CLIMATE CHANGE

Adaptive Capacity Attributes of Selected Water-related Policies in Malaysia

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CONTENT

FOREWORD

Climate change, quoted by Time Magazine as the 'Mother of All Risks', has become a topic frequently discussed at the national level over the years. With Malaysia experiencing extreme climate variability through the form of shifting rainfall patterns, escalating floods, and drought concurrences, the "Climate Change: Adaptive Capacity Attributes of Selected Water-related Policies in Malaysia" study report is a timely contribution by the Academy of Sciences Malaysia (ASM) to assist the government in formulating sustainable laws and policies that would enable adaptation to the changing climate.

As an independent thought leader and the apex advisory body for matters related to science, technology and innovation (STI), ASM has been actively pursuing studies pertaining to the water sector with the Integrated Water Resources Management (IWRM) as its central philosophy. Due to the significant impact of climate change on the water resources, it is timely to review the adaptive capacity of current policies to identify gaps and areas of improvement to create an effective enabling environment.

We are certain that the recommendations within this report will play a role in strengthening the policies and legislation that will lead the nation to achieve a greater adaptive capacity for climate change.

It gives me great pleasure to extend my warmest congratulations to the members of the ASM Water-related Policies and Legislation Working Group and the ASM Water Committee for the timely completion of the study. I would also like to take this opportunity to thank Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Institute (SEADPRI-UKM) for funding the study and stakeholders who have contributed to the final report.

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

PREFACE

Policies, legislative framework and financing structure fall under enabling environment; one of the pillars of the Integrated Water Resources Management (IWRM) concept. A conducive enabling environment will ensure the management of water resources in an efficient, equitable and sustainable manner.

There is a need to strengthen our policies and legislation in view of the increasing intensities of flood and water stress in the country. If left unattended, the impacts of extreme climate on water resources may devastate sectoral areas such as agriculture, energy, health, industry and tourism, which would ultimately affect the country's socio-economic landscape. By reinforcing a country's adaptive capacity through effective policies and plans, the cost of implementing adaptation strategies can be reduced while the livelihood of the poor and vulnerable can be elevated. This would eventually lead to nationwide sustainable development.

This study reviews the following five key policy and planning documents from both national and state levels to assess their effectiveness in facilitating the enhancement of adaptive capacity to climate extremes and change:

- National Policy on Climate Change
- National Water Resources Policy (NWRP)
- 10th Malaysia Plan (10th MP)
- Selangor State Structure Plan
- Sungai Selangor River Basin Management Plan

The ASM Water-related Policies and Legislation Working Group and the ASM Water Committee anticipate that the recommendations for enhancing adaptive capacity will be useful to equip policymakers with insights to formulate effective and inclusive policies designed to reduce exposure and vulnerability and strengthen preparedness for extreme climates.

We would like to thank the stakeholders who have contributed to this study. We also thank the reviewers and members of the ASM Water Committee who were involved in the process of refining the report.

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EXECUTIVE SUMMARY

There is widespread belief that climate change is a gradual process and that actions can be taken progressively as part of a long-term strategy. The reality is that the impacts of climate change are already happening and adaptation efforts are ongoing in many parts of the world. Water scarcity is expected to be a major challenge for tropical Asia due to increased water demand and lack of good management. As water availability and quality are increasingly stressed in a changing climate, the ability of institutions dealing with water resources (collectively referred to as water institutions) to absorb these stresses and cope with new realities and potential future surprises becomes critical. Enhancing the adaptive capacity of water institutions is a "no regret option" that lowers the costs of adaptation.

The Selangor River Basin, which provides 60% of the domestic and industrial water supply in Selangor and Klang Valley, was used as a case study to assess five key policy and planning documents for their effectiveness in facilitating the enhancement of adaptive capacity. These were the National Policy on Climate Change, National Water Resources Policy (NWRP), 10th MP, Selangor State Structure Plan and Sungai Selangor River Basin Management Plan. The assessment was based on six criteria, where each criterion was represented by two indicators. The criteria encompass information and knowledge; institutions and governance; human capital; economic resources; technology and infrastructure; and adaptability.

Strategies at the national level can be implemented more effectively when supported by facilitative plans at the state and local levels. With respect to the water sector, national policies that facilitate adaptive capacity of critical water institutions should be supported by state and basin level plans to be more effective. The results of the assessment of policy documents indicate that the NWRP is inadequately supported by the Sungai Selangor Basin Management Plan in facilitating the adaptive capacity of water institutions within the basin. It is urgent and important that the Sungai Selangor Basin Management Plan be reviewed to facilitate water institutions therein to be better able to adapt to climate extremes and change. This is particularly relevant as the basin supplies water to over four million people and industries in the Klang Valley.

Future work should be considered on evaluating the state of the enabling environment for Integrated Water Resources Management (IWRM) and Integrated River Basin Management (IRBM) by assessing relevant documents to get an insight on their adaptive capacity attributes. This could be done using the robust tool developed in this study, which encompasses six criteria and 12 indicators, for assessing the adaptive capacity of legislation, policies and plans related to the water sector in Malaysia. All major basin management plans in the country should be assessed and revised where necessary to be more facilitative in enhancing the adaptive capacity of water institutions. An immediate priority would be to assess the current Malaysia Plans and enhance its adaptive capacity attributes. The recommendations below may be considered to achieve a higher level of adaptive capacity of water institutions.

Information & Knowledge: There is a need to emphasise the importance of collecting and sharing scientific and technical data among stakeholders. The data must be made available and accessible through an integrated information management system. The use of open crowdsourced information should be explored (pilot basis) and mainstreamed if found to be effective. The provision of appropriate scientific and technical data at the basin level will enable water institutions to efficiently evaluate problems for decision making.

Institutions & Governance: Collaboration and cooperation between federal and state government are critical in raising the adaptive capacity. In addition, collaboration between the government, private sector, universities and community is the way forward. Encouraging participatory management by empowering local community in organisational decision making may also be an effective strategy.

Human Capital: Capacity building has to be intensified at all levels to achieve "operational excellence" to facilitate better preparedness and assessment of options for adapting to emerging threats including climate change. The capacity of water resource managers has to be enhanced to take cognizance of all types and sources of knowledge and scientific pursuits (science, social sciences and humanities), including traditional and local understanding as well as practices relevant to the sector at the basin level.

Economic Resources: By strengthening the financial resources, policy measures and financial incentives that are beneficial for climate change adaptation can be made possible. Support from the government for water operators to explore alternative financing options and models to improve business sustainability will also be crucial in enabling the development of climate change resilient infrastructures.

Technology & Infrastructure: Software development specifically for localised climate modelling may provide more reliable and accurate predictions compared to software developed internationally. There is also a need to review the country's hydrological data using the latest data acquisition technologies. New multi-disciplinary approaches should also be encouraged to identify effective and socially relevant technology and infrastructure solutions. Promotion of soft approaches and management solutions such as conserving water catchment forests and ecosystems, identifying and reserving sources of water supply and catchment areas, and controlling polluting sources have positive influence on adapting to the stresses of climate change.

Institutional Adaptability: The federal and state institutions may include prioritisation of resources and usage of alternative source during extreme climates in their policy, enactment and guidelines. This will improve flexibility in responding to sudden climate change. Institutions will also have to review their performances regularly to identify gaps and make room for continuous improvement. The IWRM and IRBM approaches in planning, managing, protecting and rehabilitating water resources should be enhanced as they facilitate successful adaptation responses and provide guidance to decision makers in designing institutional arrangements and governance measures in preparing for and responding to climate change.

1.0 INTRODUCTION

The discourse on climate change has evolved over the years from questioning its occurrence and causes to one that is more focused on how to move on and respond. The Fifth Assessment Report of the Intergovernmental on Climate Change (IPCC-AR5) has provided scientific evidence that climate change is real and human influence on the climate system is clear. The means to limit climate change exists. Globally coordinated mitigation measures offer the best opportunity to prevent further warming but the window for action is rapidly closing (IPCC, 2014). Notwithstanding this, the impacts of climate change are already happening and adaptation measures are needed to cope with negative effects. It is now necessary and urgent to drive greater efforts on adaptation, which previously has not been given adequate attention. Part of the reason for this lack of attention is the widespread belief that climate change is a gradual process and as such it is a long term issue. This belief, however, could be an invitation to a disaster. In these terms, adaptation is not a task of the future, but in fact it is a necessity of the present that should be combined with mitigation in balanced global and national strategies (Wilbanks *et al.*, 2003).

As water availability and quality are increasingly stressed in a changing climate, the ability to absorb these stresses and cope with new realities and potential future surprises becomes critical (Diaz *et al.*, 2005). The most recent findings for tropical Asia indicates that water scarcity is expected to be a major challenge due to increased water demand and lack of good management (Yasuaki *et al.*, 2014). Future rainfall projections at a sub-regional scale and thus in future freshwater availability in most parts of Asia are of low confidence. Thus, impact assessments for the water sector remain complex and highly uncertain. In this situation, policy-makers can take advantage of the very localised contexts within which adaptation to climate change takes place, by focusing on improving adaptive capacity. Governance and institutional mechanisms influence the level of adaptive capacity significantly and require greater scientific inputs for informed decision-making.

