JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF IRRIGATION AND DRAINAGE
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
MALAYSIA

THE PREPARATORY SURVEY FOR INTEGRATED RIVER BASIN MANAGEMENT INCORPORATING INTEGRATED FLOOD MANAGEMENT WITH ADAPTATION OF CLIMATE CHANGE

FINAL REPORT

Volume 1. Common Context

JANUARY 2011

CTI ENGINEERING INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD.

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The Currency Exchange Rate as of September 13, 2010 is as follows:

RM 1.00 = JPY 27.08

List of Reports

Summary

Volume 1: Common Contexts

Volume 2: Muar River Basin

Volume 3: Pahang River Basin

VOLUME 1.
COMMON CONTEXTS

Muar and Pahang River Basins

Steering Committee Meetings

Kickoff Meeting
Date : 8th September 2009
Venue : DID Headquarters, Kuala Lumpur

First Steering Committee Meeting
Date : 16th October 2009
Venue : DID Headquarters, Kuala Lumpur

Second Steering Committee Meeting
Date : 5th February 2010
Venue : DID Headquarters, Kuala Lumpur

Third Steering Committee Meeting
Date : 19th May 2010
Venue : DID Headquarters, Kuala Lumpur

Stakeholders Meeting for Muar River Basin

Stakeholders Meeting No.1 for the Muar River Basin
Date : 10th December 2009
Venue : Hotel D99, Muar, Johor

Stakeholders Meeting No.2 for the Muar River Basin
Date : 2nd May 2010
Venue : DID Segamat

Stakeholders Meeting for Muar River Basin

Stakeholders Meeting No.3 for the Muar River Basin
Date : 12th May 2010
Venue : Gemas Golf Resort, Gemas

Stakeholders Meeting No.4 for the Muar River Basin
Date : 25th August 2010
Venue : A'Famosa Resort, Alor Gajah

Stakeholders Meeting for Pahang River Basin

Stakeholders Meeting No.1 for the Pahang River Basin
Date : 2nd February 2010
Venue : Bandar Indera Mahkota, Kuantan

Stakeholders Meeting No.2 for the Pahang River Basin
Date : 10th May 2010
Venue : Temerloh Plaza, Temerloh

Stakeholders Meeting No.3 for the Pahang River Basin
Date : 23rd August 2010
Venue : Federal Building, Temerloh

Project Office

Various paper works and discussions among team member are carried out at the project office
Date : 27 January 2010
Venue : Project Office, DID, Ampang, Kuala Lumpur

The Preparatory Survey
for Integrated River Basin Management incorporating Integrated Flood Management with Adaptation of Climate Change

Final Report
Part 1. Common Context

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Abbreviations

AMRFF	Atmospheric model-based rainfall and flood forecasting system
AR4	IPCC Fourth Assessment Report
ARI	Average Recurrence Interval
ASMA	Alam Sekitar Malaysia Sdn. Bhd.
B/C	Benefit/Cost
BAKAJ	Johor Water Regulatory Body (*Badan Kawalselia Air Johor*)
BKSA	Water Regulatory Body (*Badan Kawalselia Air*)
BOD/BOD5	Biochemical oxygen demand
BORDA	Bremen Overseas Research and Development Association
COD	Chemical oxygen demand
CORPRI Model	Corporatization and Privatization Model
DID	Department of Irrigation and Drainage
DEWATS	Decentralised Wastewater Treatment Solution
DMRC	Disaster Management and Relief Committee
DO	Dissolved oxygen
DOCC	District Disaster Operations Control Center
DOE	Department of Environment
DTGSM	Peninsular Malaysia Geodetic Vertical Datum (*Datum Tegak Geodesi Semenanjung Malaysia*)
DTM	Digital Terrain Model
DVS	Department of Veterinary Service (*Jabatan Perkhidmatan Veterinar*)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPU	Economic Planning Unit (Unit Perancang Economi)
EQA	Environmental Quality Act 1974
EQR	Environmental Quality Report
ESA	Environmental Sensitive Area
EXCO	Executive Council
GCM	General Circulation Model
GEV	General Extreme Value
GHG	Greenhouse gas
GRDP	Gross Regional Domestic Products
HH	Household
IEE	Initial Environmental Evaluation
IFM	Integrated Flood Management
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
IST	Individual septic tank
IWK	Indah Water Konsortium Sdn. Bhd.
IWRM	Integrated Water Resources Management
JAS	Department of Environment (*Jabatan Alam Sekitar*)
JBA	Water Supply Department *(Jabatan Bekalan Air*)
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JKPS	River Management Committee (*Jawatankuasa Pengurusan Sungai*)
JKR	Public Works Department (*Jabatan Kerja Raya*)
JMG	Department of Mineral and Geoscience (*Jabatan Mineral dan Geosains*)
JPBD	Department of Town and Country Planning (*Jabatan Perancangan Bandar dan Desa*)
JPBB	Disaster Management and Relief Committee *(Jawatankuasa Pengurusan dan Bantuan Bencana)*
JPBBD	District Disaster Management and Relief Committee (*Jawatankuasa Pengurusan dan Bantuan Bencana Daerah*)
JPPH	Valuation and Property Services Department (*Jabatan Penilaian dan Perkhidmatan Harta*)
JUPEM	Department Survey and Mapping Malaysia (*Jabatan Ukur dan Pemetaan Malaysia*)
Kg.	Village (*kampung*)
KL	Kuala Lumpur
LA	Local authority
LKIM	Malaysian Fisheries Development Board (*Lembaga Kemajuan Ikan Malaysia*)
LTFM	Linear Transfer Function Model
LUAN	Kedah Water Management Authority (*Lembaga Urus Air Negeri Kedah*)
LUAS	Selangor Water Management Authority (*Lembaga Urus Air Selangor*)
MaCGDI	Malaysian Center for Geospatial Data Infrastructure
MCM	Million cubic meter
Mld	Million liter per day
MMD	Malaysian Meteorologial Department
MRSO	Malaysian Rectified Skew Orthomophic
MyGDI	Malaysian Geospatial Data Infrastructure
NAHRIM	National Hydraulic Research Institute of Malaysia
NCLG	National Council for Local Government

NGVD	National Geodetic Vertical Datum
NH3-N	Ammoniacal nitrogen
NPV	Net present value
NRE	Natural Resources and Environment
NRW	Non-Revenue Water
NSC	National Security Council
NWQS	National Water Quality Standard
NWRC	National Water Resources Council
NWRD	National Water Resources Department
NWRS	National Water Resources Study (2000)
NWRS	National Water Resources Study, Malaysia (JICA, 1982)
NWSC	Suruhanjaya Perkhidmatan Air Negara
OJT	On-the-job training
PAAB	Water Asset Management Company (*Pengurusan Aset Air Berhad*)
PERHILITAN	Department of Wildlife and Natural Park Peninsular Malaysia (*Jabatan Perlindungan Hidupan Liar dan Taman Negara, Semenanjung Malaysia)*
PFA	Pig farm area
ppm	Part per million
PRECIS	Providing Regional Climate Impact Studies
PTG	Land and Mines Office (*Pejabat Tanah dan Galian*)
PWCC	PricewaterhouseCoopers Consulting Sdn. Bhd.
RBC	River Basin Committee
RB-DSS	National River Basin Decision Support System
RB-IMS	River Basin Infrastructure Management System
RBMO	River Basin Management Office
RBO	River Basin Organization
RB-SMS	River Basin Geographical Information System
RB-SMS	River Basin Simulation Modeling System
RCM	Regional Climate Model
RegHCM-PM	Regional Hydroclimate Model of Peninsular Malaysia
RM	Ringgit Malaysia
RMK-10	Tenth Malaysia Plan
RMK-8	Eighth Malaysia Plan
RMK-9	Ninth Malaysia Plan
RRB	National Register of River Basin Study
RRB2	Second Phase of the National Register of River Basin Study
RTU	Remote Terminal Unit
SAINS	Syarikat Air Negeri Sembilan Sdn. Bhd.
SAJ	Johor Water Company (*Syarikat Air Johor*)
SBMO	Sub-Basin Management Office
Sg.	River (*sungai*)
SPAN	Suruhanjaya Perkhidmatan Air Negara
SS	Suspended solids
st.	Station
STP	Sewage treatment plant
SWM	SWM Environment Sdn. Bhd.
SWRC	State Water Resources Council
TDS	Total dissolved solids
Tg.	Tanjung
TNB	Tenaga Nasional Berhad
TOR	Terms of Reference
TSS	Total suspended solids
UPEN	State Economic Planning Unit (*Unit Perancang Ekonomi Negeri*)
UPPP	Federal Project Implementation Unit (*Unit Pelaksanaan Projek Persekutuan*)
USD	US Dollar
USEPA	The United States Environmental Protection Agency
W.L.	Water Level
WRD	Water Resources Department
WQI	Water Quality Index

Measurement Units

(Length)		
mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)
(Area)		
mm^2	:	square millimeter(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
ha	:	hectare(s)
(Weight)		
g, gr	:	gram(s)
kg	:	kilogram(s)
ton	:	ton(s)
(Time)		
s, sec	:	second(s)
min	:	minute(s)
h, hr	:	hour(s)
d, dy	:	day(s)
y, yr	:	year(s)
(Volume)		
cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)
l, ltr	:	liter(s)
mcm	:	million cubic meter(s)
(Speed/Velocity)		
cm/s	:	centimeter per second
m/s	:	meter per second
km/h	:	kilometer per hour

CHAPTER 1 INTRODUCTION

1.1 Background of the Survey

Malaysia is one of the fast-developing countries in the Association of Southeast Asian Nations (ASEAN) which have made remarkable growth recently. Malaysia had once had a monoculture type of economic system depending on rubber and tin exports; however, the country had achieved significant economic growth as a result of the industrial policy implemented after 1985 despite the adverse effect of the Asian economic crisis in 1997. The per-capita GNI achieved in 2007 was USD6,540, and the Development Assistance Committee (DAC) listed Malaysia as a middle or high income country with the human development index indicating a high value (63rd place among 177 countries).

In the meantime, flood in Malaysia is recently increasing its frequency and seriousness . According to the EM-DAT (Emergency Events Database), 20 floods struck Malaysia between 2000 and 2008, affecting 390 thousand people and causing damages of 1 billion USDs in total. Thus, floods are recognized as a major obstacle to achieving sustainable growth and development in Malaysia.

The Federal Government of Malaysia has taken initiative to conduct IRBM (Integrated River basin Management) incorporating IFM (Integrated Flood Management) to achieve clean water, sufficient water, safe basin and sound environment which are line with the Ninth Malaysia Plan (2006-2010). However, many river basins in Malaysia are still facing difficulties in implementing IRBM and IFM plans due to constraints in institutional, technological, and/or financial aspects.

Besides, as the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) indicates, climate change is projected to increase frequency of extreme floods and draughts and cause sea level rise. It is neither possible to monitor nor to handle these impacts for an individual river management authority. They must be carried out in a coordinated and integrated manner. Therefore, it is crucial to introduce appropriate adaptation measures in each river basin by implementation of IRBM against uncertain threats as a result of climate change.

Under the above mentioned circumstance, Japan International Cooperation Agency (hereinafter referred to as "JICA") recognizes the importance to assist the Government of Malaysia for development of IRBM and IFM plans. Therefore, JICA, the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, decided to implement this Preparatory Survey. Finally JICA selected a joint-venture group consisting of CTI Engineering International Co., Ltd. and Yachiyo Engineering Co., Ltd. as the Study Team, and then dispatched it to Malaysia in the beginning of September 2009 to commence the Preparatory Survey.

1.2 Narrative Summary of the Preparatory Survey

The overall goal, objectives, outputs, beneficiaries, and the implementation of the Preparatory Survey are tabulated in **Table 1.2.1**.

Table 1.2.1 Summary of the Preparatory Study

Item	Contents
Overall Goal	Flood mitigation projects are implemented, and local and national economies are sustainably developed.
Objectives	To strengthen capacities of River Basin Committees (RBCs) of 2 selected river basins, To support them for elaborating Integrated River Basin Management (IRBM) and Integrated Flood Management (IFM) plans, and To conduct feasibility studies on high-priority flood mitigation projects that should be urgently implemented.
Outputs	Two river basins are selected as target river basins out of four candidate river basins (Muar, Pahang, Sarawak, Kinabatangan), taking into accounts flood risks, etc. Impact of climate change on rainfall patterns (quantity, intensity, etc) are estimated by using existing projection results of Climate Change. The RBCs of the two target river basins are strengthened through elaboration of IRBM and IFM plans that incorporate the estimated impacts of Climate Change. Feasibility studies on high-priority projects of the IFM plans are conducted.
Beneficiaries	Direct beneficiaries: DID staff and members of the two RBCs Indirect beneficiaries: people in the 2 river basins.
Implementation Agency	Department of Irrigation and Drainage (DID).

1.3 Survey Schedule

The overall survey schedule is given in **Figure 1.3.1**. The actual duration of the Preparatory Survey is about 12 months from September 2009 to September next year. Five reports are prepared in the course of the Survey. The Draft Final Report will be prepared in the middle of September 2010, ant then it will be modified into the Final Report in January 2011, taking into account comments from agencies concerned.

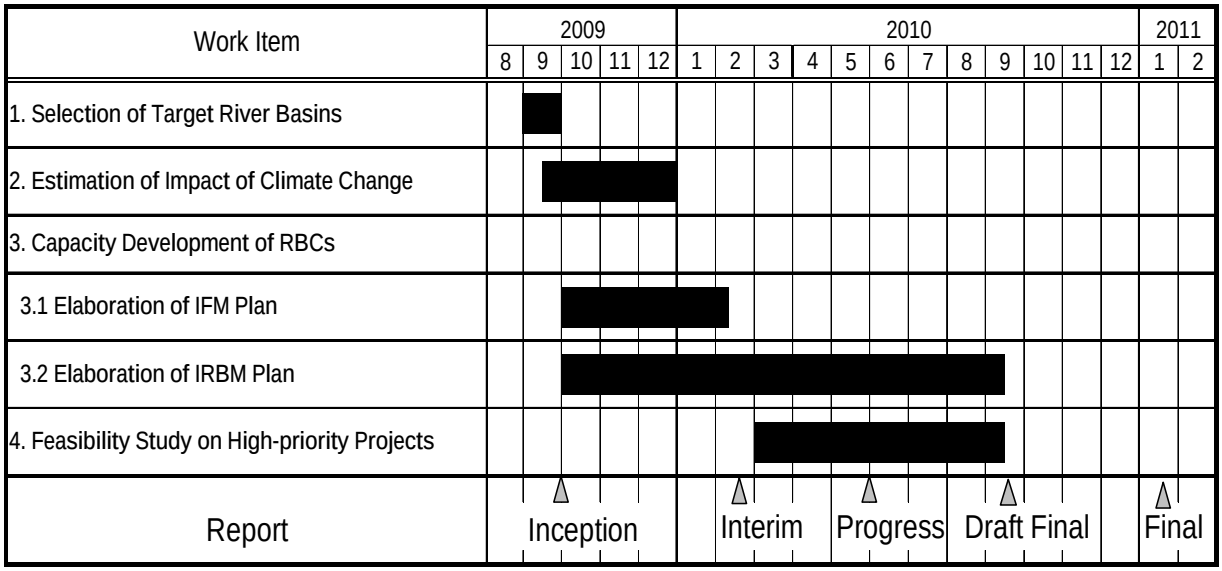


Figure 1.3.1 Project Schedule

1.4 Staffing Schedule

The JICA Study Team is composed of 13 members from CTI Engineering International Co., Ltd and Yachiyo Enginnering Co., Ltd. Their assignment schedule is presented in **Figure 1.4.1**.

