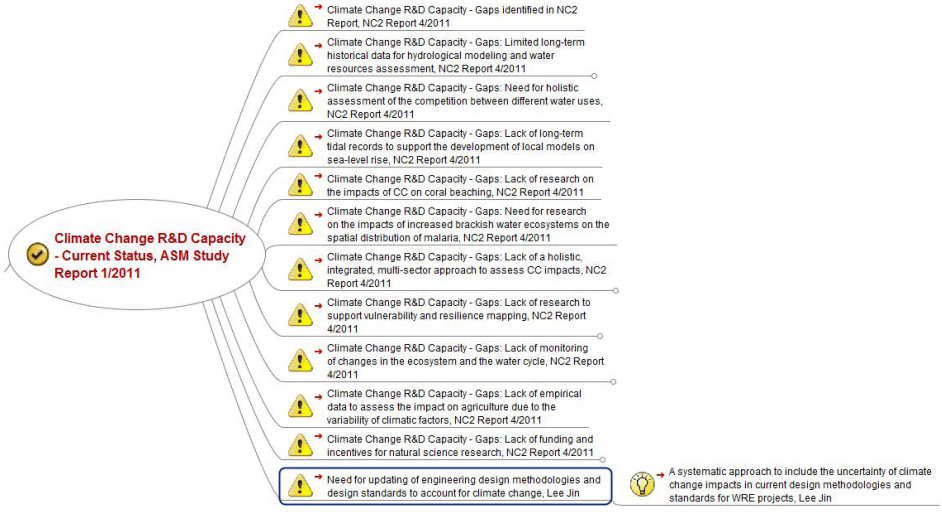

Figure B9. The 'FreeMind' 'Mind Map' view of the "Climate Change R&D Capacity – Current Status", 'Focused Entry' web page

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