2.0 BACKGROUND

The approach taken by Malaysia thus far on adaptation in the water sector has not adequately addressed aspects of adaptive capacity. Several key studies in the country adopted the impact assessment approach (Fussel and Klein, 2006) that evaluates the potential effects of the projected climate change scenarios on the water sector (ADB, 1994; MOSTE, 2000; NRE, 2011). The climatic stimuli were developed based on the assumptions of future CO2 scenarios, before being applied on the sector for evaluating its exposure and sensitivity in the assessments of the vulnerability to the potential impacts. Limited (if not none at all) consideration, however, was given on the sector's adaptive capacity with regard to its current or future ability to cope with future climate change. The inadequacy in such detailed analysis may be attributable to the projected future scenarios of climate change that remain greatly uncertain as well as the assessment of adaptive capacity only emerged as a critical focus of attention as observed in the IPCC Third Assessment Report (Ahmad *et al.*, 2001). There is an urgent need to look into the factors influencing the mechanisms, and how these mechanisms relate to one another to equip decision makers within designing management and governance institutions with information to make the right decisions when responding to climate change.

Sungai Selangor has been identified as a major source of water supply for domestic, industrial and irrigation in the state of Selangor since the early 1960s (DID, 2007). The 110km long river basin provides 60% of the domestic and industrial water supply in Selangor and Klang Valley. Most of the major development works have been undertaken for the last three decades for supplying water extends far beyond the basin boundary to over four million people and industries in the Klang Valley. Due to the significant importance of the Selangor river basin, the basin was used as a case study.

DEFINITION OF ADAPTIVE CAPACITY

Adaptive capacity is defined by the Intergovernmental Panel on Climate Change (IPCC) as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptive capacity is important for management of the country's water resources because climate change will inevitably induce changes in water availability.

High adaptive capacity allows proper pre-emptive measures to be taken to safeguard water resources for maintaining the economy and sustaining livelihoods. The main advantage of strengthening a country's adaptive capacity is that it is a "no regret option" that lowers the costs of adaptation. The enhancement of adaptive capacity can also serve to improve the livelihood of the poor and vulnerable groups and promote sustainable development.

2.1 Study Approach

Content Analysis

Content analysis is a technique that enables objective, systematic and quantitative description of the substance of a text. It enables the clustering of qualitative data of similar meaning into categories to allow for quantitative inferences of the text. The method has been employed in various fields such as marketing and media studies, ethnography, psychology and cognitive studies as well as policy studies (Berelson, 1974; Weber, 1990; Gagnon-Lebrun & Agrawala, 2007; de Aguiar 2009). The method has its limitations particularly with respect to variability of judgement due to norms and views, whereby two researchers may come to different conclusions (Klostermann *et al*. 2009; Gupta *et al.* 2010). However, an assessment by the same researcher can offer a perspective that is consistent for comparative purposes, particularly when the assessment is strongly guided by a fixed criteria and indicators. In the context of climate change, content analysis has been employed to review policies, plans, national communications and other types of official documents (Leiserowitz, 2006; Urwin and Jordan, 2008; Klostermann, 2009; Roders *et al.*, 2011; and Coutts, 2012).

Table 2.1
Scoring based on the category of contribution

Score	Category of Contribution
0	**No contribution**
1	**Indirect contribution**
2	**Direct contribution**

The study was conducted using content analysis on five policy and planning documents concerning water resources management for Sungai Selangor Basin. The aim is to critically review the policies and plans to identify strengths and potential gaps in institutional capacity for adaptation in a changing climate. This will facilitate the identification of pathways to mainstream adaptation options that may lead to a greater adaptive capacity of water-related institutions. The review is necessary as significant gaps in institutional adaptation were noted by researchers where the organisations that are most at risk, that are making long-term investments and commitments, and that have the planning, forecasting and institutional capacity to adapt, have not yet done so.

A scale of three categories to judge the policy and planning documents on the different criteria was used. The three-category scale helps to create a structured approach for evaluation of the different documents. A 0-point score is assigned if the document does not contain any provision that contributes to the criteria. If yes, it is either a one-point score that indicates indirect contribution or 2-point score for a definite and direct effect on the criteria. The scores of each indicator were added and then divided by the total number of indicators per criteria for sub-index of each criterion. The adaptive capacity index is obtained by adding the normalised sub-index of the criteria.

Rationale of the Adaptive Capacity Assessment Framework

The adaptive capacity assessment framework is the first effort to provide a comprehensive (but not exhaustive) list of criteria and indicators for assessing adaptive capacity as articulated in the documents. Its application in a systematic way shows which criteria and indicators that may need attention, and in which respects a specific policy or plan can be improved to enhance the adaptive capacity of water institutions. The assessment framework can also be used as a tool for learning how policies and plans can be derived in order to provide more adaptive capacity. Through this framework, the adaptive capacity of each policy is quantified using indicators and indices. With greater comprehension of the vulnerability towards climate change, policy-makers will be more capable in making informed decisions regarding investments on adaptation. The assessment framework has been tested on five key policy and planning documents to the management of water resources in Sungai Selangor Basin (Figure 2.1). The adaptive capacity assessment framework used to review the adaptive capacity of water-related policies within this report was designed based on six criteria covering information and knowledge; institutions and governance; human capital; economic resources; technology and infrastructure; and adaptability. Two indicators that best depict the component were selected for each of the six criteria (Table 2.2).

Figure 2.1 Five key policy and planning documents used in this study to evaluate water resources management in Sungai Selangor River Basin

Table 2.2
Criteria and indicators used in the study

Criteria	Indicators	
Criterion 1: Information & Knowledge	1.1	Availability of scientific knowledge
	1.2	Access to scientific knowledge
Criterion 2: Institutions & Governance	2.1	Regulatory & institutional arrangement
	2.2	Coordination & collaboration
Criterion 3: Human Capital	3.1	Leadership
	3.2	Availability of technical expertise
Criterion 4: Economic Resources	4.1	Financial resources
	4.2	Risk spreading mechanism
Criterion 5: Technology & Infrastructure	5.1	Technology for adaptation
	5.2	Resilience of infrastructure
Criterion 6: Adaptability	6.1	Flexibility
	6.2	Continuous improvement

3.0 ADAPTATION ATTRIBUTES IN WATER-RELATED POLICIES

3.1 National Policy on Climate Change

The National Policy on Climate Change was formulated as part of the Policy Study on Climate Change, an initiative under the 9th Malaysia Plan. The study was initiated by the Ministry of Natural Resources and Environment (NRE) Malaysia in 2007. It adopted a consultative approach and created multiple platforms for stakeholders of multi-sectoral and disciplinary constituencies and backgrounds as well as diverse interest to interact with each other and share views (Tan *et al.*, 2013). The National Policy on Climate Change was adopted by the Cabinet of Malaysia in 2009.

Provisions on Adaptive Capacity

The National Policy on Climate Change seeks to ensure climate-resilient development to fulfil national aspirations for sustainability.
The objectives of the Policy are:

1. Mainstreaming climate change through wise management of resources and enhanced environmental conservation resulting in strengthened economic competitiveness and improved quality of life;

2. Integration of responses into national policies, plans and programmes to strengthen the resilience of development from arising and potential impacts of climate change; and

3. Strengthening of institutional and implementation capacity to better harness opportunities to reduce negative impacts of climate change.

The National Policy on Climate Change recognises the need to enhance the country's adaptive capacity to actual or expected impacts of climate change which is observable through its key elements that include five Principles, ten Strategic Thrusts and 43 Key Actions (Figure 3.1).

POLICY STATEMENT

Ensure climate-resilient development to fulfil
National aspirations for sustainability

OBJECTIVES

1. Mainstreaming climate change for strengthened competitiveness and improved quality of life;
2. Integration of climate change responses into policies, plans and programmes; and
3. Strengthening of institutional and implementation capacity.

PRINCIPLES

P1:	P2:	P3:	P4:	P5:
Development on a Sustainable Path	Conservation on Environmental & Natural Resources	Coordinated Implementation	Effective Participation	Common but Differentiated Responsibilities

STRATEGIC THRUSTS & KEY ACTIONS

ST1: Facilitate harmonisation of existing policies & institutions; **ST2:** Institute measures on low carbon economy; and **ST3:** Support climate-resilient Investment	**ST4:** Strengthen environmental & resource conservation; and **ST5:** Consolidate the energy policy.	**ST6:** Integrate cross-cutting issues; and **ST7:** Support knowledge-based decision making.	**ST8:** Improve collaboration; and **ST9:** Increase Awareness & Community participation	**ST10:** Strengthen involvement in International programmes
11 Key Actions	**12 Key Actions**	**10 Key Actions**	**6 Key Actions**	**4 Key Actions**

Figure 3.1 The National Policy on Climate Change at a glance
Source: LESTARI, 2009

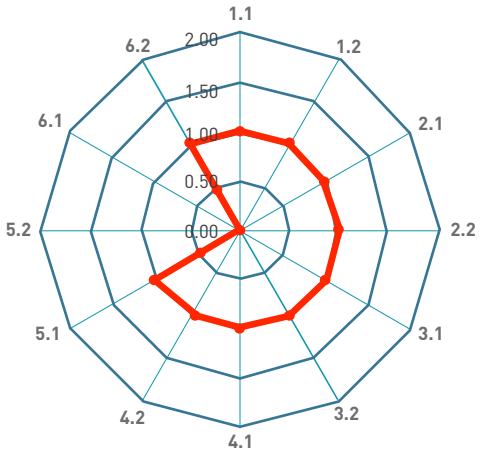
Facilitation of Adaptive Capacity

A total of 20 Key Actions were identified to be relevant in the adaptive capacity assessment framework (Table 6.1 in Appendix). Even though the key actions almost have a full coverage on all the indicators studied (except for 'resilience of infrastructure' and 'flexibility'), their contributions were indirect giving each of them a score of 1 as shown in Table 3.1.