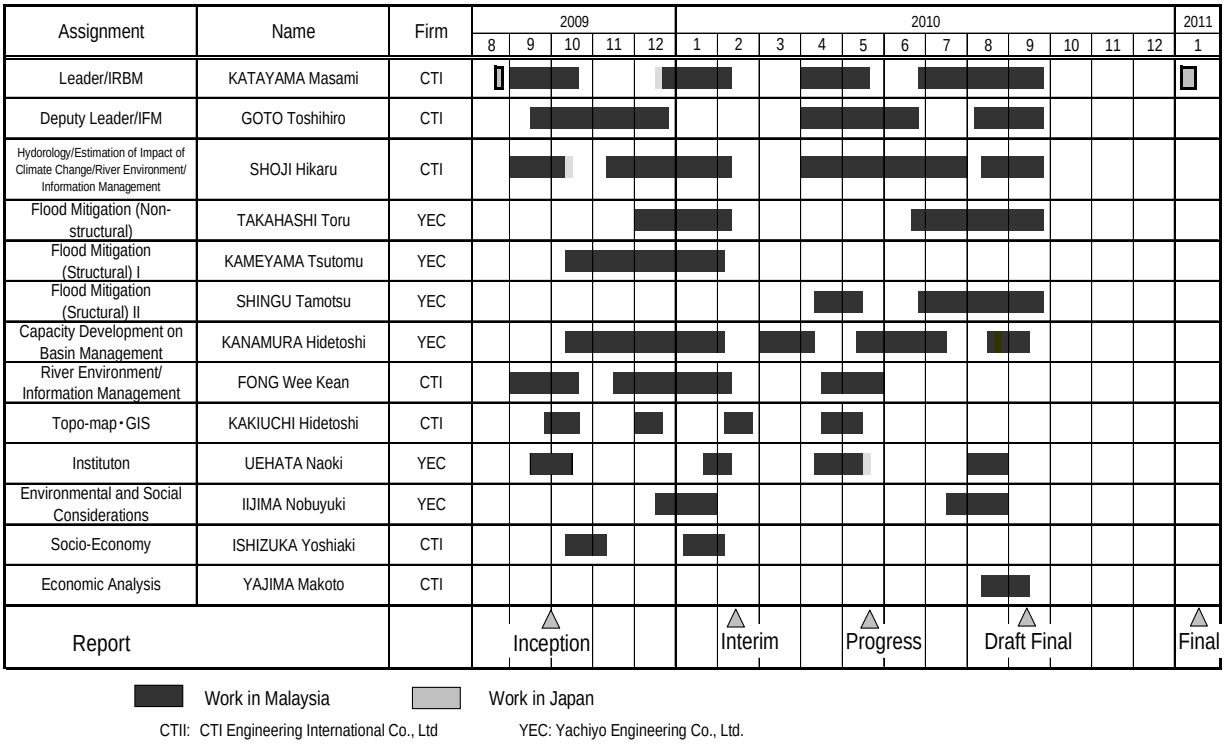


Figure 1.4.1 Members of JICA Study Team and Their Assignment Schedule

1.5 Target River Basins

As described in **Table 1.2.1**, this Survey targets two river basins that were to be selected from four candidate river basins, namely Muar, Pahang, Sarawak and Kinabatangan. At the kickoff meeting which was held on September 8, 2009 with the presence of some 20 officials from federal and state DIDs and related agencies, the Muar and Pahang River Basins were decided as the target river basins.

The Muar River Basin is shared by four states, namely Negeri Sembilan, Johor, Melaka and Pahang. The Pahang River Basin is shared by two states, Pahang and Negeri Sembilan. Since both the two rivers are trans-state rivers, decision making of the two river basins can be taken over by the Federal Government when the concerned states can not come to an agreement.

Profiles of the two river basins are summarized in **Table 1.5.1**, and explained below.

Table 1.5.1 Profiles of the two Target River Basins

Items	Muar	Pahang
Population in 2010*	660, 000	1,190,000
Catchment Area (km^2)	6,595	29,300
River Length (km)	300	420
River gradient	1/4,000	1/6,500

*: Projected by the JICA Study Team

1.6 Organization for Implementation of the Survey

1.6.1 River Basin Committees (RBCs) for Target River Basins

As for the target two river basins, river basin committees are being set up for the implementation of Integrated River Basin Management (IRBM). Since the two river basins are shared by two or more states, the Federal Government also can intervene in accordance with the Constitution, and each of the two river basin committees has a four-layer structure, namely a management committee and a technical committee at the federal level, and (a) task force(s) and working groups at the state level, as shown in **Figure 1.6.1**.

1.6.2 Setup of Working Groups for Capacity Development

As the objectives of the Preparatory Survey say, the capacity development of the river basin committees is one of the important components. The Preparatory Survey aims to execute the capacity development through the OJT (On the Job Training) for elaborating IRBM and IFM plans. Therefore, the JICA Study needs regular working partners in the river basin committees.

For this purpose, four or five working groups (a coordinating group and three or four groups under the coordinating group for specific subjects such as flood mitigation, environment and water utilization) were organized under each state task force. The working groups are consisting of several state or district government staff at an operational level.

1.6.3 Organization for Implementation of Preparatory Survey

The organization for the implementation of the Preparatory Survey has been established as shown in **Figure 1.6.1**. The JICA Study Team regularly works together with the working groups for elaborating IRBM and IFM plans. Important issues raised in the course of the Preparatory Survey are discussed in the steering committee, of which a meeting is supposed to be held at every occasion of the report submission in principle. The JICA Study Team supports DID for organizing the steering committee meetings.

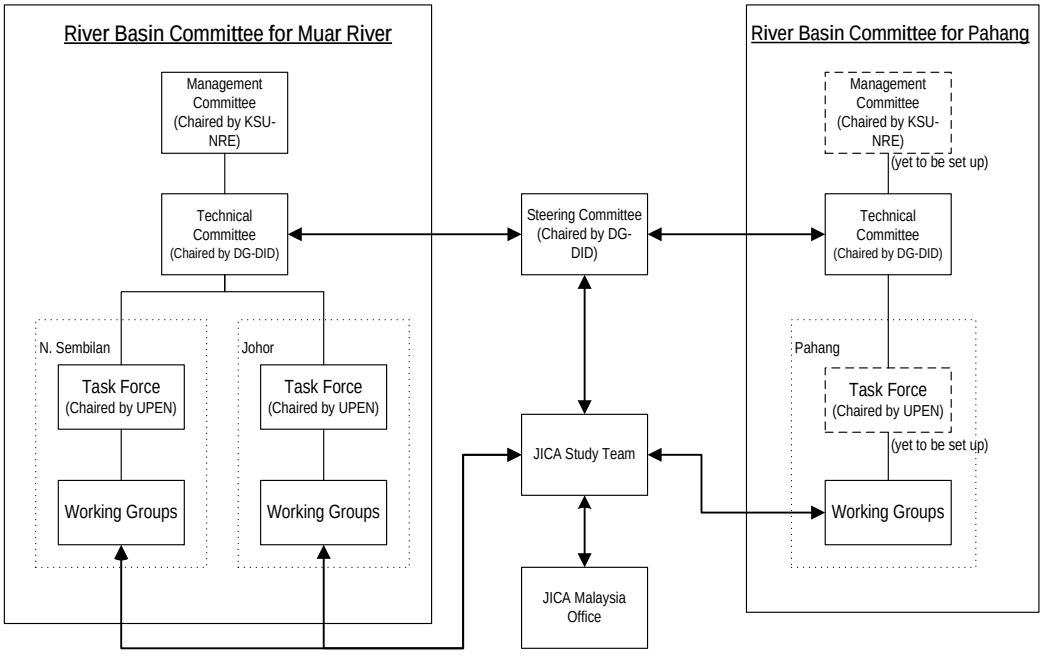


Figure 1.6.1 Organization for Implementation of Preparatory Survey

1.7 Capacity Development Activities

1.7.1 Stakeholder Meeting

Public participation is one of the most important key factors for the success of IRBM. To elaborate an IRBM plan that reflects voices from a variety of stakeholders, it is necessary to involve them in the IRBM planning form early stages.

In line with this policy, the Preparatory Survey has been making efforts to hold stakeholder meetings since the commencement of the survey. A total of seven stakeholder meetings, four meetings for the Muar River Basin, three meetings for the Pahang River Basin, were held in the one-year study period. It is noted that officials of state government agencies of Johor and Negeri Sembilan States met together for the first time at the Muar River Basin stakeholder meeting in December 2009. These meetings are summarized in **Table 1.7.1**.

Table 1.7.1 Stakeholder Meetings

River Basin	Date	Venue	Main Subjects	Participants
Muar	10 December '09	Muar	Extraction of Issues on IRBM	69 persons (62 government employees and 7 private citizens)
	5 February '10	Segamat	Discussion on proposed IFM Plan	38 persons (government employees only)
	12 May '10	Gemas	Discussions on proposed IRBM Plan and proposed Gemas Flood Mitigation Project	24 persons (government employees only)
	25 August '10	Alor Gajah	Discussions on proposed IRBM Plan and proposed Gemas Flood Mitigation Project	47 persons (46 government employees, 1 private citizens)
Pahang	2 February '10	Kuantan	Extraction of Issues on IRBM and Discussion on proposed IFM Plan	70 persons (68 government employees and 2 private citizens)
	10 May '10	Temerloh	Discussions on proposed IRBM Plan and proposed Temerloh Flood Mitigation Project	24 persons (government employees only)
	23 August '10	Temerloh	Discussions on proposed IRBM Plan and proposed Temerloh Flood Mitigation Project	40 persons (government employees only)

The main subjects at the stakeholder meetings were:

- Extraction of issues on IRBM (the 1st meeting for Muar and Pahang), ,
- Proposed IFM plan (the 2nd meeting for Muar and the 1st meeting for Pahang), and
- Proposed IRBM plan and feasibility study on proposed flood mitigation project (the 3rd and 4th meetings for Muar and the 3rd meeting for Pahang)

Discussions on issues on IRBM issues at the 1st meetings were useful for identification of IRBM issues. A lot of local issues that are likely to be missed by the federal and state agencies were collected from the participants. Discussions on the proposed IRBM and IFM plans and the feasibility studies were reflected to make them more acceptable by the stakeholders. Especially it was clarified at the meetings that height of bunds was a great concern of the participants for both the river basins. The Study Team came up with various ideas to lower and strengthen bunds as much as possible.

1.7.2 Working Group Meetings

As main part of the capacity development activities, 23 working group meetings (Muar: 12, Pahang: 11) in total were held in the course of the Preparatory Survey.

Table 1.7.2 Working Group Meetings

Serial	Date	State	Activity	Main subjects of discussion	Number of participants	River Basin
1	15 Oct 2009	N.S.	Joint Working Group Meeting No.1	Data/information collection	20	Muar River Basin
2	19 Oct 2009	Johor	Joint Working Group Meeting No.1	Data/information collection	26	
3	9 Dec 2009	Johor	Environment Working Group Meeting No.2	Identification of issues	9	
4	9 Dec 2009	Johor	Flood Mitigation Working Group Meeting No.2	Check of condition of Data/information collection, Identification of issues	8	
5	15 Dec 2009	N.S.	Environment Working Group Meeting No.2	Identification of issues	4	
6	30 Dec 2009	N.S.	Water Utilization Working Group Meeting No.2	Data/information collection	10	
7	20 Jan 2010	Johor	Environment Working Group Meeting No.3	Confirmation of issues	15	
8	5 Mar. 2010	N.S.	Consultation	Data/information collection	1	
9	8 Mar. 2010	Johor	Consultation	Data/information collection	1	
10	11 Mar. 2010	N.S.	Consultation	Data/information collection	1	
11	2 Apr. 2010	Johor	Consultation	Data/information collection	2	
12	5 Apr. 2010	Johor	Consultation	Data/information collection	1	
1	12 Oct 2009	Pahang	Joint Working Group Meeting No.1	Data/information collection	15	Pahang River basin
2	12 Dec 2009	Pahang	Flood Mitigation Working Group Meeting No.2	Data/information collection	20	
3	16 Dec 2009	Pahang	Water Utilization Working Group Meeting No.2	Data/information collection	8	
4	21 Dec 2009	Pahang	Environment Working Group Meeting No.2	Identification of issues	22	
5	30 Dec 2009	N.S.	Water Utilization Working Group No.2	Data/information collection	10	
6	4 Mar. 2010	Pahang	Consultation	Data/information collection	2	
7	5 Mar. 2010	N.S.	Consultation	Data/information collection	1	
8	11 Mar. 2010	N.S.	Consultation	Data/information collection	1	
9	15 Mar. 2010	Pahang	Water Utilization Working Group Meeting	Data/information collection	11	
10	24 Mar. 2010	Pahang	Consultation	Data/information collection	3	
11	6 Apr 2010	Pahang	Consultation	Data/information collection	3	

1.7.3 Technical Meetings

In addition to the above stakeholder meetings and the working group meetings, several technical meetings on specific technical matters with relevant DID divisions were held as follows:

Table 1.7.3 Technical Meeting with DID Relevant Divisions

Date	Venue	Main Subject	Participants from
5 Jan. 2010	DID HQ	IFM plans for Muar and Pahang Rivers	River Div., FM Div.
28 Jan. 2010	DID HQ	IFM plans for Muar and Pahang Rivers	River Div., FM Div.
22 April 2010	DID Ampang	Follow up of hydrological analyses applied in IFM planning	River Div., HWR Div.
5 May 2010	DID HQ	Concepts of flood mitigation projects for Temerloh-Mentakab and Gemas	River Div., FM Div., Tampin District DID, Temerloh District DID
6 May 2010	DID HQ	Concepts of IRBM plans for Muar and Pahang Rivers	River Div
18 May 2010	DID Ampang	Proposed Institutional setup for implementation of IRBM for Muar and Pahang Rivers	River Div., HWR Div. Ranhill
28 June 2010	DID Ampang	Long-term runoff analysis with consideration of Climate Change for Muar and Pahang Rivers	HWR Div.
4 Aug. 2010	DID HQ	Proposed flood mitigation projects for Temerloh-Mentakab and Gemas	River Div., FM Div. Segamat District DID

Note:
River Div.: : River Management and Coastal Zone Division, DID
FM Div.: : Flood Management Division, DID
HWR Div. : Hydrology and Water Resources Division, DID
Ranhill : Ranhill Consiulting Sdn Bhd

CHAPTER 2 NATIONAL CONTEXTS

2.1 Socio-Economy

2.1.1 Government

Malaysia is a constitutional monarchy country, nominally headed by paramount ruler (commonly referred to as the King) and a bicameral Parliament consisting of a nonelected upper house and an elected lower house.

The system of administration of Malaysia is three-tiered, consisting of the federal government, the regional (state) governments, and local authorities (city, municipal, and district councils). There are 13 states (11 of which are in Peninsular Malaysia) and 144 local authorities (as of 2007).

2.1.2 Population

The national projected population in 2008 is 27,729,000 as shown in **Table 2.1.1**. Those of the related three states are also presented in this table for reference. The annual population growth rate is about 2 %.

Table 2.1.1 Population

(1000)

Year	Malaysia	State of Pahang	State of N. Sembilan	Stare of Johor
2000 (Census Data)	23,275	1,296	866	2,763
2008 (Mid-term Projection)	27,729	1,513	996	3,312
Average Annual Increase Rate (2000 to 2008)	2.2%	2.0%	1.8%	2.3%

Source: Department of Statistics, Malaysia

Malaysia is a multi-racial country, including Malay (50%), Chinese (24%), indigenous (11%), Indian (7%) and others (8%).

2.1.3 Economic Profile

(1) Gross Domestic Product

The gross domestic product of Malaysia at the current price reached RM 640,844 million in 2008, growing at 3.13% during the last 5years from 2004 to 2008. The share rate of the GDP in 2008 by economic activity is 36% for services, 30% for manufacturing, 19% for mining and quarrying and 12% for agriculture.

(2) Prices

The annual inflation rates from 1970 to 2009 were estimated from the Consumer Price Indices (CPIs). The annual inflation rates are generally about 5% or less in the most of the period although higher rates of about 10% or more were recorded in 1973, 1974 and 1981.

Table 2.1.2 Average Annual Inflation Rate by Decade

(1,000)

Year	1970 to 1979	1980 to 1989	1990 to 1999	2000 to 2009
Average Annual Inflation Rate	5.50%	3.65%	3.71%	2.27%

Source: JPM

(3) Prices

The total labor force in Malaysia is 10,890,000 persons in 2007, sharing about 40% of the total population. The unemployment rate has been kept at a level of 3% for the last five years from 2003 to 2007. Manufacturing, wholesale and retailing, and agriculture and forestry are three major industries in terms of labour force, occupying 19%, 16% and 14% respectively.

2.1.4 Financial Status of Government

The total current revenue of the Federal Government was about RM 160 billion in 2008, accounting for 25% of GDP. The current budget almost tripled in the 9 years from 1999 and 2008 with an average annual increase rate of 12%.

Table 2.1.3 Revenue in Consolidated Federal Government Finance

(million RM)

Year	Revenue in Total	Tax Revenue													Non Tax Revenue					Non Revenue Receipts
		Direct Tax						Indirect Taxes												
		Corpo-ration Income Tax	Petro-leum Income Tax	Personal Income Tax	Stamp Duties	Others	Direct Tax in Total	Export Duties	Import Duties	Excise Duties	Sales Tax	Service Tax	Others	Indirect Tax in Total	Licenses and Permits	Petro-leum Royalty	Interest and Returns on Invest-ment	Others	Non Tax Revenue in Total	
1999	58,674	15,742	2,856	6,419	1,566	663	27,246	670	4,720	4,723	4,488	1,459	2,040	18,100	3,637	974	7,007	1,055	12,673	655
2000	61,865	13,905	6,010	7,015	1,799	428	29,157	1,032	3,599	3,803	5,968	1,701	1,914	18,017	3,785	1,763	7,383	1,161	14,092	599
2001	79,567	20,770	9,858	9,436	1,650	382	42,096	867	3,193	4,130	7,356	1,927	1,922	19,395	3,994	2,000	10,056	1,254	17,304	772
2002	83,514	24,642	7,636	9,889	1,732	451	44,350	803	3,668	4,745	9,243	2,214	1,836	22,509	4,282	1,600	8,353	1,524	15,759	896
2003	92,608	23,990	8,466	7,984	2,008	568	43,016	1,156	3,919	5,031	7,965	2,038	1,766	21,875	4,492	2,142	15,201	1,296	23,131	4,586
2004	99,398	24,388	11,479	8,977	2,381	1,479	48,704	1,600	3,874	6,427	6,816	2,350	2,280	23,347	4,608	2,498	17,778	1,627	26,511	836
2005	106,303	26,381	14,566	8,649	2,460	1,487	53,543	2,085	3,385	8,641	7,709	2,582	2,648	27,050	5,039	3,293	14,849	1,872	25,053	657
2006	123,546	26,477	20,674	10,196	2,522	1,703	61,572	2,362	2,679	8,577	6,532	2,685	2,225	25,058	4,972	4,240	24,794	1,999	36,005	910
2007	139,885	32,149	20,453	11,661	3,404	1,729	69,396	2,322	2,424	8,990	6,642	3,013	2,380	25,772	5,282	4,152	32,408	2,108	43,950	766
2008	159,793	37,741	24,191	14,966	3,492	1,747	82,138	2,779	2,635	10,682	8,374	3,345	2,944	30,760	5,193	5,908	32,271	2,539	45,911	985

Source: National Bank of Malaysia (NBM).

The total expenditure consisting of operating and development expenditures also increased considerably during the same period, and amounted to RM 196 billion (RM 153 billion for the operation one and RM 43 billion for the development one) in 2008, accounting for 31% of GDP.

Table 2.1.4 Expenditure in Consolidated Federal Government Finance

1) Operating Expenditure (million RM)

Year	Total	Emolu-ments	Pension and gratuities	Debt service charges			Supplies and services	Subsidies	Asset acquisition	Grants and transfers	Other expenditure
				Total	Domestic	External					
1999	46,699	14,436	3,792	7,941	7,057	884	6,074	1,136	422	11,124	1,774
2000	56,547	16,357	4,187	9,055	7,868	1,187	7,360	4,824	572	11,757	2,435
2001	63,757	17,443	4,711	9,634	8,484	1,150	10,703	4,552	1,339	13,524	1,851
2002	68,699	20,242	5,134	9,669	7,977	1,692	11,269	3,677	968	15,948	1,792
2003	75,222	21,721	5,870	10,546	8,663	1,883	13,968	2,679	1,409	16,323	2,706
2004	91,297	23,779	6,060	10,919	9,161	1,758	16,633	5,796	1,764	21,264	5,082
2005	97,744	25,587	6,809	11,604	9,875	1,729	17,984	13,387	1,603	20,427	343
2006	107,694	28,522	7,008	12,496	10,990	1,506	20,923	10,112	1,949	26,294	391
2007	123,084	32,587	8,251	12,911	11,485	1,426	23,622	10,481	2,532	31,501	1,197
2008	153,499	41,011	10,022	12,797	11,642	1,155	25,197	29,867	2,835	30,922	849

Source: National Bank of Malaysia (NBM).

2) Development Expenditure (million RM)

Year	Total	Defense and security	Economic services						Social services					General admini-stration[1]
			Sub-total	Agriculture and rural development	Trade and industry	Trans-port	Public utilities	Others	Sub-total	Education	Health	Housing	Social and community services	
1999	22,614	3,122	8,969	1,088	2,798	2,893	1,850	340	6,936	3,865	836	1,081	1,154	3,587
2000	27,941	2,332	11,639	1,183	3,667	4,863	1,517	408	11,076	7,099	1,272	1,194	1,511	2,894
2001	35,235	3,287	12,725	1,394	4,830	5,042	1,092	367	15,384	10,363	1,570	1,269	2,183	3,839
2002	35,977	4,333	12,433	1,364	3,474	5,401	1,808	387	18,043	12,436	1,503	1,808	2,296	1,168
2003	39,353	6,029	13,793	1,620	3,456	7,354	920	443	17,707	10,193	2,681	1,928	2,905	1,824
2004	28,864	4,133	11,851	2,881	1,201	6,630	945	193	10,260	4,316	2,352	1,593	1,999	2,620
2005	30,534	4,803	14,957	2,482	3,221	7,660	1,481	112	7,450	3,736	1,220	1,082	1,412	3,325
2006	35,807	4,803	17,404	3,999	3,389	7,751	2,244	21	9,525	5,349	1,298	1,347	1,531	4,076
2007	40,564	5,702	20,116	3,842	4,904	8,500	2,358	512	12,893	6,271	1,496	2,947	2,178	1,853
2008	42,847	5,779	21,353	4,184	4,581	9,212	2,795	581	13,717	7,892	1,652	1,780	2,393	1,998

Source: National Bank of Malaysia (NBM).

2.1.5 DID Budget

It should be made clear that the Government Budget in Malaysia is not based on "one-year budget", but on "5-year budget". Budget on the development expenditure of the State Governments is allocated from the federal Government based on budget proposal made by the States. The budget of DID is also allocated by the same basis. The time of this survey (from 2009 – 2010) is in the final stage of the 9th Malaysia Plan from 2006 to 2010. **Table 2.1.5** shows a summary of annual allocation of the budget for management for DID Headquarters of the 9th Malaysia Plan.

Table 2.1.5 Summary of Annual Allocation of DID Budget for Management of the 9th Malaysia Plan

(a) Annual Allocation of Budget for Management for DID Headquarters

Year	Amount (million RM)
2006	64.5
2007	69.5
2008	76.3
2009	79.5
2010	77.7
Total	367.5

(b) Details of Allocated Budget for 2009 for DID Headquarters in 2009

Description	Amount (RM)
Emolument	54,394,100
Supply and Services	22,120,100
Grant and Fixed Payment	15,000
New Policy	1,303,200
Others	1,650,000
Total	79,482,400

Source: DID.

As shown in the above table, the allocated amount for DID Headquarters in the 9th Malaysia Plan is a sum of RM 367.5 million. And in 2009, the amount of emolument has occupied 68 % of the annual allocated amount in 2009. Next, the amount of supply and services has occupied 28 %.

Of course, there are allocated amounts of development budget for certain projects for DID in addition to the said amount of management. **Table 2.1.6** shows a summary of it by projects and amounts of expenditure which have been paid out.

Table 2.1.6 DID Development Budget in the 9th Malaysian Budget Plan

(RM)

Description of Projects	Total	2006	2007	2008	Cumulative Amount since 2006 till 2008	Remaining Amount
River Works	564,700,598	130,079,501	94,792,000	94,030,000	318,901,501	245,799,097
Coastal Works	708,823,000	104,659,851	61,800,000	101,300,000	267,759,851	441,063,149
Flood Mitigation Projects	5,293,170,020	304,307,083	444,444,228	1,161,814,389	1,910,565,700	3,382,604,320
Urban Drainage Projects	300,999,980	18,557,243	41,360,000	68,920,000	128,837,243	172,162,737
Hydrology and Water Resources	83,500,000	3,555,019	19,800,000	20,600,000	43,955,019	39,544,981
Structure, Geotechnical and Dams	108,000,000	10,541,228	15,300,000	10,150,000	35,991,228	72,008,772
Mechanical and Electrical Works	87,270,000	15,787,320	13,700,000	13,300,000	42,787,320	44,482,680
Corporate Development Projects	132,280,000	7,106,130	11,100,000	8,000,000	26,206,130	106,073,870
Career Advancement and Training	30,000,000	2,473,957	8,000,000	14,010,000	24,483,957	5,516,043
Information Technology	15,000,000	1,915,169	3,000,000	3,470,000	8,385,169	6,614,831
Total	7,323,743,598	598,982,501	713,296,228	1,495,594,389	2,807,873,118	4,515,870,480

(Source: DID)

As shown in **Table 2.1.6**, the amount of development budget in the 9th Malaysia Plan for DID is a sum of around RM 7,324 million in total. In this development budget, the actual amount paid out for flood mitigation projects occupies 68 % of the total amount of expenditure since 2006 till 2008. In the case of the expenditure for river works to be added, it has occupied 79 % of the expenditure in total.

In the flood mitigation budget only in addition, the actual expenditures are reported as a sum of RM 838,232,280 in the term of 7th budget plan (1996 – 2000), and RM 1,531,349,246 in the term of 8th budget plan (2001 – 2005). And, the budget for flood mitigation projects in the term of 9th budget plan has been reported to revise to a sum of RM 3,819 million. It means that the budget for flood mitigation projects has been revised downward by the amount of around RM 1,474 million from the original amount of the budget of around RM 5,293 million. Nevertheless, the amount of budget for flood mitigation projects has been gradually increased term by term of the budget plan. **Table 2.1.7** shows an allocation plan of the said each budget term.

Table 2.1.7 DID Development Budget Allocation to Districts in the 7th, 8th and 9th Malaysian Budget Plan

(RM)

State	Actual Expenditure in 7th Budget Plan	Actual Expenditure in 8th Budget Plan	Ceiling Amount of in 9th Budget Plan
Melaka	7,172,250	5,900,000	17,700,000
Perlis	15,856,010	4,000,000	17,700,000
Kedah	33,912,000	414,865,000	1,080,200,000
Pulau Pinang	84,325,000	78,889,943	182,700,000
Perak	56,738,000	19,700,000	20,200,000
Selangor	47,599,000	250,000,000	147,000,000
Negeri Sembilan	58,300,000	27,600,000	27,000,000
Johor	63,678,000	28,100,000	47,000,000
Pahang	22,870,000	11,000,000	33,700,000
Terengganu	26,055,010	20,150,000	30,200,000
Kelantan	39,824,000	15,700,000	360,200,000
Sabah	9,000,010	21,023,020	47,200,000
Federal Territories	364,603,000	614,080,000	102,500,000
Sarawak	8,300,000	15,275,000	197,000,000
SMART	-	-	1,012,000,000
Batu/Jinjang Ponds	-	-	452,000,000
Urgent Flood Mitigation	-	5,066,283	20,000,000
KESBAN	-	-	25,000,000
Total	838,232,280	1,531,349,246	3,819,300,000

Source: DID.

On the other hand, development budgets for state DIDs are decided by the Department of Budget of the Ministry of Finance based on the proposal submitted by the state DIDs through DID Headquarters. And then, approved budget is allocated to the state DIDs through DID Headquarters. These development budgets for the state DIDs are prepared in addition to the said development budget for DID Headquarters. The state DID development budgets are consisting of the above allocated budgets from the federal Government, transfer from the Ministry of Agriculture (MOA), and allocated from states' own budgets and/or other resources. State DIDs can use these amounts in total for operation and maintenance of projects. Following table shows a summary of state DIDs in the 9th Malaysia Plan.

Table 2.1.8 Development Budget of State DIDs in the 9th Malaysia Plan

(million RM)

State	Through DID Headquarters	From MOA	From State/ Other Resources	Total
Perlis	91.0	21.5	75.5	188.0
Kedah	50.5	100.6	64.0	215.1
Pulau Pinang	327.7	25.0	56.0	408.7
Perak	104.8	91.2	52.8	248.8
Selangor	1,970.0	55.0	225.0	2,250.0
Negeri Sembilan	300.0	22.0	60.0	382.0
Melaka	476.3	22.7	36.5	535.5
Johor	425.6	30.0	148.0	603.6
Pahang	94.6	16.0	60.0	170.6
Terengganu	104.0	114.0	74.0	292.0
Kelantan	132.4	47.5	43.0	222.9
W.P. Kuala Lumpur	316.0	0.0	0.0	316.0
W.P. Labuan	4.8	0.0	0.0	4.8
Total	4,397.6	545.5	894.8	5,837.9

Note: W.P. = Wilayah Persekutuan (= Federal Territory).
Source: DID.

2.2 Legislation and Institution

2.2.1 Legislation

(1) Legislative Framework for River Basin Management

The river basin management is essentially related to the conservation, development and utilization of water resources, land use and environment within and surrounding of the river basin in a sustainable manner. It is important to regulate and minimize negative impacts and optimize benefits from the river basin through the enforcement of legal measures. Major relevant legislation to the river basin management is mentioned in **Table 2.2.1**.

Table 2.2.1 Summary of Relevant Legislatives

Name of Law	Issues related to IRBM
1. Federal Constitution	Government Function
2. Ministerial Functions Act 1969 (Act 2)	
3. Waters Act 1920 (Act 418)	Water Resources Management
4. National Land Code 1965 (Act 56)	Land Development
5. Drainage Works Act 1954 (Act 354)	Urban Drainage
6. Street, Drainage and Building Act 1974 (Act 133)	
7. Local Government Act 1976 (Act 171)	Government Function
8. Town and Country Planning Act 1976 (Act 172)	Land Use
9. Environmental Quality Act 1974 (Act 127)	Environmental Management
10. Protection of Wildlife Act 1972 (Act 76)	Wildlife Conservation
11. Land Conservation Act 1960 (Act 385)	Catchment Erosion
12. Geological Survey Act 1974	Ground Water
13. Irrigation Areas Act 1953	Water Utilization
14. National Forestry Act 1984 (Act 313)	Forest Conservation
15. The Merchant Shipping Ordinance 1952 (Act 70)	Navigation
16. The Port Authority Act 1963	
17. Fisheries Act 1985 (Act 317)	Fishery/Coastal Development
18. National Water Services Commission Act 2006 (Act 654)	Water Supply/Sewerage
19. Water Services Industry Act 2006 (Act 655)	
20. Solid Waste and Public Cleansing Management Act 2007 (Act 672)	Solid Waste Management
21. Solid Waste and Public Cleansing Management Corporate Act 2007 (Act 673)	
22. Animal Act 1953	Livestock Management

According to the 9th Schedule of the Federal Constitution of Malaysia, the rights, powers and responsibilities of the Federal and State government agencies are stipulated in List I -Federal List and List II-State List respectively. List III-Concurrent List stipulates the shared responsibility between the Federal and State government.