Table 3.1
Scoring of the Key Actions in National Policy on Climate Change

Indicator	No. of Relevant Key Actions	Score
Criteria 1: Information & Knowledge		
1.1 Availability of scientific knowledge	2	1
1.2 Access to scientific knowledge	1	1
Criteria 2: Institutions & Governance		
2.1 Regulatory & Institutional arrangement	1	1
2.2 Coordination & collaboration	3	1
Criteria 3: Human Capital		
3.1 Leadership	2	1
3.2 Availability of technical expertise	2	1
Criteria 4: Economic Resources		
4.1 Financial resources	2	1
4.2 Risk spreading mechanism	1	1
Criteria 5: Technology & Infrastructure		
5.1 Technology for adaptation	5	1
5.2 Resilience of infrastructure	-	0
Criteria 6: Adaptability		
6.1 Flexibility	-	0
6.2 Continuous improvement	2	1

Figure 3.2 below illustrates the table above in the form of a radar chart.



Indicators:
1.1 Availability of scientific knowledge
1.2 Access to scientific knowledge
2.1 Regulatory & institutional arrangement
2.2 Coordination & collaboration
3.1 Leadership
3.2 Availability of technical expertise
4.1 Financial resources
4.2 Risk spreading mechanism
5.1 Technology for adaptation
5.2 Resilience of infrastructure
6.1 Flexibility
6.2 Continuous improvement

Figure 3.2 Scoring of the Key Actions in National Policy on Climate Change

3.2 National Water Resources Policy

The NWRP has been formulated to meet the need for providing a comprehensive guide to aid water and water resources governance nation-wide, as stated in the 10th MP (EPU, 2011). The Policy articulates the need to harmonise existing and proposed policy directions for multiple water-related sectors. The NWRP was approved by the Cabinet of Malaysia in 2012 (NRE, 2012).

Provisions on Adaptive Capacity

The formulation of the Policy involved a series of stakeholder consultation activities (DID, 2011). Various stakeholders expressed the need for better water resources management and conservation. This resulted in four guiding philosophies that guide NRE:

1. Water for people: all to have access to safe, adequate and affordable water supply, hygiene and sanitation;

2. Water for food and rural development: provision of sufficient water that will ensure national food security and promote rural development;

3. Water for economic development: provision of sufficient water to spur and sustain economic growth within the context of a high-income economy; and

4. Water for the environment: protection of the water environment to preserve water resources (both surface water and groundwater) and natural flow regimes, biodiversity and cultural heritage, along with mitigation of water-related hazards.

The Policy is set to address five objectives, including "building the capacity of all stakeholders for effective participation and collaboration in water resources governance at multiple scales and levels focusing on developing human resources, science, technology and practices as well as encouraging investment in research, development and innovation. "It comprises four Key Core Areas, nine Thrusts, 18 Targets, 28 Strategies and 69 Strategic Action Plans. The strategies and strategic action plans have been designed to address immediate problems and concerns today by structuring a short to medium term work programme that will strengthen existing water resources governance and address the gaps and constraints that exist through its implementation mechanism (Figure 3.3). This study focuses on the Strategic Action Plans.

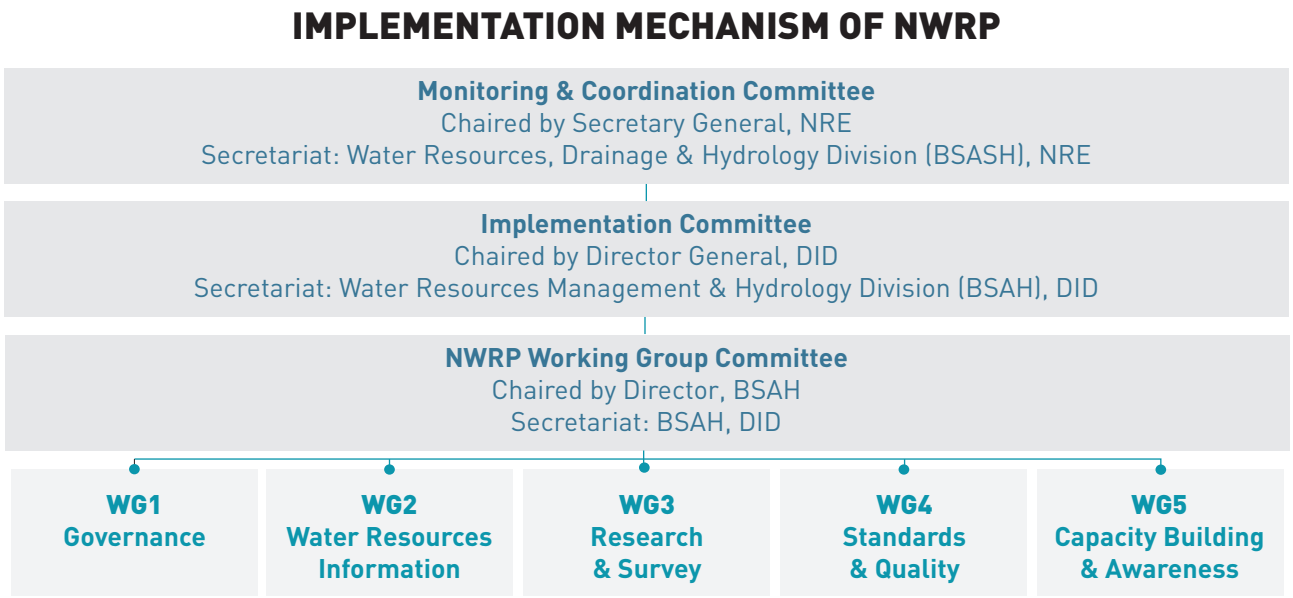


Figure 3.3 Implementation Mechanism of NWRP
Source: Abdullah *et al.* (2016)

Facilitation of Adaptive Capacity

From the content analysis assessment, all Strategic Action Plans were found to be relevant in the adaptive capacity assessment framework (Table 6.2 in Appendix 1).

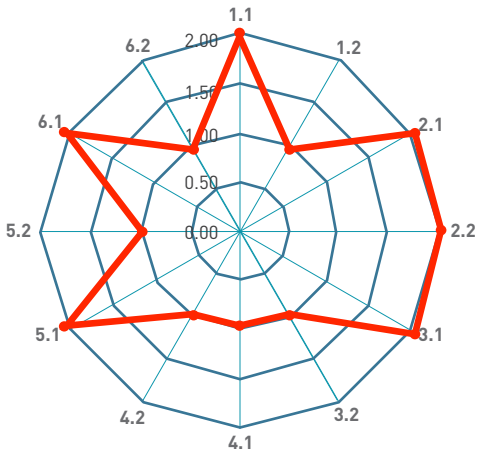
With score of 2 for half of the indicators and 1 for the rest of the indicators studied as shown in Table 3.2, the NWRP strategic action plans directly contribute (2 points) to the following indicators:

- Availability of scientific knowledge
- Regulatory & institutional arrangement
- Coordination & collaboration
- Leadership
- Technology for adaptation
- Flexibility

Table 3.2
Scoring of the Strategic Action Plans in the NWRP

Criteria / Indicator	No. of Relevant Strategic Action Plans	Score
Criteria 1: Information & Knowledge		
1.1 Availability of scientific knowledge	13	2
1.2 Access to scientific knowledge	7	1
Criteria 2: Institutions & Governance		
2.1 Regulatory & Institutional arrangement	21	2
2.2 Coordination & collaboration	17	2
Criteria 3: Human Capital		
3.1 Leadership	7	2
3.2 Availability of technical expertise	4	1
Criteria 4: Economic Resources		
4.1 Financial resources	4	1
4.2 Risk spreading mechanism	7	1
Criteria 5: Technology & Infrastructure		
5.1 Technology for adaptation	7	2
5.2 Resilience of infrastructure	1	1
Criteria 6: Adaptability		
6.1 Flexibility	2	2
6.2 Continuous improvement	2	1

The radar chart to show the scoring of the Strategic Action Plans in in the NWRP is illustrated in Figure 3.4.



Indicators:

1.1 Availability of scientific knowledge
1.2 Access to scientific knowledge
2.1 Regulatory & institutional arrangement
2.2 Coordination & collaboration
3.1 Leadership
3.2 Availability of technical expertise
4.1 Financial resources
4.2 Risk spreading mechanism
5.1 Technology for adaptation
5.2 Resilience of infrastructure
6.1 Flexibility
6.2 Continuous improvement

Figure 3.4 Scoring of the Strategic Action Plans in the NWRP

3.3 10th Malaysia Plan

The 10th MP (2011-2015) recognises the need for more prudent and efficient management of water resources and supply with a growing economy. The Plan articulates the need to reassess water resources management across the entire water cycle, from its source to the end user and its final disposal as wastewater. The measures for ensuring sustainable water supply encompass three areas of focus. These include "developing a long-term strategy for water resource management to achieve water security, continuing efforts to restructure the water services industry and protecting rivers from pollution".