Based on the Federal Constitution, the Federal government shall be responsible for rivers crossing among more than two states without any agreement between the states. On the other hand, the State government has power, authority and responsibility to manage, control and develop a river if the river is wholly within the state.

(2) Legislative Framework for Flood Management

National Security Council Directive No. 20 stipulates the mechanism for the natural disaster management. Under this integrated emergency management system in the Directive, the functions and responsibilities of various relevant agencies are defined for the smooth and practical implementation of disaster relief.

2.2.2 Institution

There are various institutions involved in river basin management in Malaysia. As stipulated in the Ministerial Functions Act 1969 (Act 2), these substantial government agencies and other institutions involved have their own goals and targets to be achieved under their policies. The major relevant institutions involved in river basin management are listed in **Table 2.2.2**.

Table 2.2.2 Roles and Responsibilities in Relevant Government Agencies

Government Agencies	Role and Responsibilities	Issues related to IRBM
National Council		
National Water Resources Council (NWRC)	• To facilitate harmonious and synergistic cooperation between Federal and State Governments • To facilitate development, allocation and management of the national water resources	• Policy and Strategy
Federal Institution		
a) National Security Council	• To formulate national security policies and coordination of national security measures	• Policy on Disaster Management
b) Economic Planning Unit (EPU)	• To prepare medium and long term development plans, and to monitor and evaluate their achievement	• Development Plan
c) Ministry of Natural Resources and Environment (NRE)		
Department of Irrigation and Drainage	• To provide advices to local authorities on drainage planning • To implement flood mitigation, drainage, irrigation and river works	• Flood Mitigation • River Management • Urban Drainage • Coastal Management
Department of Environment	• To monitor and control industrial discharge of sewerage • To regulate EIA process • To enforce EQA	• Water Quality Monitoring
Forestry Department	• To manage, conserve and protect biological diversity, water and soil, and their utilization	• Forest Conservation
Department of Wildlife and National Parks	• To protect, manage and preserve protected areas	• Flora and Fauna Conservation
Department of Director General of Lands and Mines	• To manage and control mining activities in safety, efficient and systematic manner	• River Sand Mining
Department of Minerals and Geoscience	• To manage, conserve and protect groundwater resources	• Ground Water
d) Ministry of Energy, Green Technology and Water (MEGTW, *KeTTHA*)		
Department of Water Supply	• To implement construction works of water supply	• Water Supply Services
Department of Sewerage Services	• To implement construction works of sewerage systems	• Sewerage Services
National Water Services Commission (NWSC or SPAN)	• To enforce, supervise and regulate water supply services and sewerage services activities under the Water Services Industry Act 2006 and National Water Services Commission Act 2006f	• Regulation of Water Service Industry
Water Asset Management Company (WAMCO or *PAAB*)	• To construct, refurbish, improve, upgrade, maintain and repair water infrastructure and all other assets in relation to the water systems	• Water Supply Services
Indah Water Konsortium Sdn. Bhd. (IWK)	• To construct and operate and maintain the public sewage treatment plants and network of underground sewerage pipelines	• Sewerage Services
e) Ministry of Housing and Local Government (MHLG)		
Town and Country Planning Department	• To organize, regulate and coordinate land development, usage and conservation through the implementation of the Town and Country Planning Act and other related acts	• Land Use
Department of National Solid Waste Management	• To implement solid waste management policy • To regulate and issue solid waste management licenses	• Solid Waste
f) Ministry of Agriculture and Agro-Based Industries (MAAI)		
Department of Fisheries	• To develop and manage fishing industries in a sustainable manner	• Fishing/Navigation/ Aquaculture
Department of Agriculture	• To determine and advise on soil and land utilization for agricultural development	• Irrigation Development
Department of Veterinary Services	• To control the production of livestock, livestock products and anima feed	• Livestock
g) Ministry of Science, Technology and Innovation (MAAI)		
Malaysia Meteorological Department	• To provide climatological services • To provide early warnings on dangerous climatological conditions to public, media and government for disaster mitigation	• Construction and Analysis of Climate Change Model
h) Ministry of Works		
Public Works Department	• To plan, design, manage and supervise infrastructure projects (road, government building, airport, port and jetty projects)	• Infrastructure
State Institution		
Water Regulatory Body (BKSA: *Badan Kawal Selia Air*)	• Issuance of licenses • Regulation of water supply services • Regulation of licensed companies • Law enforcement	• Regulation of Raw Water Abstraction
Land Office	• To regulate the land and river use • To gazette the river reserve • To approve plantation development • To issue license for river sand dredging	• Land Use
Local Authority	• To provide the social services in the local authority area • To construct and maintain the urban drainage • To control all the places in local authority area for public use	• Urban Drainage

For the effective reform in water sector, the following national frameworks were established, namely, National Water Resources Council Moreover, water supply services and sewerage services sectors were also transformed.

(1) National Water Resources Council (NWRC)

Following bitter experiences of serious water shortage in 1997, the National Water Resources Council (NWRC) was constituted in 1998. NWRC, which is chaired by the Prime Minster, is the highest institution for water resources management in the Federal level. NWRC plays a role of a platform to discuss about the water resources management for the coordination with various federal and state governments. NWRC consists of members stated in **Table 2.2.3**.

Table 2.2.3 Members of National Water Resources Council

No	Members of NWRC	Tasks
1.	Prime Minister	Chairman
2.	Deputy Prime Minister	
Federal Governments		
3.	Ministry of Finance	
4.	Ministry of Natural Resources and Environment	Joint Secretariat
5.	Ministry of Energy, Green Technology and Water	
6.	Ministry of Works	
7.	Ministry of Agriculture and Agro-based Industry	
8.	Ministry of Housing and Local Government	
9.	Ministry of Plantation Industries and Commodities	
State Governments		
10.	State Governments of Perlis, Kedah, Perak, Selangor, Negeri Sembilan, Johor, Pahang, Terengganu and Kelantan, and Chief Ministers of Pulau Pinang, Melaka, Sabah and Sarawak.	

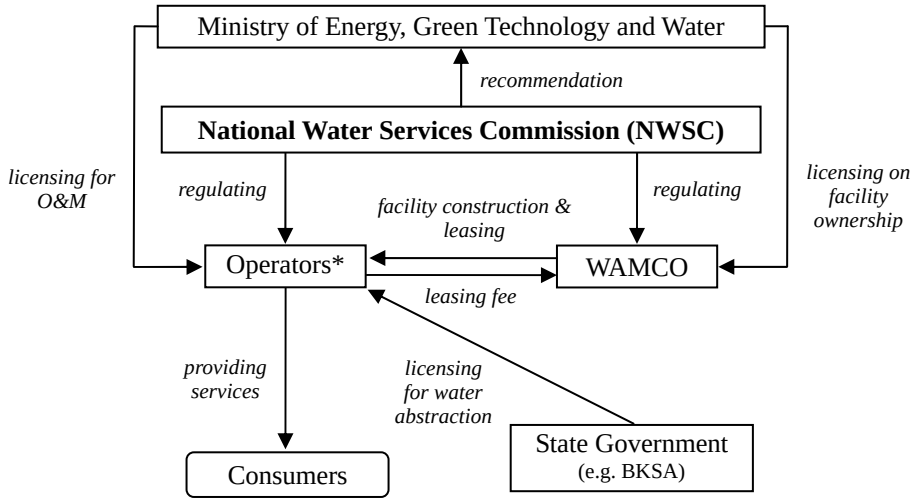
In 2003, NWRC accepted to conduct integrated river basin management (IRBM) in Malaysia. Based on the concept of IRBM, river basin master plans for all 189 river basins will be prepared. Moreover, NWRC is also a platform to discuss on issues related to water, so policies for flood mitigation started to be discussed in NWRC recently.

(2) National Water Services Commission (NWSC)

The Federal Constitution was amended in January 2005 to transfer matters related to water supply services from the List II-State List to the List III-Concurrent List. The amendment enabled the Federal Government to regulate the water supply services while ownership and control of water resources, dams and catchment areas remained with the state governments.

When the authority of water supply and sewerage was under the State governments, some of the State governments privatized water supply and sewerage services. However, this privatization caused several problems for the maintenance of the facilities to the State governments. Therefore, in order to regulate and improve the water supply and sewerage and formulate the effective and efficient framework on water services in Malaysia, National Water Services Commission (NWSC or *Suruhanjaya Perkhidmatan Air Negara*: SPAN) was established under the National Water Services Commission Act 2006 (Act 654).

Under the NWSC scheme, the water supply and sewerage sectors are experiencing a transition period for its sectoral reform. The overall regulative and operative scheme in the public water supply and sewerage service sectors will be established as briefly described in **Figure 2.2.1**.



Remarks:
WAMCO: Water Asset Management Company or *Pengurusan Aset Air Berhad* (PAAB)
BKSA: *Badan Kawal Selia Air* or Water Regulatory Body
IWK: Indah Water Konsortium Sdn. Bhd.
*: Sewerage services have been provided by Indah Water Konsortium Sdn. Bhd. (IWK).

Figure 2.2.1 Frameworks for Water Supply and Sewerage Services

In accordance with the National Water Services Commission Act 654/2006, National Water Services Commission (NWSC) was established with the following mandates.

- To advise the Minister on all matters in relation to the national policy objectives of the water supply and sewerage services laws and to implement and promote the national policy objectives
- To implement and enforce the water supply and sewerage services laws and to consider and recommend reforms to the water supply and sewerage services laws
- To increase concerted efforts towards improving the operational efficiency of the industry and in particular the reduction of non-revenue water through short-term, medium-term and long-term programmes
- To advise the Minister on a fair and efficient mechanism for the determination of tariffs that have been established through appropriate mechanism and tools

Moreover, for both water supply and sewerage services, in accordance with Water Services Industry Act 2006 (Act 655), the Minister of Energy, Green Technology and Water with recommendation of the National Water Services Commission issues the license and permit for the ownership, construction and operation and maintenance of water supply and sewerage assets. The type of licenses and permits is shown in **Table 2.2.4**.

Table 2.2.4 Licenses and Permits for Water Supply and Sewerage Services

License/Permit	Description
1) License	
Type of License	• Individual License: for public water supply system and sewerage system
	• Class License: for private water supply system and sewerage system
Category of License	• Facilities License: to own public or private water supply system or sewerage system or any part of the systems
	• Services License: to undertake, provide or make available public or private water supply services or sewerage services or part of the services by means of operating a public or private water supply system (treatment and distribution) or sewerage system
2) Permit	
Type of Permit	• IPA* Type A: to carry out any construction of, connection of, modification of or repair to water pipes and water fittings which convey or will convey water from the public mains
	• IPA* Type B: to carry out any works necessary to connect a private connection pipe to a sewer or sewage treatment works
	• IPA* Type C: to carry out any construction of, installation of or modification to any part of a water supply system or sewerage system
	• IPA* Type D: to carry out maintenance services for a water supply system or a sewerage system but which does not involve the operation of such system
	• IPA* Type E: to undertake, provide or make available sewerage desludging services

* IPA : Industri Perkhidmatan Air（Water Services Industry)

The Federal government regulates the water supply service and sewerage service sectors by issuing the license and permit to the operators. The State government through water regulatory body such as BKSA (*Badan Kawal Selia Air*) regulates raw water abstraction and diversion. For the water supply and sewerage services, Water Asset Management Company (WAMCO or PAAB), which is a wholly-owned company by the Ministry of Finance Incorporated, has responsibility for the construction, refurbishment, improvement, upgrading, maintenance and repair of water supply and sewerage assets. The water service operators will lease the water assets from WAMCO for providing the water services to the customers. Under this new model, there is a separation of responsibilities between water assets owners and operators.

On the other hand, in the public sewerage services, Indah Water Konsortium Sdn. Bhd. (IWK), which is wholly owned by the Ministry of Finance Incorporated, is responsible for provision of the public sewerage services and construction and operation and maintenance of the public sewerage treatment plants and network of underground sewerage pipelines.

CHAPTER 3 GUIDELINES FOR INTRODUCING IRBM

3.1 Backgrounds

According to the 10th Malaysia Plan, the IWRM approaches will be continued to be encouraged in planning, managing, protecting and rehabilitating water resources. In line with this national policy, IRBM will be continued to be promoted and introduced to other river basins. When diffusing IRBM to the other river basins in Malaysia, the experiences of the Preparatory Survey are very useful. Therefore, the experiences for preparing IRBM and IFM plans for the Muar and Pahang River Basins are definitely worth recording as Guidelines for Introducing IRBM.

3.2 Objective

Based on the above backgrounds, the objective of the guidelines is set up as follows:

Objective: To describe methodologies and lessons learnt in the course of the Preparatory Survey, which will be referred to when IRBM is introduced in the other river basins, especially for preparation of an IRBM and/or an IFM plan.

3.3 Contents of Guidelines

The prepared guidelines are given in Annex and the Table of Contents is presented below:

Guidelines for Introducing IRBM

Table of Contents

ANNEX

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF IRRIGATION AND DRAINGE
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
MALAYSIA

THE PREPARATORY SURVEY
FOR INTEGRATED RIVER BASIN MANAGEMENT
INCORPORATING INTEGRATED FLOOD MANAGEMENT
WITH ADAPTATION OF CLIMATE CHANGE

GUIDELINES
FOR
INTRODUCING IRBM

JANUARY 2011

CTI ENGINEERING INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD.

Guidelines for Introducing IRBM
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Abbreviations

AMRFF	Atmospheric model-based rainfall and flood forecasting system
AR4	IPCC Fourth Assessment Report
ARI	Average Recurrence Interval
ASMA	Alam Sekitar Malaysia Sdn. Bhd.
B/C	Benefit/Cost
BAKAJ	Johor Water Regulatory Body (*Badan Kawalselia Air Johor*)
BKSA	Water Regulatory Body (*Badan Kawalselia Air*)
BOD/BOD5	Biochemical oxygen demand
BORDA	Bremen Overseas Research and Development Association
COD	Chemical oxygen demand
CORPRI Model	Corporatization and Privatization Model
DID	Department of Irrigation and Drainage
DEWATS	Decentralised Wastewater Treatment Solution
DMRC	Disaster Management and Relief Committee
DO	Dissolved oxygen
DOCC	District Disaster Operations Control Center
DOE	Department of Environment
DTGSM	Peninsular Malaysia Geodetic Vertical Datum (*Datum Tegak Geodesi Semenanjung Malaysia*)
DTM	Digital Terrain Model
DVS	Department of Veterinary Service (*Jabatan Perkhidmatan Veterinar*)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPU	Economic Planning Unit (Unit Perancang Economi)
EQA	Environmental Quality Act 1974
EQR	Environmental Quality Report
ESA	Environmental Sensitive Area
EXCO	Executive Council
GCM	General Circulation Model
GEV	General Extreme Value
GHG	Greenhouse gas
GRDP	Gross Regional Domestic Products
HH	Household
IEE	Initial Environmental Evaluation
IFM	Integrated Flood Management
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
IST	Individual septic tank
IWK	Indah Water Konsortium Sdn. Bhd.
IWRM	Integrated Water Resources Management
JAS	Department of Environment (*Jabatan Alam Sekitar*)
JBA	Water Supply Department *(Jabatan Bekalan Air*)
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JKPS	River Management Committee (*Jawatankuasa Pengurusan Sungai*)
JKR	Public Works Department (*Jabatan Kerja Raya*)
JMG	Department of Mineral and Geoscience (*Jabatan Mineral dan Geosains*)
JPBD	Department of Town and Country Planning (*Jabatan Perancangan Bandar dan Desa*)
JPBB	Disaster Management and Relief Committee *(Jawatankuasa Pengurusan dan Bantuan Bencana)*
JPBBD	District Disaster Management and Relief Committee (*Jawatankuasa Pengurusan dan Bantuan Bencana Daerah*)
JPPH	Valuation and Property Services Department (*Jabatan Penilaian dan Perkhidmatan Harta*)
JUPEM	Department Survey and Mapping Malaysia (*Jabatan Ukur dan Pemetaan Malaysia*)
Kg.	Village (*kampung*)
KL	Kuala Lumpur
LA	Local authority
LKIM	Malaysian Fisheries Development Board (*Lembaga Kemajuan Ikan Malaysia*)
LTFM	Linear Transfer Function Model
LUAN	Kedah Water Management Authority (*Lembaga Urus Air Negeri Kedah*)
LUAS	Selangor Water Management Authority (*Lembaga Urus Air Selangor*)
MaCGDI	Malaysian Center for Geospatial Data Infrastructure
MCM	Million cubic meter
Mld	Million liter per day
MMD	Malaysian Meteorologial Department
MRSO	Malaysian Rectified Skew Orthomophic
MyGDI	Malaysian Geospatial Data Infrastructure
NAHRIM	National Hydraulic Research Institute of Malaysia
NCLG	National Council for Local Government
NGVD	National Geodetic Vertical Datum
NH3-N	Ammoniacal nitrogen

NPV	Net present value
NRE	Natural Resources and Environment
NRW	Non-Revenue Water
NSC	National Security Council
NWQS	National Water Quality Standard
NWRC	National Water Resources Council
NWRD	National Water Resources Department
NWRS	National Water Resources Study (2000)
NWRS	National Water Resources Study, Malaysia (JICA, 1982)
NWSC	Suruhanjaya Perkhidmatan Air Negara
OJT	On-the-job training
PAAB	Water Asset Management Company (*Pengurusan Aset Air Berhad*)
PERHILITAN	Department of Wildlife and Natural Park Peninsular Malaysia (*Jabatan Perlindungan Hidupan Liar dan Taman Negara, Semenanjung Malaysia)*
PFA	Pig farm area
ppm	Part per million
PRECIS	Providing Regional Climate Impact Studies
PTG	Land and Mines Office (*Pejabat Tanah dan Galian*)
PWCC	PricewaterhouseCoopers Consulting Sdn. Bhd.
RBC	River Basin Committee
RB-DSS	National River Basin Decision Support System
RB-IMS	River Basin Infrastructure Management System
RBMO	River Basin Management Office
RBO	River Basin Organization
RB-SMS	River Basin Geographical Information System
RB-SMS	River Basin Simulation Modeling System
RCM	Regional Climate Model
RegHCM-PM	Regional Hydroclimate Model of Peninsular Malaysia
RM	Ringgit Malaysia
RMK-10	Tenth Malaysia Plan
RMK-8	Eighth Malaysia Plan
RMK-9	Ninth Malaysia Plan
RRB	National Register of River Basin Study
RRB2	Second Phase of the National Register of River Basin Study
RTU	Remote Terminal Unit
SAINS	Syarikat Air Negeri Sembilan Sdn. Bhd.
SAJ	Johor Water Company (*Syarikat Air Johor*)
SBMO	Sub-Basin Management Office
Sg.	River (*sungai*)
SPAN	Suruhanjaya Perkhidmatan Air Negara
SS	Suspended solids
st.	Station
STP	Sewage treatment plant
SWM	SWM Environment Sdn. Bhd.
SWRC	State Water Resources Council
TDS	Total dissolved solids
Tg.	Tanjung
TNB	Tenaga Nasional Berhad
TOR	Terms of Reference
TSS	Total suspended solids
UPEN	State Economic Planning Unit (*Unit Perancang Ekonomi Negeri*)
UPPP	Federal Project Implementation Unit (*Unit Pelaksanaan Projek Persekutuan*)
USD	US Dollar
USEPA	The United States Environmental Protection Agency
W.L.	Water Level
WRD	Water Resources Department
WQI	Water Quality Index

Measurement Units

(Length)		
mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)
(Area)		
mm^2	:	square millimeter(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
ha	:	hectare(s)
(Weight)		
g, gr	:	gram(s)
kg	:	kilogram(s)
ton	:	ton(s)

(Time)		
s, sec	:	second(s)
min	:	minute(s)
h, hr	:	hour(s)
d, dy	:	day(s)
y, yr	:	year(s)
(Volume)		
cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)
l, ltr	:	liter(s)
mcm	:	million cubic meter(s)
(Speed/Velocity)		
cm/s	:	centimeter per second
m/s	:	meter per second
km/h	:	kilometer per hour

CHAPTER 1 INTRODUCTION

1.1 Backgrounds

IRBM, Integrated River Basin Management is not a new thing for Malaysia.Several attempts of IRBM have been already commenced for the Langat, Kerian/Kurau, Kedah and Selangor River Basins. Based on these experiences, a framework for a IRBM study has been proposed in "The Study on a Blueprint for Integrated River Basin Management, Interim Report 1: Preliminary IRBM Framework, September 2008, DID ". Here, the proposed IRBM framework is summarized in a table matrix form showing objectives, data collection type and techniques, analysis type & methodology and output for every sector, which are required for the preparation of the IRBM study.

Development of technical guidelines and manuals, procedures, standards related to IRBM also has been progressed recently by DID and other related agencies. Among them, DID manual is a voluminous work developed through contributions from experiences in water and water resources engineering of nearly 200 professionals from the Government as well as private sectors. The manual consists of eleven separate volumes covering Flood Management; River Management; Coastal Management; Hydrology and Water Resources; Irrigation and Agricultural Drainage; Geotechnical, Site Investigation and Engineering Survey; Engineering Modeling; Mechanical and Electrical Services; Dam Safety, Inspections and Monitoring; Contract Administration; and Construction Management, and includes the latest standards and practices, technologies and best engineering practices that are applicable and useful for the country.

With these manuals, guidelines and framework, it seems that there is no need left for further development of any guidelines on IRBM. However, this Preparatory Survey still includes a few new challenges to Malaysia in terms of IRBM and IFM, and is very unique in followings:

- The two target river basins, Muar and Pahang are interstate river basins. This Preparatory Survey attempted, for the first time in Malaysia, to prepare IRBM and IFM plans for such interstate river basins,

- Impact of Climate Change was taken into consideration for the preparation of the IRBM and IFM plan. The adaptation to climate change in water resources management and flood management is also a new subject for Malaysia, and

- Capacity development was one of the main objectives of this survey. Capacity development activities including holding working group meetings and stakeholder meetings were vigorously executed through the survey.

According to the 10th Malaysia Plan, the IWRM approaches will be continued to be encouraged in planning, managing, protecting and rehabilitating water resources. In line with this national policy, IRBM will be continued to be promoted and introduced to other river basins. When diffusing IRBM to the other river basins in Malaysia, the above-said experiences of the Preparatory Survey are very useful. Therefore, these experiences are definitely worth recording as Guidelines for Introducing IRBM.

1.2 Objectives of Guidelines

Based on the above backgrounds, the objective of the guidelines is set up as follows:

Objective: To describe methodologies and lessons learnt in the course of the Preparatory Survey, which will be referred to when IRBM is introduced in the other river basins, especially for preparation of an IRBM and/or an IFM plan.

CHAPTER 2 NECESSITY OF IRBM

2.1 Current Fragmented River Basin Management

According to the 9th Schedule of the Federal Constitution of Malaysia, the rights, powers and responsibilities of the Federal and State government agencies are stipulated in List I -Federal List and List II-State List respectively. List III-Concurrent List stipulates the shared responsibility between the Federal and State government. Overall, the responsibility for management of land and water falls in the List II-State List, and water resources are therefore predominantly a state responsibility. However, the federal government is responsible for river basins shared by states, unless they are regulated by an agreement with all the states concerned. Hydropower is also a federal matter.

The target river basins for the Preparatory Survey, Muar and Pahang are both interstate river basins. The Muar River Basin is composed of four states, Negeri Sembilan, Johor, Pahang and Melaka, while the Pahang River Basin is composed of two states, Pahang and Negeri Sembilan. However, collaboration and coordination for river basin management is really dull among these states. According to officials of the concerned state DIDs, almost no significant collaboration activities including meetings for management of the two river basins had been held among the states concerned until the stakeholder meetings held between December 2009 and February 2010. Accordingly there is no agreement for river basin management among them.

Similar to the state-state relationship, the agency-agency relationship is also very weak. There are a variety of agencies that plan, develop and manage water and land for their needs. **Table 2.1.1** presents agencies at state level involved in IRBM-related activities. Each of the agencies works for own purposes, and as a result the river basin management has been fragmented.

Table 2.1.1 Distribution of IRBM-related Functions at State Level

Function	Responsible Agency	Remarks
River basin planning	UPEN, DID and JPBD	
Water abstraction	State Authority (regulator) JMG (technical advisor on groundwater)	
Water supply services	Provider: JBA, SAJH, SAINS Regulator: SPAN	Water supply services migrated into Concurrent List with the amendment of the Federal Constitution in January 2005.
Irrigation services	DID(MoA)	
Flood mitigation	DID(MNRE)	
Storm water management, urban drainage	Local authority DID (Technical advisor)	
Effluent management	Large industrial outlets: DOE Sewerage treatment plants: DOE Discharge to sewerage services: DSS	
Sewerage services	Provider: IWK Technical regulator: DSS Economic regulator: SPAN	Water supply services migrated into Concurrent List with the amendment of the Federal Constitution in January 2005.
Hydropower*	Operator: TNB Regulator: MEGTW	
Fishery/Aquaculture	Regulator: DOFi	
Inland/Navigation	Regulator: DOFi	

*: Hydropower is federal list.

2.2 Necessity of Integrated Approach

In spite of the fragmented river basin management, it seems that there have been so far almost no serious issues arising in the Muar and Pahang River Basins except for floods and some localized minor issues. It is probably because of their abundant river water resources and less development in the river basins. The

abundant water has allowed loose water resources management and diluted contaminated river water. The past urban development was so small in the vast river basins that the river basin environment has not drastically changed yet so far.

However, the fortunate conditions will not continue so long. It is projected by 2025 that demands for water supply will increase 150% to 200% for the Muar River Basin and 200% to 300% for the Pahang River Basin. As much as 700 km^2 and 4,600 km^2 of the present forest lands will be transformed into agricultural lands or build-up areas respectively for the Muar and Pahang River Basins. In addition, impacts of climate change are about to become tangible over the two river basins. If these issues are dealt with improperly, these changes definitely will cause a serious problem on water utilization, river environment, flood protection, etc.

What made it more difficult is that these issues will never be solved by a conventional sectoral approach. No single agency can deal with any of them. In stead a holistic, integrated approach, which associates a collaborative effort by the many stakeholders and with inputs from many technical disciplines, has become necessary. To cope with the increasing water demand, for example, not only development of water sources and water supply facilities but also demand management inclusive of improvement of NRW (Non Revenue Water) and promotion of water saving is indispensable. For the water resources development and the drought disaster management, coordination with other water users (agricultural sector) and between the upstream and downstream states concerned should be made based upon the basin-wide perspective.

2.3 Definition of IWRM, IRBM and IFM

A concept of the integrated approach emerged around the 1980s in response to increasing pressures on water resources from competition amongst various users for a limited water resource. DID defines **IWRM**（Integrated Water Resources Management） as a process, which promotes the coordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

IRBM, Integrated River Basin Management is generally referred to in the context of implementing **IWRM** for the provision of water services at the river basin level. It is defined by DID that IRBM is a process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary restoring freshwater ecosystems.

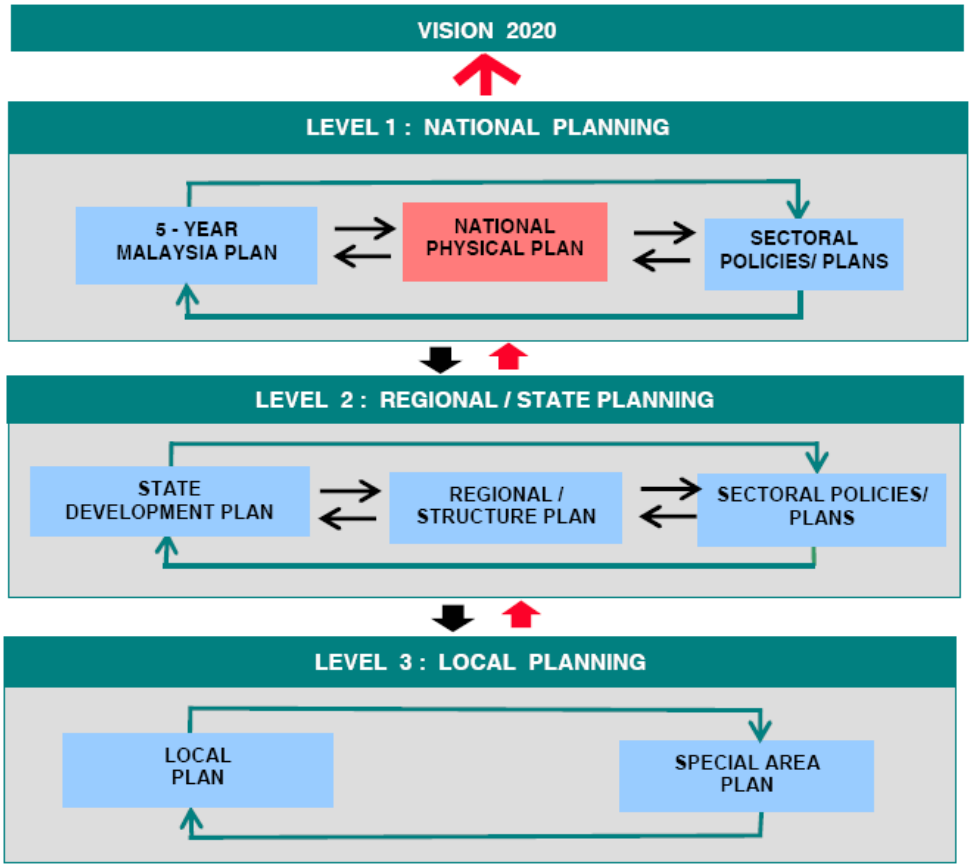
IFM, Integrated Flood Management is also an integrated approach, of which objective is to mitigate negative impact of floods. DID has defined it as a process of promoting an integrated approach to flood management incorporated into the Integrated Water Resources Management (IWRM) aimed at maximising benefits from the use of floodplains without compromising on sustainability of the vital ecosystems.

Experience in various countries has shown that such an integrated approach is an essential prerequisite for effectively coordinating water development strategies across diverse sectors, political jurisdictions and geographical regions within a river basin. Thus it is now a global trend to introduce integrated approach as the World Summit on Sustainable Development (WSSD) in 2002, where Malaysia joined other governments in committing to put in place plans for sustainable management of water resources by 2005.

2.4 Federal Policies on IRBM

Development planning is practiced at all the three tiers of government. At the national level, development planning is guided by the Five-Year Malaysia Plan (FYMP), the National Physical Plan (NPP) and the sector policies that emanate from Cabinet, the respective Ministries and Sector Councils. Contextually development planning in the country will operate within the stated goals outlined in Vision 2020 and the Outline Perspective Plans (OPP3) as shown in **Figure 2.4.1**. Similarly at the state level, development will

be guided by the Structure Plans and sector policies that are articulated from time to time. Local level planning will be carried out in the form of statutory development plans such as the Local Plans and Special Area Plans for the local authority areas.



Quoted from "National Physical Plan, JPBD"

Figure 2.4.1 National Development Planning Framework

2.4.1 Five-Year Malaysia Plan (FYMP)

The five-year Malaysia Plan specifies the size and allocation of the public sector development program, and plays the role of a de facto investment plan. In other words, the Malaysia Plan clearly lays out the public investment priorities that are backed by budget implications.

(1) 8th Malaysia Plan (2001-2005)

In the 8th Malaysia Plan, covering 2001-2005, the integrated river basin approach was emphasized for the first time. This plan also encouraged state government to establish water management bodies such as LUAS to ensure proper planning, monitoring, enforcement and management of water resources on a river-basin basis.