Provisions on Adaptive Capacity

Sustainability of water resources is becoming an increasingly important as the economy expands. Water shortages are already occurring in some growth centres. The mismatch between regions that have abundant access to water resources and areas with elevated economic and population growth with high water demand makes water resource management challenging. In developing a long-term strategy for water resource management to achieve water security, several measures will be focused during the Plan period. These measures include the following:

i) Formulating the NWRP to chart the future course for the sector by establishing "a process for ensuring the security of water supply in an era of rapid economic development, growing cities and population growth, all of which have important implications on how Malaysia manages its water resources in the coming years"

ii) Strengthening implementation of IWRM and IRBM approaches in planning, managing, protecting and rehabilitating water resources

iii) Enhancing research and development in conservation of water resources "to support efforts to develop a sustainable water sector for the national economy"

In continuing efforts to restructure the water services industry, covering water supply and sewerage services, which began during the Eighth Plan period with the objective of creating an efficient and sustainable water services industry, the restructuring efforts will enter into its final phase with a focus on the several areas. These areas include the following:

i) "Moving towards full cost recovery: Tariffs in 2009 covered only 78% of operating expenditure. To address this problem, the government will phase in a tariff-setting mechanism that allows full recovery of costs to encourage sustained investments in upgrading and rehabilitating water treatment plants and distribution systems. The phasing of the tariff increases will be segregated into tariff bands based on consumption levels to ensure that the vulnerable segments of society are protected"

i) "Driving efficiency in operations and capital expansion: Water operators will be required to provide detailed 30-year business plans and 3-year operational plans. These plans will be the basis for a roadmap towards full cost recovery and will allow Pengurusan Aset Air Berhad to plan long term capital expenditure funding. National Water Services Commission (SPAN) will regulate and monitor the performance of water operators based on the plans, linking tariff increases to efficiency gains in operations and capital expenditure"

iii) "Improving water services infrastructure: The national water supply coverage will increase from 93% of population in 2009 to 97% in 2015. The non-revenue water programme, involving replacement of pipes and old meters, will be expanded with an allocation RM1.1 billion to improve the quality of water and reduce losses in water supply"

iv) Integrating water and sewerage services: Restructuring of sewerage services will be implemented by parcelling out the operations of centralised sewerage services to the respective state water operating companies. When completed, the industry will move towards implementing an integrated tariff for both water and sewerage services. This will link sewerage charges to water consumption, moving away from flat rate tariffs that do not adequately capture the cost of service provision given the inherent link between water consumption and sewerage production profiles

In protecting rivers from pollution, efforts to tackle the problem will focus on "major sources of pollution include improper discharge from sewerage treatment plants, agro-based factories, livestock farming, land clearing activities and include the following:

i) Strengthening the enforcement on industrial effluents and sewage discharge in line with the revisions to the regulations under the Environmental Quality Act 1974

ii) 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

iii) Revising the current Water Quality Index to incorporate additional parameters, such as biological parameters, for more accurate river water classification

Facilitation of Adaptive Capacity

From the content analysis assessment that focused on the above measures, all Strategic Action Plans were found to be relevant in the adaptive capacity assessment framework (Table 6.3 in Appendix 1).

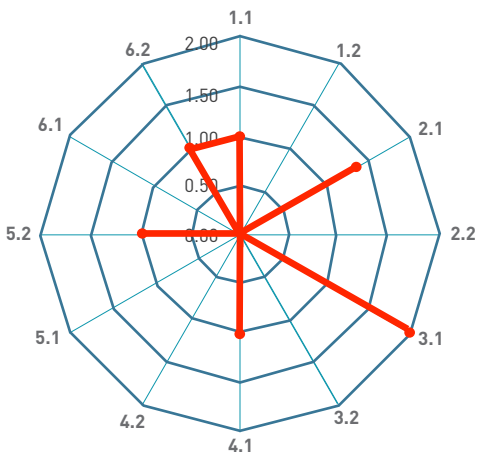
From all the measures in the 10th MP assessed, "leadership" scored the highest (2 points) among the other criteria. As shown in Table 3.3, the criteria which received indirect contributions from the 10th MP are as follows:

- Availability of scientific knowledge
- Regulatory & Institutional arrangement
- Financial resources
- Resilience of infrastructure
- Continuous improvement

Table 3.3
Scoring of the Measures in the 10th Malaysia Plan

Criteria / Indicator	No. of Relevant Measures	Score
Criteria 1: Information & Knowledge		
1.1 Availability of scientific knowledge	1	1
1.2 Access to scientific knowledge	-	0
Criteria 2: Institutions & Governance		
2.1 Regulatory & Institutional arrangement	6	1
2.2 Coordination & collaboration	-	0
Criteria 3: Human Capital		
3.1 Leadership	1	2
3.2 Availability of technical expertise	-	1
Criteria 4: Economic Resources		
4.1 Financial resources	3	1
4.2 Risk spreading mechanism	-	0
Criteria 5: Technology & Infrastructure		
5.1 Technology for adaptation	-	0
5.2 Resilience of infrastructure	2	1
Criteria 6: Adaptability		
6.1 Flexibility	-	0
6.2 Continuous improvement	1	1

The radar chart for the scoring of the measures in the 10th MP is as follows:



Indicators:
1.1 Availability of scientific knowledge
1.2 Access to scientific knowledge
2.1 Regulatory & institutional arrangement
2.2 Coordination & collaboration
3.1 Leadership
3.2 Availability of technical expertise
4.1 Financial resources
4.2 Risk spreading mechanism
5.1 Technology for adaptation
5.2 Resilience of infrastructure
6.1 Flexibility
6.2 Continuous improvement

Figure 3.5 Scoring of the measures in the 10th MP

The 10th MP provides financial resources that could be used for considering and implementing adaptation in a changing climate. The plan also comes with economic and financial instruments such as tariff-setting mechanism that allows full recovery of costs, requirement of a detailed 30-year business plans and 3-year operational plans by water operators and implementation of an integrated tariff for both water and sewerage services which are crucial in boosting the adaptive capacity of the water supply and wastewater services in the country.

3.4 Selangor State Structure Plan

Selangor State Structure Plan 2020 is a planning document that steers and oversees physical development in the Selangor State until 2020. It is the first structure plan for the state that covers the whole state in its planning areas. The Plan 2020 was developed to incorporate the principles of sustainable development (Town and Country Planning Department of Selangor, 2005). The goal of the Selangor State Structure Plan is to ensure physical development that supports the vision of a holistically developed state, sustainable development and the formation of a prosperous society ensuring the national strategic policies in the National Physical Plan (NPP) are translated and implemented at the state level. The preparation of the Selangor State Structure Plan was in accordance to the Town and Country Plan Act 1976 (Act 172). It is required as part of the Development Planning System in Peninsular Malaysia that covers four levels: (i) National Physical Plan; (ii) State Structure Plan; (iii) Local Plan; and (iv) Special Region Plan.

Provisions on Adaptive Capacity

The Selangor State Structure Plan endeavours to ensure sustainable utilisation of existing economic and natural resources base according to current needs and to conserve environmentally sensitive areas that have been identified and to improve environmental quality. Without the Selangor State Structure Plan, physical development in the state will not be coordinated with other states as per direction in the NPP and results in unhealthy competition.

Its economic development objectives endeavours to diversify economic activities, use available and natural economic resource sustainably, and introduce new innovative and sustainable economic base, as well as to support economic and trade development in an environmental-friendly and continuous manner. The social development objective will improve the living quality of the society and development that is in harmony with the environment. The objectives of physical and environmental development are four folds. These include ensuring sustainable use of natural resources based on current needs, conserving Environmentally Sensitive Areas that have been identified and improving environmental quality, and improving the efficiency and sufficiency in the provision of connecting facilities, infrastructure and utilities.

To achieve the above objectives, it recommended 34 policies which consist of nine (9) policies for economic development, 19 policies for physical and environmental development and six (6) policies for social development. This study focuses on the first two sets of the policies.

Facilitation of Adaptive Capacity

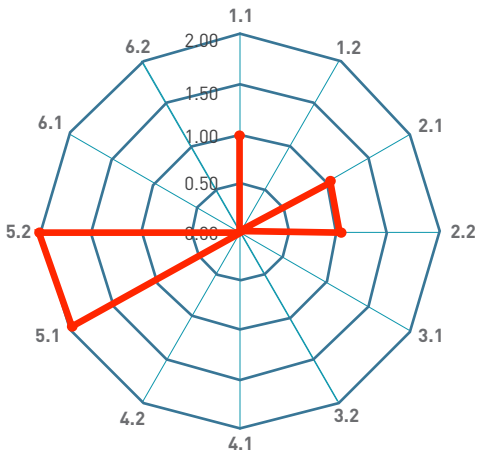
From the content analysis assessment that focused on the policies, the proposed policy measures that were found to be relevant in the adaptive capacity assessment framework are summarised in Table 6.4 (Appendix 1).

The Selangor State Structure Plan contains measures that will be beneficial to the adaptive capacity of the water institutions mostly in several indicators. These include regulatory and institutional arrangement, technology for technology, and resilience of infrastructure. As shown in Table 3.4, there are 16, 10 and 4 proposed policy measures that are found relevant and have positive effects on the three indicators, respectively.

Table 3.4
Scoring of the Proposed Policy Measures in Selangor State Structure Plan 2020

Criteria / Indicator	No. of Relevant Policy Measures	Score
Criteria 1: Information & Knowledge		
1.1 Availability of scientific knowledge	2	1
1.2 Access to scientific knowledge	-	0
Criteria 2: Institutions & Governance		
2.1 Regulatory & Institutional arrangement	16	1
2.2 Coordination & collaboration	3	1
Criteria 3: Human Capital		
3.1 Leadership	-	0
3.2 Availability of technical expertise	-	0
Criteria 4: Economic Resources		
4.1 Financial resources	-	0
4.2 Risk spreading mechanism	-	0
Criteria 5: Technology & Infrastructure		
5.1 Technology for adaptation	10	2
5.2 Resilience of infrastructure	4	2
Criteria 6: Adaptability		
6.1 Flexibility	-	0
6.2 Continuous improvement	-	0

The scoring of the proposed policy measures in Selangor State Structure Plan is illustrated in the form of radar chart in Figure 3.6.



Indicators:
1.1 Availability of scientific knowledge
1.2 Access to scientific knowledge
2.1 Regulatory & institutional arrangement
2.2 Coordination & collaboration
3.1 Leadership
3.2 Availability of technical expertise
4.1 Financial resources
4.2 Risk spreading mechanism
5.1 Technology for adaptation
5.2 Resilience of infrastructure
6.1 Flexibility
6.2 Continuous improvement

Figure 3.6 Scoring of the proposed policy measures in Selangor State Structure Plan

The Selangor State Structure Plan proposes to undertake feasibility studies of using groundwater as alternative water resource (FZ51 C4) and utilisation of surface runoff as a water resource to appropriate activities (FZ51 C5). These studies, when undertaken, will allow scientific inputs and knowledge to be considered in problem evaluation and decision making. The Hybrid off River Augmentation System (HORAS), an initiative by the Selangor Water Management Board (LUAS), is a result of the feasibility studies that has proven to be a success when water is sufficiently supplied during the dry season.

There are a number of proposed measures in the Structure Plan that are expected to contribute constructively to the current regulatory and institutional arrangement for managing water resources. Among all, the IRBM and IWRM approaches to be advocated could facilitate recognition of the need for adaptation to a changing climate and institutionalisation of adaptation in the mandate and decision-making processes.

3.5 Sungai Selangor River Basin Management Plan

Sungai Selangor is one of the most important rivers in the state as it is the main source of water for Selangor and Kuala Lumpur. In order to safeguard the resources while address the environmental pressures from different activities and rapid economic development in the basin, the state government recognised the need to handle the issues in an integrated manner (DID, 2007). It is in that context that the Sungai Selangor River Basin Management Plan (2007-2012) was published by the Department of Irrigation and Drainage (DID) in 2007. The outstanding tasks of the Sungai Selangor River Basin Management Plan were reassigned to the LUAS Strategic Plan (2012-2016) (Pelan Strategik Lembaga Urus Air Selangor, 2012-2016), which sets out the 5-year implementation plan for LUAS. The agency recognises the need for management of change, which may be driven by internal and external factors. The objectives of the Plan are (1) sustainability of water resources quality and quantity, (2) empowerment of implementation of function, (3) efficiency of delivery system, and (4) collaboration with stakeholder. The Plan contains several activities pertaining to Sungai Selangor River Basin. Under Objective 1, LUAS will monitor and enforce pollution prevention and conduct study for access of additional water resources in the basin. Under Objective 2, it will establish a monitoring station on the quality and quantity of water in the basin. Under Objective 4, LUAS will complete the implementation of IRBM plan for Sungai Selangor basin.

Provisions on Adaptive Capacity

The Plan took stock of the current conditions and analysed the factors that may affect the available water resources. There were four key issues being highlighted (DID, 2007):

1. The surface water resources in the basin are intensively utilised and the scope for further exploitation is very limited. Demand continues to grow and there is a need to protect existing resources and optimise their utilisation.

2. The water quality at the major intakes is Class II most of the time, but it is under pressure from a number of pollution sources.

3. Although flood is not a major issue in the basin, there are local problems and development activities that need to consider the flood risk, especially in the flood-prone areas.

4. The fireflies at the lower stretch of the river are important for tourism and the local economy and they have become a symbol for the river. Conservation of the fireflies needs to be ensured.

The Sungai Selangor River Basin Management Plan documents four policies that are elaborated in 19 strategies. Each strategy contains one to several measures that should be implemented by responsible agencies in short- to long-terms. The measures will be reviewed against the indicators identified. The policies and strategies are summarised in Table 3.5.

Table 3.5
Policies and strategies in the Sungai Selangor River Basin Management Plan
(Source: DID, 2007)

Policy	Strategy
Ensure sufficient water	1. Increased emphasis on demand management 2. Increased use of groundwater resources 3. Better use of surface water 4. Restoration of wetlands (especially peat swamp) 5. Exploration for additional resources
Ensure clean water	6. Reduce pollution from industrial wastewater 7. Upgrade sewerage system and sewage treatment 8. Reduce pollution from other urban sources 9. Reduce pollution from aquaculture 10. Reduce pollution from animal husbandry 11. Reduce sedimentation and suspended solids 12. Reduce pollution from landfills 13. Strengthen protection of reservoirs
Protect against floods	14. Improve storm water management 15. Improve river corridor management 16. Carry out river works at problem sites
Conserve the fireflies	17. Establish firefly park 18. Improve conditions for firefly tourism 19. Continue monitoring and research related to the fireflies

Facilitation of Adaptive Capacity

The measures that are considered relevant to this study are those categorised in the first policy to Ensure Sufficient Water and the relevant measures are listed in Table 6.5 (Appendix 1).

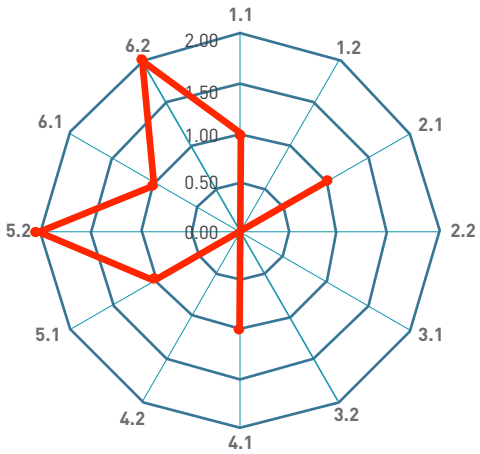
As observed in Table 3.6, the criteria on "Resilience of Infrastructure" and "Continuous Improvement" scored 2 points through the measures within the Sungai Selangor Basin Management Plan, while the indicators below received 1 point each for having an indirect contribution from the management plan:

- Availability of scientific knowledge
- Regulatory & Institutional arrangement
- Financial resources
- Technology for adaptation
- Flexibility

Table 3.6
Scoring of the Measures in Sungai Selangor Basin Management Plan

Criteria / Indicator	No. of Relevant Policy Measures	Score
Criteria 1: Information & Knowledge		
1.1 Availability of scientific knowledge	1	1
1.2 Access to scientific knowledge	-	0
Criteria 2: Institutions & Governance		
2.1 Regulatory & Institutional arrangement	3	1
2.2 Coordination & collaboration	-	0
Criteria 3: Human Capital		
3.1 Leadership	-	0
3.2 Availability of technical expertise	-	0
Criteria 4: Economic Resources		
4.1 Financial resources	2	1
4.2 Risk spreading mechanism	-	0
Criteria 5: Technology & Infrastructure		
5.1 Technology for adaptation	5	1
5.2 Resilience of infrastructure	4	2
Criteria 6: Adaptability		
6.1 Flexibility	2	1
6.2 Continuous improvement	1	2

The radar chart depicting the scoring of the proposed policy measures in Selangor State Structure Plan is shown in Figure 3.7.



Indicators:
1.1 Availability of scientific knowledge
1.2 Access to scientific knowledge
2.1 Regulatory & institutional arrangement
2.2 Coordination & collaboration
3.1 Leadership
3.2 Availability of technical expertise
4.1 Financial resources
4.2 Risk spreading mechanism
5.1 Technology for adaptation
5.2 Resilience of infrastructure
6.1 Flexibility
6.2 Continuous improvement

Figure 3.7 Scoring of the proposed policy measures in Sungai Selangor River Basin Management Plan

The direct contribution to "Resilience of Infrastructure" comes from the management plan's advocacy on alternative resources and management solutions that are found to be constructive in complementing the role of technological solutions for climate change adaptation. These measures are as follows:

Measure 2.1: Investigate groundwater resources within the basin

Measure 2.2: Plan the utilisation and conservation of groundwater resources

Measure 2.3: Monitor groundwater resources

Measure 3.4: Examine options for improved irrigation

Measure 5.1: Explore additional resources in the state

3.6 Adaptive Capacity Index of Water-related Policies

This section provides an overview of how six policies and plans that relate to water resources management for Sungai Selangor Basin influence the adaptive capacity of the water management institutions. The exercise focused on adaptation attributes that contribute most to institutional adaptive capacity. The sub-indices of the criteria and Adaptive Capacity Index calculated for each document are shown for each policy in Table 3.7, Table 3.8, Table 3.9, Table 3.10 and Table 3.11, and are summarised in Table 3.12 and depicted in Figure 3.8.

Table 3.7
Adaptive capacity index as a result of the Key Actions in the National Policy on Climate Change

Criteria	Sub-Index	Normalised Sub-Index	Adaptive Capacity Index
Criteria 1: Information & Knowledge	1.0	0.08	0.40
Criteria 2: Institutions & Governance	1.0	0.08	
Criteria 3: Human Capital	1.0	0.08	
Criteria 4: Economic Resources	1.0	0.08	
Criteria 5: Technology & Infrastructure	0.5	0.04	
Criteria 6: Adaptability	0.5	0.04	

Table 3.8
Adaptive capacity index as a result of the Strategic Action Plans in the NWRP

Criteria	Sub-Index	Normalised Sub-Index	Adaptive Capacity Index
Criteria 1: Information & Knowledge	1.5	0.13	0.77
Criteria 2: Institutions & Governance	2.0	0.17	
Criteria 3: Human Capital	1.5	0.13	
Criteria 4: Economic Resources	1.0	0.08	
Criteria 5: Technology & Infrastructure	1.5	0.13	
Criteria 6: Adaptability	1.5	0.13	

Table 3.9
Adaptive capacity index as a result of the measures in the 10th MP

Criteria	Sub-Index	Normalised Sub-Index	Adaptive Capacity Index
Criteria 1: Information & Knowledge	0.5	0.04	0.28
Criteria 2: Institutions & Governance	0.5	0.04	
Criteria 3: Human Capital	1.0	0.08	
Criteria 4: Economic Resources	0.5	0.04	
Criteria 5: Technology & Infrastructure	0.5	0.04	
Criteria 6: Adaptability	0.5	0.04	

Table 3.10
Adaptive capacity index as a result of the proposed policy measures in Selangor State Structure Plan

Criteria	Sub-Index	Normalised Sub-Index	Adaptive Capacity Index
Criteria 1: Information & Knowledge	0.5	0.04	0.29
Criteria 2: Institutions & Governance	1.0	0.08	
Criteria 3: Human Capital	0	0	
Criteria 4: Economic Resources	0	0	
Criteria 5: Technology & Infrastructure	2.0	0.17	
Criteria 6: Adaptability	0	0	