(2) 9th Malaysia Plan (2006-2010)

The 9th Malaysia Plan (2006-2010) aims to concentrate the country's efforts on priority areas which ultimately leads to achieving Vision 2020 (Malaysia is a fully developed country by the year 2020. These priority areas encompass the nation's global competitiveness, human capital development, national integration, ethnic relations, distribution of income and wealth and the quality of life. Major policies related to IRBM highlighted in the 9th Malaysia Plan are presented in **Table 2.4.1**.

Table 2.4.1 Policies and Targets Related to IRBM in the 9th Malaysia Plan

Sector	Policies and Targets
Water Supply	• Efforts are undertaken to conserve the quality and improve the quality of existing water resources as well as identify potential water resources. • The water demand and the water production for domestic and industrial use are expected to increase to 665 mld and 722 mld for Negeri Sembilan, 1,489 mld and 1,747 mld for Johor, and 1,187 mld and 1,340 mld for Pahang in 2010, respectively. • The efficiency of water supply is improved through NRW reduction programme with measures including strict enforcement against water theft, pipe and meter replacements, GIS maping of distribution networks, rehabilitation of distriburtion systems and upgrading of existing WTPs as well as setting up of operation centers. The target NRW in 2010 is 35%, 521 mld for Johor and 45%, 299 mld for Negeri Sembilan, and 40%, 475 mld for Pahang respectively. • To increase accessibility to potable water in rural areas, priority will be given to states with low supply coverage such as Sabah, Sarawak, Pahang, Kelantan, Trengganu and Kedah. • The groundwater exploration and development programme is also undertaken to supply water to other water shortage areas and for irrigation. • IWRM (Integrated Water Resources Management) approachis promoted to achieve sustainable water resources development. • Non-structural measures to improve water supply services continue to be implemented including the promotion of wise use of water. • The SPAN is operationalized during the Plan period to regulate water supply and sewerage services in Peninsular Malaysia. In addition WAMCO(Water Asset Management Company) is established to develop future water supply structures.
Sewerage	• Sewerage services continue to be expanded to essure the quality of effluent discharged into receiving water bodies comply with environmental standards and safeguard public health. • Upgrading, rehabilitation, and refurbishment of existing sewerage treatment systems, which are in the catchments of public water supply systems continue to be given priority. • Awareness campaigns on the importance of managing wastewater and sewerage systems for maintaining cleanliness and protecting the environment as well as water resources is intensified.
Flood Mitigation	• Continuous efforts are undertaken to reduce flood hazards in the Klang Valley as well as other flood prone areas throughout the country with the implementation of both structural measures such as the construction of flood retention ponds, river improvement works and flood diversion as well as non-structural measures such as land use controls and integrated flood forecasting, warning and response systems. • The Urban Stormwater Management Manual for Malaysia (MSMA) is extended to new development areas throughout the country.

(3) 10th Malaysia Plan (2011-2015)

The 10th Malaysia Plan (2011-2015) was tabled by the Prime Minister in Parliament in June 2010. In his speech it was stressed that the 10th Malaysia Plan is critical for the continuation of the national agenda to realize Vision 2020. The 10th Malaysia Plan targets the gross national income per capita to increase to RM 38,850 in 2015; and this requires the GDP to grow 6 % per annum.

Regarding policies related to IRBM, the IWRM approaches are continued to be encouraged in planning, managing, protecting and rehabilitating water resources. It is noted that the 10th Malaysia Plan committed that Malaysia would adopt a dual strategy in addressing climate change impacts, first adaptation strategies to protect economic growth and development factors from the climate change impacts, and second mitigation strategies to reduce emission of greenhouse gases. **Table 2.4.2** presents policies and strategies related to IRBM in the 10th Malaysia Plan.

Table 2.4.2 Policies and Strategies Related to IRBM in the 10th Malaysia Plan

Sector Policies	Strategies	Measures	Contents
Provide efficient public utilities and services (Public Utilities)	Manage water endowment and Supply	Develop a long-term strategy for water resource management to achieve water security	• Establish the National Water Resources Policy (NWRP). • Expand the implementation of IRBM approaches in planning, managing, protecting and rehabilitating water resources. • Provide RM 5 billion for flood mitigation.
		Continue efforts to restructure the water services industry	• Complete the migration of state water operators • Move towards full cost recovery • Drive efficiency in operations and capital expansion • Improve water services infrastructure • Integrate water and sewerage services
		Protect rivers from pollution	• Strengthen the enforcement on industrial effluents and sewage discharge in line with the revisions to thr regulations under the Environmental Quality Act 1974. • Assess the total maximum daily load and carrying capacity of rivers for both points and non-point sources of pollution. • Revise the current Water Quality Index • Develop the National Marine Water Quality index to replace the current Marine Water Quality Criteria and Standards • Expand outreach and awareness programs
	Restructure Solid Waste Management	Provide support to local authorities	• Relieve local authorities of solid waste management and public cleansing by privatization
		Deliver comprehensive and Sanitary services	• Stringently manage the performance of the three concessionaires
		Ensure waste is managed in a sustainable manner	• Promote 3R (the reduce, reuse, recycle)
Value the nation's environmental endowments (Environment)	Develop a climate resilient growth strategy	Protect the Nation from the Risks of Climate Change (Climate Adaptation)	• Develop a robust risk framework to assess and quantify the climate risk and prioritise measures to address those risks • Implement policy decision framework to ensure that future infrastructure investments are climate resilient • Enhance capacity in the field of climate prediction and modelling
		Reduce Malaysia's Carbon Footprint (Climate Mitigation)	• Create stronger incentives for investments in renewable energy (RE) • Promote energy efficiency to encourage productive use of energy; • Improve solid waste management; • Conserve forests • Reduce emissions to improve air quality.
	Enhance conservation of the nation's ecological assets	Enhance forest and wildlife conservation efforts	• Implement the Central Forest Spine of 4.32 million hectars in Peninsular Malaysia • Enhance regulations governing the trade of endangered fauna and flora • Link or integrate existing biodiversity inventory and databases.
		Ensuring sustainable and safe utilisation of resources	• Co-opting local communities in conservation efforts • Establish a legal framework on access and benefit sharing

2.4.2 National Physical Plan (NPP)

The National Physical Plan (NPP), which was approved by the National Physical Plan Council on April 26, 2006, is a written statement of strategic policies on the physical development and conservation throughout Peninsular Malaysia. The plan needs to be a guideline for the physical planning by federal and state agencies in constructing projects and programs for the Five Year Malaysia Plan (FYMP) and should be implemented at federal and states level throughout Peninsular Malaysia.

The NPP has a goal "The establishment of an efficient, equitable and sustainable national spatial framework to guide the overall development of the country towards achieving developed nation status by 2020" with following four objectives:

- To rationalise national spatial planning for economic efficiency and global competitiveness,
- To optimise utilisation of land and natural resources for sustainable development,
- To promote balanced regional development for national unity, and
- To secure spatial and environmental quality and diversity for a high quality of life.

The NPP contains a set of 36 policies. Out of them the following nine policies are related to IRBM:

Table 2.4.3 NPP Policies related to IRBM

Number	Policies
NPP 18	• Environmentally Sensitive Areas (ESA) shall be integrated in the planning and management of land use and natural resources to ensure sustainable development.
NPP 19	• A Central Forest Spine (CFS) shall be established to form the backbone of the Environmentally Sensitive Area network.
NPP 21	• Land development in the highlands shall be strictly controlled to safeguard human safety and environmental quality.
NPP 22	• All surface and ground water resources are strategic assets to be safeguarded and used optimally.
NPP 30	• The supply and projected demand for water by quantity and location should guide the planning of water resource areas.
NPP 31	• Ground water resources and recharge areas shall be identified and protected from activities that cause pollution and reduce yield.
NPP 32	• All urban settlements shall be serviced by a centralised sewerage treatment system.
NPP 33	• All urban settlements shall be serviced by an integrated network of solid waste disposal and/or recovery facilities.
NPP 34	• Land utilised for main drains, streams and rivers shall be designated as drainage or river reserves.

2.5 Current Situation of IRBM

In line with the national policy, several attempts have been materialized in relation to the implementation of IRBM. IRBM plans have been already prepared for the Langat (Selangor), Kedah, Selangor and Kerian/Kurau Rivers, although the pace is very slow compared to the commitment in the World Summit on Sustainable Development (WSSD) in 2002. Institutional strengthening for the IRBM implementation has also commenced. LUAS is the first apex organization devoted to IRBM in Malaysia. The Kedah State Government is about to establish Water Resources Board. In 2009, just before the commencement of this Preparatory Study, Management and Technical Committees for the Muar River Basin and Technical Committee for the Pahang River Basin were organized under the initiative of DID. These achievements are summarized in **Table 2.5.1**.

Table 2.5.1 History of Achievements for Implementation of IRBM in Malaysia

Year	Achievements
1998	Creation of National Water Resources Council (NWRC)
1999	Formation of Apex organization (LUAS)
2001	Publication of Storm Water Management Manual (MSMA)
2002	National Sewerage project-National Strategic Plan for Solid Waste Management
2003	NWRC's acceptance of IRBM Study on Integrated catchment management of Sungai Damansara
2004	Creation of Ministry of National Resources and Environment (MNRE)
2005	National Study for the Effective Implementation of IWRM in Malaysia Sungai Langat Integrated River Basin Management Study
2007	Sungai Selangor Basin Management Plan Sungai Kedah Basin Management Plan
2008	The Study on a Blueprint for Integrated River Basin Management Water Service Industry Act
2009	Creation of Management Committee and Technical Committee for Muar River Basin Creation of Technical Committee for Pahang River Basin
2010	Review of National Water Resources Study (2000-2050) and Formulation of National Water Resources Policy

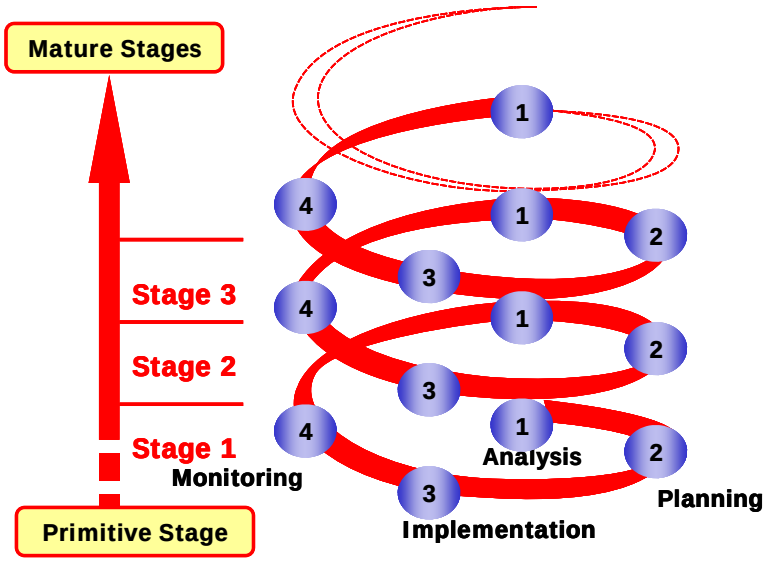
2.6 Spiral Evolution of IRBM

Similar to IWRM, IRBM is likened to an upward spiral process. The IRBM process moves upward in several stages starting from the initial primitive stage toward the more mature stages as shown in **Figure**

2.6.1. This means that river basin management evolves over time by addressing new demands and needs and utilizing innovative solutions at each stage.

Moreover, each of the stages in the process is composed of following four sequent steps, (1)Assessment, (2)Planning, (3)Implementation and (4)Monitoring. Each stage is followed by the next stage composed of another sequence of the steps. IRBM could be continuously improved in this process.

At the national level it can be said that Malaysia already reached the second stage if the above-said history of the IRBM Implementation is taken into consideration. In introducing IRBM to a new river basin, the experiences of the advanced states and river basins should be utilized as much as possible.



Source: UNESCO IWRM Guidelines, 2009

Figure 2.6.1 IRBM Spiral Process

CHAPTER 3 SETUP OF RIVER BASIN COMMITTEES

3.1 Introduction

River water-related policies and projects are executed by many different agencies in Malaysia. If the river crosses a state boundary, river basin management becomes much more complicated. In order to implement an IRBM process, a mechanism for coordinating their interests is necessary at the basin level. There are generally two types of management systems, 1) IRBM under a solo apex authority and 2) IRBM managed by a river basin committee comprised of various sectors.

To create such an apex authority, however, it is required to make a law or an enactment first. This means it takes a considerable long time to establish the apex authority. On the other hand, creation of committees is much easier and needs no legislation process. As the first step of the IRBM process, it is realistic to start with a river basin committee, which will work for preparing an IRBM plan at least as experienced in the Preparatory Survey. The institutional setup for the second step after the establishment of the IRBM, namely implementation of the IRBM plan, can be discussed in the course of the IRBM planning or temporal IRBM implementation under the committee. Followings are descriptions about the river basin committees that were established for the Preparatory Survey.

3.2 Creation of River Bain Committee

Since the two river basins, Muar and Pahang are shared by two or more states, the Federal Government also can intervene in accordance with the Constitution, and each of the two river basin committees has a four-layer structure, namely a management committee and a technical committee of the federal level, and (a) task force(s) and working groups of the state level, as shown in **Figure 3.2.1**.

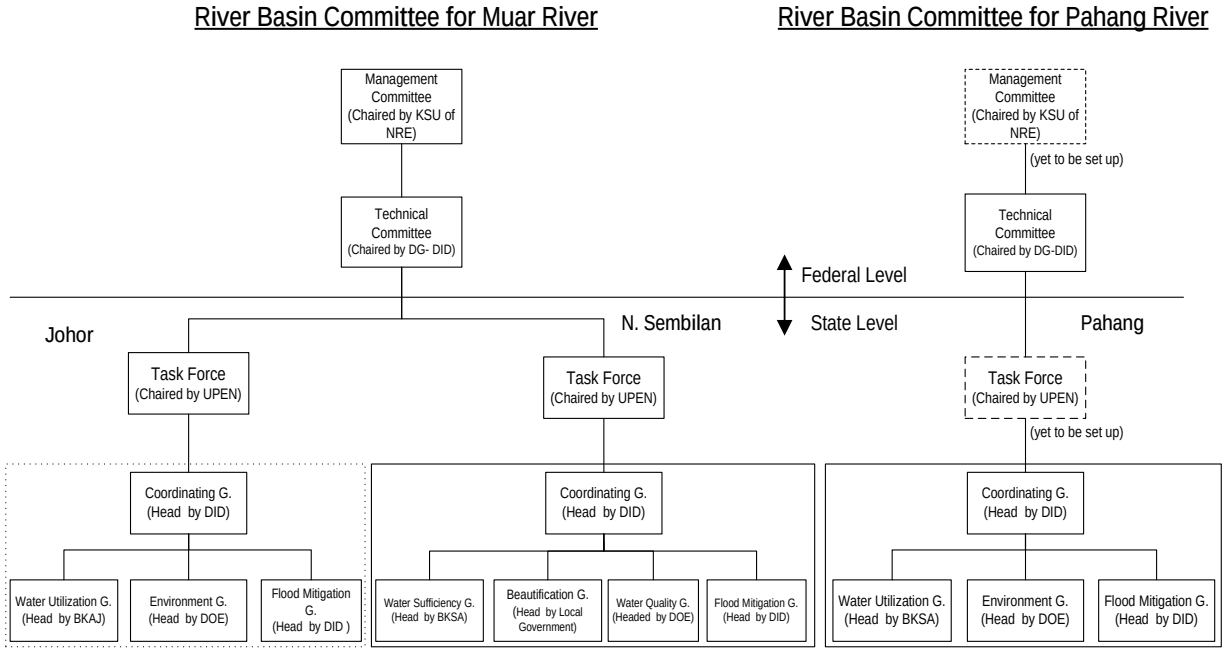


Figure 3.2.1 Structure of River Basin Committees

The management committee and the technical committee for the Muar River Basin and the technical committee for the Pahang River Basin were established until the kick-off meeting of the Preparatory Survey, the management committee for the Pahang River Basin is yet to be set up. A task force was required only for every important state for the two river basins that occupies a significant catchment area, namely Negeri Sembilan and Johor for the Muar River Basin, and Pahang only for the Pahang River Basin. However, two states of Melaka and Pahang are involved in the federal level committees for the Muar River Basin, although they have no task force. Similarly the State of Negeri Sembilan is involved in the technical committee for the Pahang River. In case of a river basin, of which entire basin falls in a

single state, two committees at the federal level are not necessary, and the state's task force will be the top decision-making organization for the river basin. The TORs and the members for the committees are summarized in **Table 3.2.1**.