Table 3.11
Adaptive capacity index as a result of the proposed policy measures in Sungai Selangor River Basin Management Plan 2007-2012

Criteria	Sub-Index	Normalised Sub-Index	Adaptive Capacity Index
Criteria 1: Information & Knowledge	0.5	0.04	0.38
Criteria 2: Institutions & Governance	0.5	0.04	
Criteria 3: Human Capital	0	0	
Criteria 4: Economic Resources	0.5	0.04	
Criteria 5: Technology & Infrastructure	1.5	0.13	
Criteria 6: Adaptability	1.5	0.13	

Table 3.12
Adaptive Capacity Index of the policies and planning documents

Policy / Plan	Sub-Index						Adaptive Capacity Index
	Criteria 1: Information & Knowledge	Criteria 2: Institutions & Governance	Criteria 3: Human Capital	Criteria 4: Economic Resources	Criteria 5: Technology & Infrastructure	Criteria 6: Adaptability	
National Policy on Climate Change	0.08	0.08	0.08	0.08	0.04	0.04	**0.40**
National Water Resources Policy	0.13	0.17	0.13	0.08	0.13	0.13	**0.77**
10th Malaysia Plan	0.04	0.04	0.08	0.04	0.04	0.04	**0.28**
Selangor State Structure Plan	0.04	0.08	0	0	0.17	0	**0.29**
Sungai Selangor Basin Management Plan	0.04	0.04	0	0.04	0.13	0.13	**0.38**

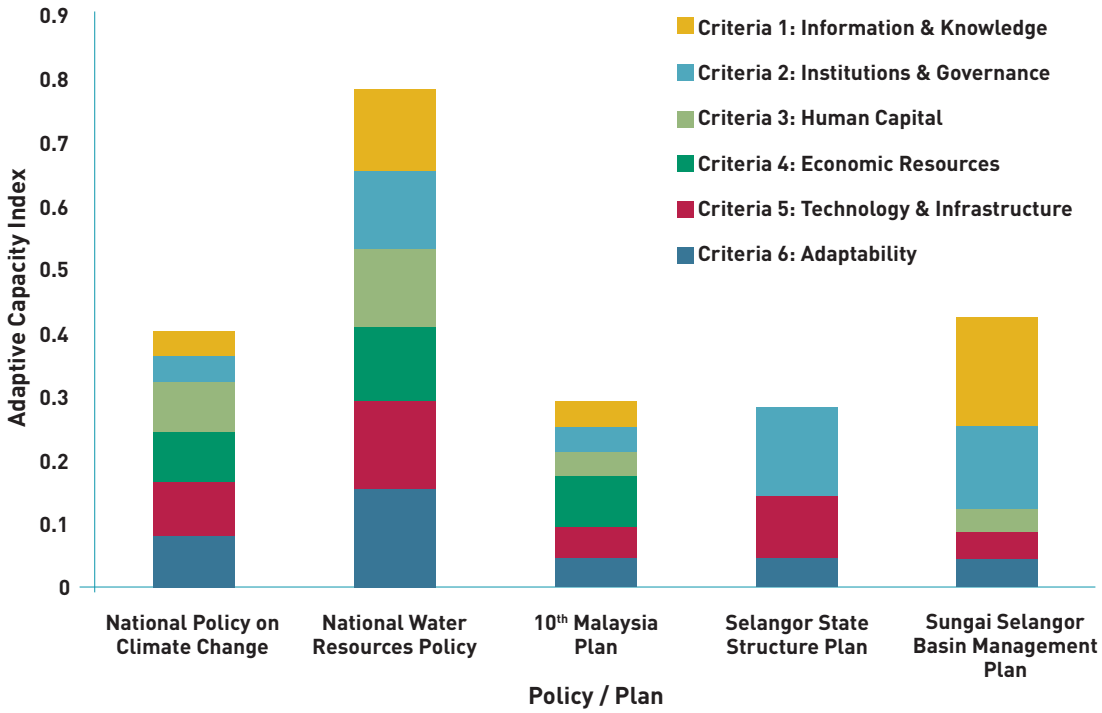


Figure 3.8 Adaptive Capacity Index of the policies and planning documents

Of the five policies and plans assessed, the NWRP scores the highest index (0.77), followed by the National Policy on Climate Change (0.40) and Sungai Selangor Basin Management Plan (0.38).

There are two main reasons that results in the highest index from the NWRP. Firstly, the Policy addresses the issue that is directly and most pertinent to the subject matter of this study, i.e. ensuring availability of water resources. Secondly, and equally important, the formulation of the Policy was very recent (i.e. in year 2011) and was able to capture the need to manage the climate change factors that is still quite a new issue in the country. The Policy is considered comprehensive from the perspective of the assessment framework in this study, as clearly shown from the level of sub-indices that are generally balance between the criteria.

Among all, the Information and Knowledge criteria and the Institutions and Governance criteria show higher sub-indices because these two factors are the main concerns of the Policy (NRE, 2011). The NWRP will steer the development of comprehensive information on water resources, which includes aspects such as sources, location, scale, size, state, hydrological condition, threats, risks as well as impacts, both existing and emerging. It is critical for the Policy to boost water intelligence and secure what the country has by strengthening the knowledge base and science of water resources, taking into account all types and sources of knowledge and scientific pursuits (science, social sciences and humanities), including traditional and local understanding as well as practices. This will help both the federal and state governments to better safeguard the water resources within their respective jurisdiction.

Both the National Policy on Climate Change and Sungai Selangor Basin Management Plan score higher than the other two documents but relatively much lower than the NWRP. The Policy and the Management Plan mainly cover one of the two key issues being focused in this study. The National Policy on Climate Change is, by its name, looking the implication of climate change in all relevant aspects, mainly at the national level. Although the water sector is a key concern, most Key Actions in the Policy address general needs that may indirectly contribute to institutional capacity. Sungai Selangor Basin Management Plan is a specific document focusing on the case of this study, thus it is directly addressing the specific need of the basin. However, the measures outlined in the Management Plan have very limited coverage of aspects related to the risks of climate change. The LUAS Strategic Plan (2012-2016), which is essentially an extension of the Sungai Selangor Basin Management Plan, has also limited adaptive capacity attributes.

Both the Selangor State Structure Plan and the 10th MP show the lowest Adaptive Capacity Index, i.e. 0.29 and 0.28 respectively. The former document addresses water resources and supply issues in general, while the latter mainly considers water aspects generally within the environmental management context. The Plans do not have any provision that is directly dealing with the concerns of institutional capacity in a changing climate. The 10th MP shows equally balanced sub-indices of all criteria with higher scores on the Institutions and Governance and Leadership factors aspect due to its focus to expand the implementation of the IWRM and IRBM approaches in planning, managing, protecting and rehabilitating water resources. Such approaches are recognised to facilitate successful adaptation responses (Arnell *et al.*, 2001). They can also provide guidance to decision makers in designing institutional arrangements and governance measures in preparing for and responding to climate change (Engle & Lemos, 2010).

The Selangor State Structure Plan shows relatively greater focus on Technology and Infrastructure factors. There are many proposed policy measures that consider soft approaches and management solutions. These include conserving water catchment forest from activities that may affect its ecosystems, identifying and reserving sources of water supply and catchment areas, and controlling polluting sources that may degrade water bodies through appropriate structural and non-structural measures. Such measures will have positive influence on adapting to the stresses of climate change. An understanding of the current levels of the adaptive capacity serves as a basis for its improvement, which may ultimately contribute to improved adaptive management of the water resources (Pandey *et al.*, 2011).

4.0 WAY FORWARD

There is widespread belief that climate change is a gradual process and that actions can be taken progressively as part of a long-term strategy. The reality is that the impacts of climate change are already happening and adaptation measures are needed to cope with negative effects. Findings of the Intergovernmental on Climate Change Fifth Assessment Report (IPCC-AR5) reveal that water scarcity is expected to be a major challenge for tropical Asia due to increased water demand and lack of good management. In addition, future rainfall projections at a sub-regional scale are of low confidence in most parts of Asia, making forecasts of future freshwater availability unreliable. As water availability and quality are increasingly stressed in a changing climate, the ability of institutions dealing with water resources (water institutions) to absorb these stresses and cope with new realities and potential future surprises becomes critical. By enhancing the adaptive capacity of water related institutions, they will be more capable to moderate potential damages, take advantage of opportunities and cope with the consequences. The enhancement of adaptive capacity of water related institutions in Malaysia is a "no regret option" that lowers the costs of adaptation.

Strategies at the national level can be implemented more effectively when supported by facilitative plans at the state and local levels. With respect to the water sector, national policies that facilitate adaptive capacity of critical water institutions should be supported by state and basin level plans to be more effective. The results of the assessment of policy documents indicate that the NWRP is inadequately supported by the Sungai Selangor Basin Management Plan in facilitating the adaptive capacity of water institutions within the basin. It is urgent and important that the Sungai Selangor Basin Management Plan and the LUAS Strategic Plan (2012-2016), be reviewed to facilitate water institutions therein to be better able to adapt to climate extremes and change. This is particularly relevant as the basin supplies water to over four million people and industries in the Klang Valley.

Future work should be considered on evaluating the state of the enabling environment for IWRM and IRBM by assessing relevant documents to get an insight on their adaptive capacity attributes. This could be done using the robust tool developed in this study, which encompasses six criteria and 12 indicators, for assessing the adaptive capacity of legislation, policies and plans related to the water sector in Malaysia. All major basin management plans in the country should be assessed and revised where necessary to be more facilitative in enhancing the adaptive capacity of water institutions. An immediate priority would be to assess the current Malaysia Plans and enhance its adaptive capacity attributes. The recommendations below may be considered to achieve a higher level of adaptive capacity of water institutions.