Table 3.2.1 Members and TORs for River Basin Committees

Committee	Item	Muar River Basin		Pahang River Basins
		Negeri Sembilan State	Johor State	Pahang State
Management Committee (Federal Level)	Chairperson	Secretary General, NRE		Yet to be set up
	Acting Chairperson	Deputy Secretary General, NRE		
	Secretariat	Irrigation and Drainage Division and NRE and MacGDI		
	Members	12 members from the federal government and 4 members form the 4 state governments concerned.		
	TORs	• Function as a discussion forum, • Recommend IRBM policies/programs to the Government, • Monitor IRBM policies/programs, • Recommend further actions, and • Build capacity		
Technical Committee (Federal Level)	Chair	DG, DID		DG, DID
	Secretariat	River division, DID		River division, DID
	Members	6 members from the federal government, 26 members from the 4 state governments concerned and a member from a water supply company for Melaka.		12 members from the federal government, 13 members from the 2 state governments concerned and 2 members from two water supply companies for Pahang and N. Sembilan.
	TORs	• Undertake an investigation requested by NRE; • Design implementation activities and programs; • Check water quality of rivers, groundwater, swamps and lakes, and propose measures, • Make recommendations for any identified changes so as to improve the management of river basin; • Advice on approval of development works • Undertake any functions as directed by NRE, and DID		Same as Muar River Basin
Task force	Chair	Director, UPEN	Director, UPEN	In the process of being set up. (Members and TORs will be similar to those of N. Sembilan)
	Secretariat	State DID	State DID	
	Members	11 members from State Government and 6 members from the 3districts concerned.	12 members from State Government and 9 members from the 3districts concerned.	
	TORs	• Identify issues; • Recommend strategies and measures; • Implement action plans; • Prepare report on the implementation of action plans; • Recommend improvements to the action plans; • Make recommendations on any identified changes; • Undertake any functions as directed by NRE and DID	Same as N. Sembilan	

3.3 Setup of Working Group

As the objectives of the Preparatory Survey say, the capacity development of the river basin committees was one of the important components. The Preparatory Survey aims to execute the capacity development through the OJT (On the Job Training) for elaborating IRBM and IFM plans. Therefore, the JICA Study needs regular working partners in the river basin committees.

For this purpose, four or five working groups (a coordinating group and three or four groups under the coordinating group for specific subjects such as flood mitigation, environment and water utilization) were organized under each state task force as shown in **Figure 3.2.1**. The working groups are consisting of several federal, state or district agencies' staff at an operational level. Though the working groups were organized mainly for the purpose of capacity development in this Preparatory Survey, these kinds of groups seem necessary for regular works such as data collection, site visits and technical consultation for IRBM planning, too. A local consultant, who is entrusted to prepare an IRBM plan, will be helped very

much by these groups to efficiently conduct the study as the JICA Study Team was helped. Working group members of Johor State is presented in **Table 3.3.1**.

Table 3.3.1 Member Agencies of Working Groups

Coordinating Group	Department of Irrigation and Drainage (DID), Johor Advised by JICA Study Team		
Working Group	Water Utilization	Environment	Flood Mitigation
Group Head	Water Regulatory Body, Johor (BAKAJ)	Department of Environment (DOE), Johor	Department of Irrigation and Drainage (DID), Johor
Group Members	• Department of Agriculture, Johor • Fishery Department, Johor • Marine Department, Johor • Department of Irrigation and Drainage (DID), Johor • Tourism Department, Johor • Health Department, Johor • SPAN • PAAB	• Sewerage Service Department, South Branch • Health Department, Johor • Muar District Council • Segamat District Council • Ledang District Council • Department of Agriculture, Johor • Water Regulatory Body, Johor • Forestry Department, Johor • Department of Mineral and Geoscience, Johor • Department of Irrigation and Drainage (DID), Johor	• Muar District Council • Segamat District Council • Ledang District Council • Muar District Office • Segamat District Office • Ledang District Office • Land and Mines Department, Johor • Department of Mineral and Geoscience, Johor • Town and Country Planning Department, Johor • Department of Environment (DOE), Johor • Forestry Department, Johor • Department of Agriculture, Johor • BAKAJ

3.4 Stakeholder Meeting

Public participation is one of the most important key factors for the success of IRBM. To elaborate an IRBM plan that reflects voices from a variety of stakeholders, it is necessary to involve them in the IRBM planning form early stages.

In line with this policy, the Preparatory Survey has been making efforts to hold stakeholder meetings since the commencement of the survey. A total of seven stakeholder meetings, four meetings for the Muar River Basin, three meetings for the Pahang River Basin, were held in the one-year study period. It is noted that officials of Negeri Sembilan State met their counterparts of Johor for the first time at the stakeholder meeting for the Muar River Basin in December 2009. These meetings are summarized in **Table 3.4.1**.

It is regrettable that there were few or no private citizens present at the meetings. Almost all the participants were government employees of states, district offices and local authorities. A stakeholder meeting that invites NGOs and private citizens is still new in Malaysia. The state DIDs that were responsible for inviting participants were probably not so familiar with how to manage it.

Table 3.4.1 Summary of Stakeholder Meetings

River Basin	Date	Venue	Main Subjects	Participants
Muar	10 December '09	Muar	Extraction of Issues on IRBM	69 persons (62 government employees and 7 private citizens)
	5 February '10	Segamat	Discussion on proposed IFM Plan	38 persons (government employees only)
	12 May '10	Gemas	Discussions on proposed IRBM Plan and proposed Gemas Flood Mitigation Project	24 persons (government employees only)
	25 August '10	Alor Gajah	Discussions on proposed IRBM Plan and proposed Gemas Flood Mitigation Project	47 persons (46 government employees, 1 private citizens)
Pahang	2 February '10	Kuantan	Extraction of Issues on IRBM and Discussion on proposed IFM Plan	70 persons (68 government employees and 2 private citizens)
	10 May '10	Temerloh	Discussions on proposed IRBM Plan and proposed Temerloh Flood Mitigation Project	24 persons (government employees only)
	23 August '10	Temerloh	Discussions on proposed IRBM Plan and proposed Temerloh Flood Mitigation Project	40 persons (government employees only)

CHAPTER 4 IMPACT OF CLIMATE CHANGE

4.1 Introduction

Climate Change that accompanies global warning is now becoming a serious concern to be shared by all people in the world. The 4th Assessment Report that was published in 2007 by the Intergovernmental Panel on Climate Change (IPCC) shows more realistic impacts of climate change, as presented in **Table 4.1.1.**

In the Asia Region, especially in coastal and low-land areas, both the frequencies and scales of floods, storm-surge and other disasters are predicted to increase due to sea level rise, frequent heavy precipitation events. Serious droughts are also likely to increase due to a greater degree of fluctuation in precipitation. Climate change, unless people address it appropriately, may shake the foundation of people's life, as well as those on ecosystems, water resources, foods, industries, and human health.

Table 4.1.1 Impact Projection on Asia Region by IPCC

Item	Projection
Water Availability	By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
Flooding	Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.
Natural resources and Environment	Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development.
Endemic morbidity and mortality	Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

Source: "Climate Change 2007: Synthesis Report, IPCC"

As for Peninsular Malaysia, NAHRIM conducted "Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia" between 2002 and 2006 to build up knowledge in the area of climate change projection. As **Table 4.1.2** shows, the study projects that extreme hydrologic phenomenon such as floods and droughts would take place more frequently and in an amplified manner in the future.

Table 4.1.2 Impact Projection on Peninsular Malaysia by NAHRIM

Item	Projection
Temperature	The whole Peninsular Malaysia will be warmed by about 2 degrees Celsius in the next 50 years.
Precipitation	Generally higher maximum and lower minimum precipitation are projected in the future in many sub-regions of Peninsular Malaysia.
Evapotranspiration	No clear trend is projected in the future.
Soil moisture	No effect of climate change is pronounced on soil water storage.
River Flow	Inter-annual and intraseasonal variability with increased hydrologic extremes (Higher high river discharges and lower low river discharges) are expected in Kelantan, Terengganu, Pahang and Kedah watersheds.

Source: "Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia, NAHRIM, 2006.

To cope with these impacts, the IPCC report suggests that it be as important to promote "adaptation" to climate change as to promote "mitigation" since climate change "mitigation" centered around the reduction of greenhouse gases has limitations, and the climate change impacts would continue over centuries even when "mitigation" is implemented. Malaysia also committed in the 10th Malaysia Plan to adopt a dual strategy in addressing climate change impacts: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce of green house gases.

To plan effective adaptation measures dedicated to a specific river basin, it is indispensable to project impact of climate change on the river basin concerned. Based on the projection results for the river basin, adaptation measures should be studied.

In this chapter, firstly availability of projection data and several emission scenarios are described. Then methodologies applied to estimate impacts of climate change on the target river basin in this Preparatory Survey are explained, focusing on rainfall intensity during floods and long-term runoff discharges. Several adaptation measures conceived in Japan are introduced together with those implemented in the other foreign countries. Finally uncertainty of projection results by the simulation models is discussed.

4.2 Availability of Climate Change Projection Data

4.2.1 Data Availability

The 4th Assessment Report of IPCC is based on simulation results of 25 state-of-the-art General Circulation Models (GCMs) developed by leading institutes worldwide. These data are made available under the Coupled ModelIntercomparison Project phase 3 (CMIP3) as an activity of the World Climate Research Programme(WCRP).

<**About the WCRP CMIP3 Multi-Model Dataset Archive at PCMDI**>

In response to a proposed activity of the World Climate Research Programme's (WCRP's) Working Group on Coupled Modeling (WGCM), PCMDI (Program for Climate Model Diagnosis and Intercomparison) volunteered to collect model output contributed by leading modeling centers around the world. Climate model output from simulations of the past, present and future climate was collected by PCMDI mostly during the years 2005 and 2006, and this archived data constitutes phase 3 of the Coupled Model Inter-comparison Project (CMIP3). In part, the WGCM organized this activity to enable those outside the major modeling centers to perform research of relevance to climate scientists preparing the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC).

This unprecedented collection of recent model output is officially known as the "WCRP CMIP3 multi-model dataset." It is meant to serve IPCC's Working Group 1, which focuses on the physical climate system -- atmosphere, land surface, ocean and sea ice -- and the choice of variables archived at the PCMDI reflects this focus. A more comprehensive set of output for a given model may be available from the modeling center that produced it.

With the consent of participating climate modeling groups, the WGCM has declared the CMIP3 multi-model dataset open and free for non-commercial purposes. After registering and agreeing to the "terms of use," anyone can now obtain model output via the ESG data portal, ftp, or the OPeNDAP server.

As of January 2007, over 35 terabytes of data were in the archive and over 337 terabytes of data had been downloaded among the more than 1200 registered users. Over 250 journal articles, based at least in part on the dataset, have been published or have been accepted for peer-reviewed publication.
Source: http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php

19 GCMs out of the 25 have daily land surface projection outputs until the end of the 21th century are available for the purposes of the Preparatory Survey, as presented in **Table 4.2.1**. The horizontal resolutions of the GCMs are as coarse as 0.2° x 0.2° to 5° x 5°, depending upon the models. Simulations by improved GCMs are now being executed to input their results to the 5th Assessment Report, which is scheduled to be public in September 2013.

Regional Climate Models (RCMs) are similar to GCMs, but are of higher resolution and therefore contain a better representation of, for example, the underlying topography within the model domain. The general approach is to 'nest' an RCM within a 'driving' GCM so that the high resolution model simulates the climate features and physical processes in much greater detail for a limited area of the globe, whilst drawing information about initial conditions, time-dependent lateral meteorological conditions and surface boundary conditions from the GCM.

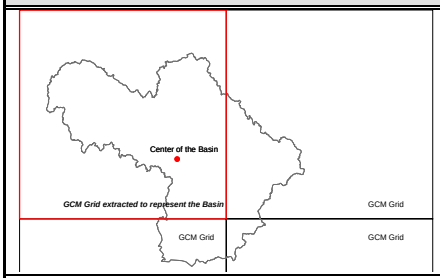
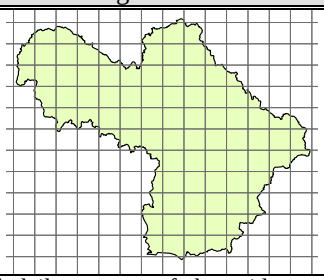
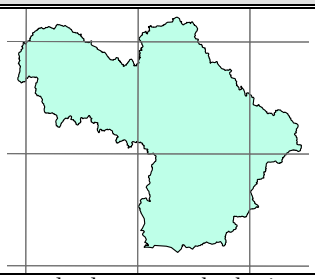
Two Malaysian institutes, NAHRIM and Malaysian Meteorological Institute developed RCMs for Peninsular Malaysia and Southeast Asia respectively. NAHRIM, jointly with University of California developed Regional Hydroclimate Model of Peninsular Malaysia (RegHCM-PM) with horizontal resolution of 9km x 9km. Malaysian Meteorological Department (MMD) has developed a Regional Climate Model (RCM) as well with horizontal resolution of 50km x 50km, covering Southeast Asia including whole Malaysia utilizing Providing Regional Climate Impact Studies (PRECIS) model developed by Hadley Centre, UK. Features of the two models are presented in **Table 4.2.1**

Table 4.2.1 Data Availablity of GCMs

Model Type	Model ID	Target Area	Spatial Resolution	Scenario	Period of Histrical Experiment	Projection Period
General Circulation Model	BCCR-BCM2.0, Norway	Entire Globe	0.2^o x 0.2^o to 5^o x 5^o, depending on the model	A1B	1981-1999	2056-2065, 2081-2099
	CCSM3, USA				1950-1999	2046-2065, 2080-2099
	CGCM3.1(T47), Canada				1961-2000	2046-2065, 2081-2100
	CGCM3.1(T63), Canada				1961-2000	2046-2065, 2081-2100
	CNRM-CM3, France				1981-2000	2046-2065, 2081-2100
	CSIRO-Mk3.0, Australia				1981-2000	2046-2065, 2081-2100
	CSIRO-Mk3.5, Australia				1981-2000	2046-2065, 2081-2100
	ECHAM5/MPI-OM, Germany				1981-2000	2046-2065, 2081-2100
	ECHO-G, Germany/Korea				1959-1998	2043-2062, 2078-2098
	GFDL-CM2.0, USA				1981-2000	2046-2065, 2081-2100
	GFDL-CM2.1, USA				1981-2000	2046-2065, 2081-2100
	GISS-AOM, USA				1961-2000	2046-2065, 2081-2100
	GISS-ER, USA				1961-2000	2046-2065, 2081-2100
	INGV-SXG, Italy				1981-2000	2046-2065, 2081-2100
	IPSL-CM4, France				1961-2000	2045-2064, 2080-2099
	MIROC3.2(hires), Japan				1981-2000	2046-2065, 2081-2100
	MIROC3.2(medres), Japan				1961-2000	2046-2065, 2081-2100
	MRI-CGCM2.3.2, Japan				1981-2000	2046-2065, 2081-2100
	PCM, USA				1890-1999	2040-2059, 2080-2099
Regional Climate Model (RCM)	RegHCM-PM by NAHRIM	Peninsula Malaysia	9 km x 9 km	IS92a	1984-1993	2026-2035, 2041-2050
	PRECIS by MMD	Southeast Asia	50 km x 50 km	A1B	1961-1990	2001-2099

Usually a GCM and a RCM databases contain a huge volume of data. It is necessary to extract necessary data for the target river basin from the huge database. In the case of the Muar River Basin, objective daily data were extracted in consideration of the relationship between the size of the river basin and the model resolution (grid), as shown in **Table 4.2.2**.