Information & Knowledge: There is a need to emphasise the importance of collecting and sharing of scientific and technical data among stakeholders. The data must be made available and accessible through an integrated information management system. The use of open crowdsourced information should be explored on a pilot basis and mainstreamed if found to be effective. The provision of appropriate scientific and technical data at the basin level will enable water institutions to efficiently evaluate problems and make effective decisions.

Institutions & Governance: Collaboration and cooperation between federal and state government is critical in raising the adaptive capacity. In addition, collaboration between the government, the private sector, universities and the community is the way forward. Encouraging participatory management by empowering the local community in organisational decision making may also be an effective strategy. Current legal framework and regulatory processes are designed to function under fairly static and predictable conditions and may often be inappropriate to a changing climate, challenging the capacity of institution to adapt to such situation. In the implementation of NWRP, development of relevant legal instruments may facilitate agencies to engage in more extensive adaptation planning and action as well as provide sufficient rules and incentives for different stakeholders in the regulation of water use that ensure compliance.

Human Capital: Capacity building has to be intensified at all levels to achieve "operational excellence" to facilitate better preparedness and assessment of options for adapting to emerging threats including climate change. The capacity of water resource managers has to be enhanced to take cognizance of all types and sources of knowledge and scientific pursuits (science, social sciences and humanities), including traditional and local understanding as well as practices relevant to the sector at the basin level.

Economic Resources: By strengthening the financial resources, policy measures and financial incentives that are beneficial for climate change adaptation can be made possible. Support from the government for water operators to explore alternative financing options and models to improve business sustainability will also be crucial in enabling the development of climate change resilient infrastructures.

Technology & Infrastructure: Software development specifically for localised climate modelling may provide more reliable and accurate predictions compared to software developed internationally. There is also a need to review the country's hydrological data using the latest data acquisition technologies. New multi-disciplinary approaches should also be encouraged to identify effective and socially relevant technology and infrastructure solutions. Promotion of soft approaches and management solutions such as conserving water catchment forests and ecosystems, identifying and reserving sources of water supply and catchment areas, and controlling polluting sources have positive influence on adapting to the stresses of climate change.

Institutional Adaptability: The federal and state institutions may include prioritisation of resources and usage of alternative source during extreme climates in their policy, enactment and guidelines. This will improve flexibility in responding to sudden climate change. Institutions will also have to review their performances regularly to identify gaps and make room for continuous improvement. The IWRM and IRBM approaches in planning, managing, protecting and rehabilitating water resources should be enhanced as they facilitate successful adaptation responses and provide guidance to decision makers in designing institutional arrangements and governance measures in preparing for and responding to climate change.

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6.0 APPENDIX

Appendix 1 Assessment matrix of the Key Actions in each policy that is relevant in the adaptive capacity assessment framework

Table 6.1 National Policy on Climate Change

Key Actions in National Policy on Climate Change	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
KA2-ST1: Incorporate climate change as a priority area in the National Development Planning Council					x							
KA3-ST1: Establish an inter-ministerial and cross-sectoral committee to enable the implementation of climate change measures					x							
KA5-ST2: Incorporate and facilitate implementation of climate-friendly measures and technologies by strengthening laws and regulations and enforcement; human resource development; finance and incentives; research and development; transfer of technology; and outreach to relevant stakeholders									x			
KA6-ST2: Allocate adequate financing and appropriate technological measures for promoting low carbon economy through market mechanisms, financial and fiscal incentives and disincentives, mobilising public-private partnerships, and involvement of financial and insurance sectors							x					
KA8-ST2: Establish criteria and indices for environmentally sustainable socio-economic growth			x									
KA9-ST3: Strengthen investment evaluation mechanisms to capitalise and ensure a climate-resilient industry in achieving sustainable development							x	x				
KA13-ST4: Incorporate measures, including mobilise financing and technical assistance, into the key areas									x			
KA14-ST4: Develop and implement plans for public-private, NGOs and communities' collaboration on climate change				x								
KA18-ST4: Develop multiple national climate and hydroclimate projection models for identifying vulnerabilities and assessing potential impacts of climate change	x											

Key Actions in National Policy on Climate Change	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
KA24-ST6: Stocktaking of current measures, taking into account initiatives already implemented by stakeholders, and undertake economic evaluation for incorporation into future Malaysia Plans												x
KA26-ST6: Integrate climate change considerations at the planning level by applying tools that include Integrated Environmentally Sensitive Areas, Strategic Environmental Assessment; Economic Evaluation of Ecological Services; and Sustainable Development Indicators						x						
KA27-ST6: Enhance the coordinating mechanism to oversee the planning, implementation and monitoring of climate change measures												x
KA28-ST7: Establish and implement a national R&D agenda on climate change taking into account the following areas: agriculture and food security; water security and services; forestry and ecosystem services; sustainable bio-energies; public health services and delivery; localised modelling for projection of future scenarios; innovative socio-economic and financing mechanisms; vulnerability due to extreme weather events and natural disasters; and policy analysis harmonising national and international issues									x			
KA29-ST7: Strengthen national data repository through periodic national inventory	x											
KA30-ST7: Institutionalise the following stage-based climate-friendly technology transfer programme to nurture self-innovativeness and R&D sustainability in local firms and institutions									x			
KA31-ST7: Promote pragmatic cooperation programmes through effective mechanisms and tools for technology cooperation in specific sectors; collaborative R&D to access knowledge and technologies; support for endogenous development and diffusion of technology; and regional cooperation on technology development									x			
KA34-ST8: Establish and institutionalise effective and efficient communication and consultation mechanisms among all stakeholders				x								

Key Actions in National Policy on Climate Change	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
KA37-ST8: Strengthen collaborative networks and capacity of agencies at the federal, state and local government				x								
KA38-ST9: Adopt systematic and targeted formal and informal education and awareness raising on climate change through the involvement of various stakeholders including NGOs, CBOs and the media, enhance cooperation between government and private sectors including corporate responsibility, and targeting special groups						x						
KA40-ST10: Establish a register and expand the pool of climate change experts		x										

Table 6.2 National Water Resources Policy

Strategic Action Plans in National Water Resources Policy	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
PTS1: Identify existing scientific and technical data available related to water, water resources, use and users	x	x										
PTS2: Identify repositories and repository holders	x	x										
PTS3: Identify and adopt methods and processes for continuous analysis and synthesis of scientific and technical data	x	x										
PTS4: Review existing database framework, identify gaps, and revise scope and coverage	x	x										
PTS5: Review existing evaluation, analysis and review methods	x		x									
PTS6: Establish processes for information provisioning, collecting, cataloguing and management	x	x										
PTS7: Develop a profile of stakeholders and existing information database		x		x								
PTS8: Provide mechanisms for sharing of information and access between stakeholders		x		x								
PTS9: Review existing and develop new criteria for water resources state, status and condition evaluation and analysis			x		x							
PTS10: Profile methods and measures used to determine threshold and yield			x		x							
PTS11: Develop system to consolidate information to establish national standards and parameters for setting threshold and yield levels for different water resources types and water bodies			x		x							
PTS12: Review, revise and reconcile current standards for determining integrity and health of water resources			x			x						
PTS13: Identify existing and emerging threats to and from water resources as well as water bodies	x	x			x							
PTS14: Identify options and measures to reduce, mitigate and remove stress, threats, impacts and risks including transboundary risks, threats, impacts and hazard events								x				
PTS15: Determine measures to aid adaptation of water resources to threats and emerging threats e.g. climate change and disasters			x			x		x				

Strategic Action Plans in National Water Resources Policy	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
PTS16: Identify and develop water resources conservation plans for high risk areas			x					x				
PTS17: Identify options for ensuring resiliency of water resources from stress, threats, impacts, hazard and disaster events												
PTS18: Profile characteristics and nature of stress, risks, threats and hazards	x											
PTS19: Identify water resources conservation options, targets and action plans			x									
PTS20: Identify levels and classifications of sensitivity and delineate sensitive areas and zones	x											
PTS21: Identify key catchment areas and zoning options			x									
PTS22: Profile measures to aid adaptability											x	
PTS23: Develop water resources sensitivity database and maps	x											
PTS24: Incorporate data related to sensitivity in physical and national development planning processes, including the evaluation, review and assessment of development programmes and projects			x							x		
PTS25: Identify alternative or conjunctive water resources options and suitability of use												
PTS26: Review, enhance or develop plans and procedures to address stressed water resources in times of threats or crisis	x							x			x	
PTS27: Identify potential disaster events	x							x				
PTS28: Identify areas and scale of potential impacts and risks								x				
PTS29: Develop risk assessment procedures			x					x				
PTS30: Identify alternative water resources to supplant affected water resources									x			
PTS31: Develop uniform use of terms to characterise water resources			x		x							

Strategic Action Plans in National Water Resources Policy	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
PTS32: Review, profile and reconcile various water resources related standards			x		x							
PTS33: Identify key users and uses				x								
PTS34: Identify key water resources use areas	x							x				
PTS35: Develop allocation and management plan for water resources based on demand priority and resource availability			x		x				x			
PTS36: Develop protection plans for the conservation of water resources, catchments and bodies to sustain the water resources, including rehabilitation and improvement covering the ecological, physical systems and aesthetical aspects									x			
PTS37: Develop water resources contiguity or conjunctive plan			x			x						
PTS38: Establish mechanisms to safeguard the hydrological and hydrogeological functions connecting surface and groundwater								x	x			
PTS39: Identify best practices in the valuation of water resources including water resources pricing and cost recovery (such as payment for ecosystems services)							x	x				
PTS40: Determine options for economic valuation of water resources amongst others according to types, location and condition							x	x				
PTS41: Recommend fiscal and financial incentives							x	x				
PTS42: Establish methods for cost determination and recovery							x	x				
PTS43: Prioritise uses based on classification according to needs and capacity through formulation of time-bound prioritisation plans			x									
PTS44: Identification and isolation of water resources stress factors, including determination of effect of single and multiple use								x				

Strategic Action Plans in National Water Resources Policy	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
PTS45: Identify and develop measures to address threats from contamination and pollution by controlling pollution at source, non-point sources as well as transboundary pollution			x									
PTS46: Optimise abstraction rate without compromising sustainability of water resources									x			
PTS47: Integrate qualitative and quantitative aspects related to surface and groundwater taking into account the natural flow conditions or water within the hydrological cycle to ensure that abstraction rates do not exceed groundwater recharge rates									x			
PTS48: Identify options to incorporate water demand management in existing regulatory and administrative arrangements			x									
PTS49: Identify and profile stakeholders				x								
PTS50: Identify common objectives, goals and targets for local water resources use and conservation				x								
PTS51: Identify and profile roles and responsibilities and options for shared responsibilities and collaboration				x								
PTS52: Identify channels of formal and informal communication networks				x								
PTS53: Identify options to strengthen collaborations, consultations and stakeholder engagement platforms				x								
PTS54: Develop consultation processes in local water plan development for integrated and concerted actions related to sustainable use and conservation of water resources				x								
PTS55: Identify processes and procedures that can be integrated to ensure shared governance of water resources			x	x								
PTS56: Identify options for the formation of formal and informal, shared and collaborative partnership platforms				x								
PTS57: Identify channels of formal and informal communication networks				x								

Strategic Action Plans in National Water Resources Policy	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
PTS58: Review and reconcile the prerequisites in adopted and accepted approaches for water resources conservation and management such as IWRM, IRBM, IFM, ILM etc.			x									
PTS59: Identify and implement on pilot basis joint projects that promote accepted approaches for water resources management such as IWRM and IRBM			x									
PTS60: Strengthen programmes on awareness and the need for shared responsibility				x								
PTS61: Identify platforms for resolution of conflicts and competing interests				x								
PTS62: Identify capacity building needs suited to type, scale and demand					x							
PTS63: Invest in research and development programmes									x			x
PTS64: Formulate training programmes with institutions of higher learning, training institutes and NGOs												x
PTS65: Formulate education, training and research programmes with local institutions of higher learning, training institutes and NGOs; and PTS66: Provide funding and research grants					x							
PTS67: Identify platforms for effective engagement of the media and stakeholders				x								
PTS68: Formulate programmes or activities to suit particular target groups or situations or needs				x								
PTS69: Create recognition programmes for individuals and entities that help promote water resources security and sustainability				x								

Table 6.3 10th Malaysia Plan

Measures in the 10th MP	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
Formulation of the NWRP to chart the future course for the sector by establishing a process for ensuring the security of water supply in an era of rapid economic development, growing cities and population growth, all of which have important implications on how Malaysia manages its water resources in the coming years			x		x							
Expanding the implementation of the Integrated Water Resources Management and Integrated River Basin Management approaches in planning, managing, protecting and rehabilitating water resources			x									
Research and development efforts will be intensified in area of conservation of water resources to support efforts to develop a sustainable water sector for the national economy	x											
Moving towards full cost recovery: Tariffs in 2009 covered only 78% of operating expenditure. To address this problem, the government will phase in a tariff-setting mechanism that allows full recovery of costs to encourage sustained investments in upgrading and rehabilitating water treatment plants and distribution systems. The phasing of the tariff increases will be segregated into tariff bands based on consumption levels to ensure that the vulnerable segments of society are protected							x					
Driving efficiency in operations and capital expansion: Water operators will be required to provide detailed 30-year business plans and 3-year operational plans. These plans will be the basis for a roadmap towards full cost recovery and will allow Pengurusan Aset Air Berhad to plan long term capital expenditure funding. SPAN will regulate and monitor the performance of water operators based on the plans, linking tariff increases to efficiency gains in operations and capital expenditure							x					x
Improving water services infrastructure: The national water supply coverage will increase from 93% of population in 2009 to 97% in 2015. The non-revenue water programme, involving replacement of pipes and old meters, will be expanded with an allocation RM1.1 billion to improve the quality of water and reduce losses in water supply										x		

Measures in the 10th MP	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
Integrating water and sewerage services: Restructuring of sewerage services will be implemented by parcelling out the operations of centralised sewerage services to the respective state water operating companies. When completed, the industry will move towards implementing an integrated tariff for both water and sewerage services. This will link sewerage charges to water consumption, moving away from flat rate tariffs that do not adequately capture the cost of service provision given the inherent link between water consumption and sewerage production profiles			x				x					
Strengthening the enforcement on industrial effluents and sewage discharge in line with the revisions to the regulations under the Environmental Quality Act 1974			x									
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			x									
Revising the current Water Quality Index to incorporate additional parameters, such as biological parameters, for more accurate river water classification			x									

Table 6.4 Policy Measures in Selangor State Structure Plan 2020

Proposed Policy Measures in Selangor State Structure Plan 2020	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
FZ1 C2: Gazette all areas of interest to the state and country such as water catchment forests and biological diversity areas			x									
FZ1 C3: Ensure transportation facilities, infrastructure and utilities are sustainably developed during preparation, operation and maintenance										x		
FZ1 C5: Implement sustainable development approaches to minimise utilisation of natural resources (renewable and non-renewable) such as recycling of water and use of rainwater			x									
FZ5 C1: Gazette and conserve Environmentally Sensitive Areas that have been identified, including natural forest reserve, research forest, and others			x									
FZ5 C2: Conserve water catchment forest from activities that may affect its ecosystems									x			
FZ8 C1: All involved government agencies should have common goal for environmentally integrated planning and management			x									
FZ8 C2: All involved agencies should practise commonly-shared resource concept including information and data that are needed in state planning and development			x									
FZ8 C4: All involved agencies should cooperate to continuously monitor environmental quality			x									
FZ18 C2: Enhance water quantity and quality in accordance to current residential and development needs									x			
FZ23 C7: Enhance monitoring of water, air and noise pollution			x									
FZ39 C4: Regular monitoring of water, air and noise quality by the authority			x									
FZ50 C1: Identify activities with polluting sources to be relocated and imposed with requirements to treat wastewater before discharging to water body			x									
FZ51 C1: Identify and reserve sources of water supply and catchment areas									x			

Proposed Policy Measures in Selangor State Structure Plan 2020	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
FZ51 C2: Control pollution of water bodies in catchment areas that have been identified or reserved			x									
FZ51 C3: Implement raw water transfer project from Kelau Dam in Pahang to Langat Dam water treatment plant (Phase 1) in Selangor before occurrence of drought crisis in Selangor										x		
FZ51 C4: Study feasibility of groundwater as alternative water resource	x											
FZ51 C5: Study feasibility of surface runoff as supporting water resource to appropriate activities	x											
FZ51 C6: Implement restoration projects on polluted rivers in Selangor in an integrated manner with the aim to restore quality of raw water suitable for use as potable water sources										x		
FZ51 C7: Control polluting sources that may degrade water bodies through appropriate structural and non-structural measures									x	x		
FZ51 C9: Integrate water reuse and recycle, and rainwater harvesting concepts, especially in urban areas									x			
FZ52 C1: Maintain and protect water catchment areas from development that is destructive and polluting			x									
FZ52 C2: Harness natural water bodies sustainably in the development process to ensure rivers are not abused and polluted			x									
FZ52 C3: Implement Integrated River Basin Management to ensure water quality and supply is effectively monitored			x						x			
FZ52 C7: Ensure groundwater sources are sustainably utilised and avoid over exploitation			x									
FZ52 C8: Implement Integrated Water Resources Management principles			x						x			
FZ53 C1: Reduce water wastage problem through sustainable technologies such as recycling and dual-flush systems									x			
FZ53 C3: Encourage rainwater harvesting for domestic and industrial purposes									x			
FZ53 C4: Implement management of treated water based on the Integrated Water Resources Management principles			x						x			

Table 6.5 Sungai Selangor River Basin Management Plan

Proposed Policy Measures in Selangor State Structure Plan 2020	Indicators of the adaptive capacity assessment framework											
	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2
Measure 1.1: Reduce physical losses in the distribution system										x		
Measure 1.2: Improve demand estimates		x										
Measure 1.3(a): Encourage water saving-techniques by promoting water conservation in households and large consumers by providing incentives and support			x									
Measure 1.3(b): Encourage water saving-techniques by including water conservation measures as part of EIA approval conditions			x									
Measure 1.4(a): Use economic instruments to reduce demand by raw water charges for all extraction other than irrigation							x					
Measure 1.4(b): Use economic instruments to reduce demand by reviewing water tariffs							x					
Measure 1.5: Increase awareness			x									
Measure 2.1: Investigate groundwater resources within the basin									x			
Measure 2.2: Plan the utilisation and conservation of groundwater resources									x			
Measure 2.3: Monitor groundwater resources									x			
Measure 3.1(a): Optimise utilisation of reservoirs through joint management of reservoirs										x		
Measure 3.1(b): Optimise utilisation of reservoirs by increasing online hydrological and rainfall monitoring in order to optimise use of water resources in the reservoirs										x		
Measure 3.2: Examine the causes of unexpected low water levels in Sungai Selangor dam in 2005												x
Measure 3.3: Allow temporary overload of some treatment plants										x	x	
Measure 3.4: Examine options for improved irrigation									x			
Measure 5.1: Explore additional resources in the state									x		x	

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