Table 4.2.2 Extraction of Necessary Data for Muar River Basin

GCMs	RegHCM-PM	PRECIS
		
Daily outputs of the grid that includes the center of the basin were extracted from the GCM result to represent the whole basin.	All daily outputs of the grids partially or completely covers the basin were extracted from the RCM results	

4.2.2 Emission Scenario

The projection of climate change impacts depends upon the scenario of future greenhouse gases emission. IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios - SRES). The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions.

The SRES team defined four narrative storylines, labelled A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century for large world regions and globally. Each storyline represents different demographic, social, economic, technological, and environmental developments that diverge in increasingly irreversible ways. Moreover, three scenarios were further developed from A1 scenario, characterising alternative developments of energy technologies: A1FI (fossil intensive), A1T (predominantly non-fossil) and A1B (balanced across energy sources). These six scenarios are summarized in **Table 4.2.3**.

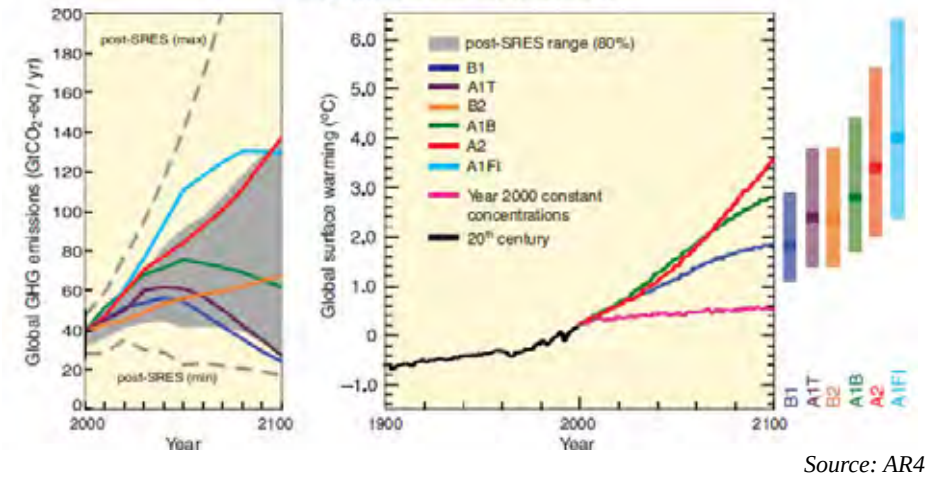
Source: SRES

Figure 4.2.1 Image of SRES Scenarios

Table 4.2.3 SRES Scenarios

SRES Senario	World assumed by the scenario	Direction of Technology
A1FI	A world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies.	Fossil intensive
A1T		Predominantly non-fossil
A1B		Balanced across all sources
A2	A very heterogeneous world with high population growth, slow economic development and slow technological change	
B1	A convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy.	
B2	A world with intermediate population and economic growth, emphasizing local solutions to economic, social, and environmental sustainability	

In this Preparatory Survey the A1B scenario, which gives mid-range projection values, was selected as a representative scenario of the six scenarios. Namely projection results only under the A1B scenario were collected and used for the succeeding analysis. As for RegHCM-PM by NAHRIM, projection results under the old scenario, IS92a were used, because the old scenario projections are alone available for this model. Whatever scenario is applied, impact projection results are not significantly different until around 2050 at least, as shown in **Figure 4.2.2**.



Source: AR4

Figure 4.2.2 Projections of Surface Temperatures for SRES Scenarios

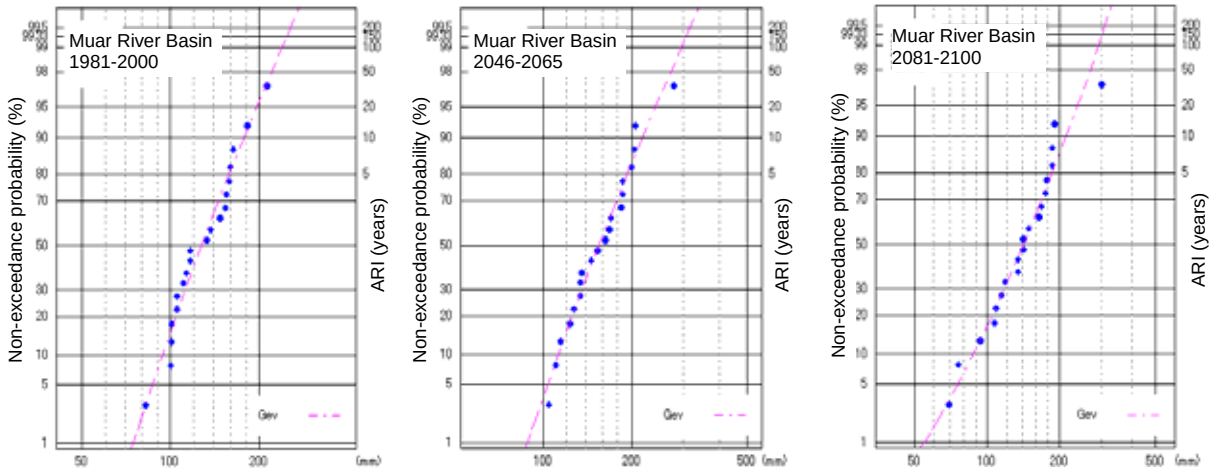
4.3 Estimation of Impact of Climate Change

4.3.1 Impact on Extremely Heavy Rainfall

It is said that as an impact of climate change flood phenomenon will become more severe and more frequently. From a viewpoint of flood management engineering, this can be explained by increase in extreme rainfall intensity for the river basin, which can be estimated from frequency analysis using the GCM and RCM projection results. Following is an example for the Muar River Basin:

(1) Frequency Analysis

Since 3 days is considered as the design flood rainfall duration for the Muar River Basin, the frequency analysis was conducted for 3-day rainfalls. First annual maximum 3-day rainfalls were calculated based on daily rainfall data of GCMs and RCMs for two 20-year periods of 2046-2065 and 2081-2100 which corresponds to approximately 40 years and 90 years from the present. Those of historical 20 years (1981-2000 or other depending upon the data availability) were also calculated to represent the current conditions. Then, the three sets of annual maximum rainfalls were analyzed respectively to estimate 3-day rainfalls with various ARIs for different three periods. **Figure 4.3.1** and **Table 4.3.1** show examples of results of a frequency analysis based on data of Canadian GCM(CGCM3.1(T47). According to **Table 4.3.1**, the probable 3-day rainfalls will increase 22% to 24% at 2050, and 11% to 22% at 2100 relative to 1990 (1981-2000), depending upon the ARI.



General Extreme Value (GEV) distribution, Plotted on Log-Normal Probability Paper

Figure 4.3.1 Frequency Plotting of 3-Day Rainfalls Based on Results of CGCM3.1(T47), Canada

Table 4.3.1 Probable 3-day Rainfalls and Incremental Ratios obtained based on CGCM3.1(T47), Canada (Upper table: Probable 3-day Rainfalls, Lower table: Incremental ratios relative to 1990(1981-2000))

3-day Rainfall (mm)

	ARI (years)						
	100	50	30	20	10	5	2
1990	238.0	220.3	207.1	196.4	177.6	157.7	127.2
2050	295.9	273.4	256.5	242.9	219.0	193.7	154.9
2090	289.3	268.5	252.2	238.7	213.9	186.3	141.1

Incremental Ratio relative to 1990 (1981-2000)

	ARI (years)						
	100	50	30	20	10	5	2
1990	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2050	1.24	1.24	1.24	1.24	1.23	1.23	1.22
2090	1.22	1.22	1.22	1.22	1.20	1.18	1.11

(2) Incremental Ratio

Results like **Figure 4.3.1** and **Table 4.3.1** were obtained for the other GCMs and the RCMs. **Figure 4.3.2** shows incremental ratios of the 100- year ARI 3-day rainfalls obtained by the GCMs and RCMs. The incremental ratios vary from 0.96 to 1.98, depending on the model. This wide variation that

implies uncertainty of the projections by the GCMs and RCMs should be noted for considering adaptation measures. In case of the Preparatory Survey, the arithmetic average ratio of all the models was used for the IFM planning.

Table 4.3.2 shows the future projected increases in the probable 3-day rainfalls for various ARIs. The results indicate 10-40% increase in 3-day rainfall by the year 2050, and then it shows slight or almost no increase until end of the century.

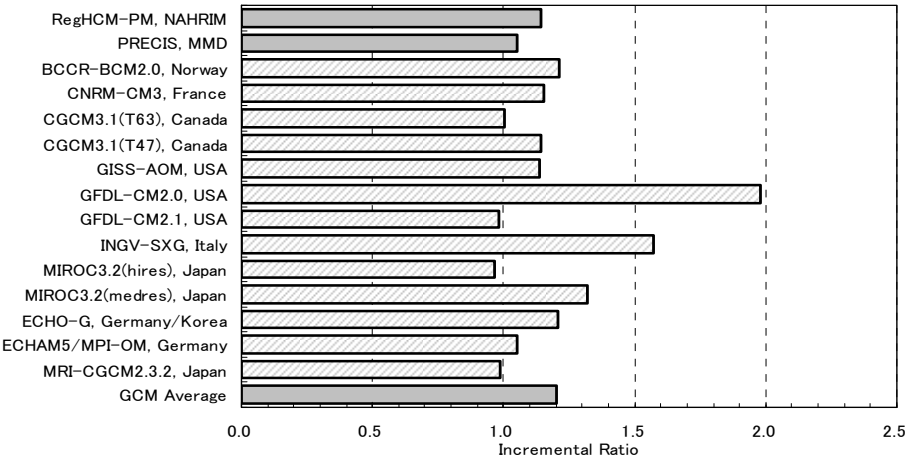


Figure 4.3.2 Incremental Ratios of 3 day Rainfall with ARI of 100 years Obtained from All GCMs and RCMs (2025)

Table 4.3.2 Incremental Ratio of 3-day Rainfalls for Various ARI and Period

ARI (years)	Period	RegHCM-PM	PRECIS	GCM Average	Average*	Maximum**	Proportion of models that show increase
100	2025	1.1	1.1	1.2	1.1(1.2)	1.2(2.0)	80%(12/15)
	2050	1.1	1.1	1.4	1.2(1.3)	1.4(2.7)	80%(12/15)
	2090	-	1.0	1.3	1.2(1.3)	1.3(2.5)	64%(9/14)
50	2025	1.2	1.0	1.2	1.1(1.2)	1.2(1.8)	87%(13/15)
	2050	1.2	1.0	1.3	1.2(1.3)	1.3(2.3)	87%(13/15)
	2090	-	1.0	1.3	1.2(1.3)	1.3(2.2)	57%(8/14)
20	2025	1.3	1.0	1.2	1.2(1.2)	1.3(1.5)	80%(12/15)
	2050	1.3	1.0	1.3	1.2(1.2)	1.3(1.9)	80%(12/15)
	2090	-	1.0	1.3	1.2(1.2)	1.3(2.0)	71%(10/14)
10	2025	1.3	1.0	1.1	1.1(1.1)	1.3(1.4)	80%(12/15)
	2050	1.3	0.9	1.2	1.1(1.2)	1.3(1.7)	80%(12/15)
	2090	-	1.0	1.3	1.2(1.2)	1.3(2.0)	71%(10/14)

**Numbers in the parenthesis are arithmetic average of all models*
***Numbers in the parenthesis are maximum of all models*

(3) Flood Simulation

Flood risk could be further aggravated as a result of projected increase in extreme rainfall events as analyzed above. **Figure 4.3.3** is a simulation result for the Muar River Basin of flood areas in a event of 100-year ARI rainfall under the current condition without climate change and the future 2025 conditions with it. Predicted total flood area with water depth above 10cm is 266km^2 in the current conditions, while 405km^2 under the projected 2025 conditions.

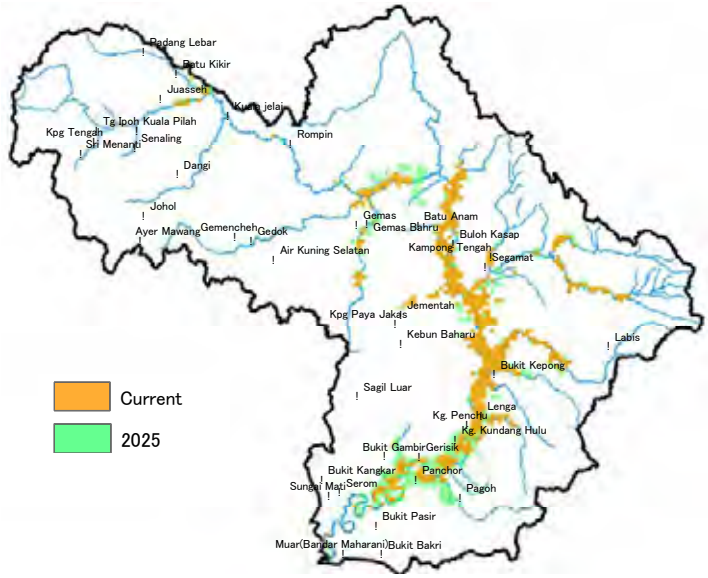


Figure 4.3.3 Simulated Flood Areas for Muar River Basin

4.3.2 Impact on Long-term Runoff Discharge

Future long-term runoff discharges are estimated by applying a runoff simulation model to estimated future precipitation and evapotranspiration data under Climate Change. To transform observed precipitation and evapotranspiration data to those under climate change, incremental ratios that are obtained by comparing those of historical experiment and of future projection of the GCMs and RCMs are used, similar to the estimation of flood rainfall intensity. The estimation process is explained concretely with the Muar Rive Basin as an example as follows:

(1) Estimation of Incremental Ratio

Incremental ratios by model of monthly precipitation and evapotranspiration due to climate change impact are summarized in **Figure 4.3.4** and **Table 4.3.3** The results show that changes of both the annual precipitation and the annual transpiration will be very little with a range of 0% to 7%. Regarding the monthly ratios, monthly variation of the precipitation ratio by RegHCM-PM of NAHRIM is significant, and the average increment ratio at 2025 is 1.65 in January but 0.53 in July.

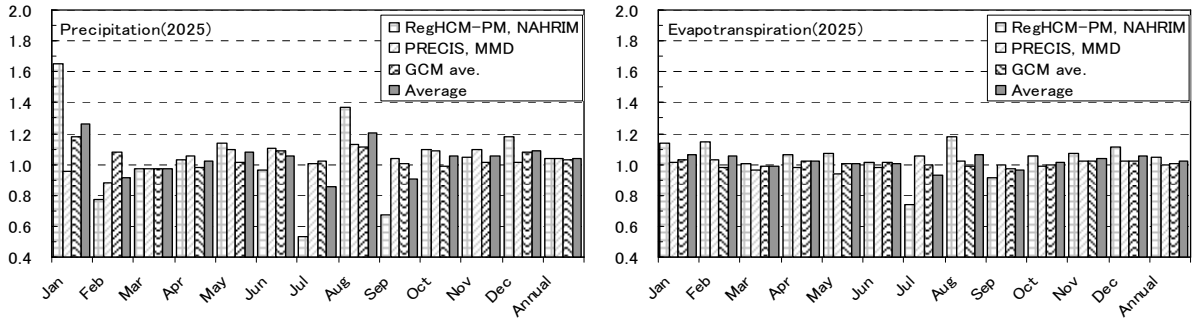


Figure 4.3.4 Monthly and Annual Precipitation and Evapotranspiration Incremental Ratios of 2025 Relative to 1990 for Muar River Basin

Table 4.3.3 Incremental Ratio of Annual and Monthly Precipitation and Evapotranspiration Relative to 1990 for Muar River Baisn

Precipitation

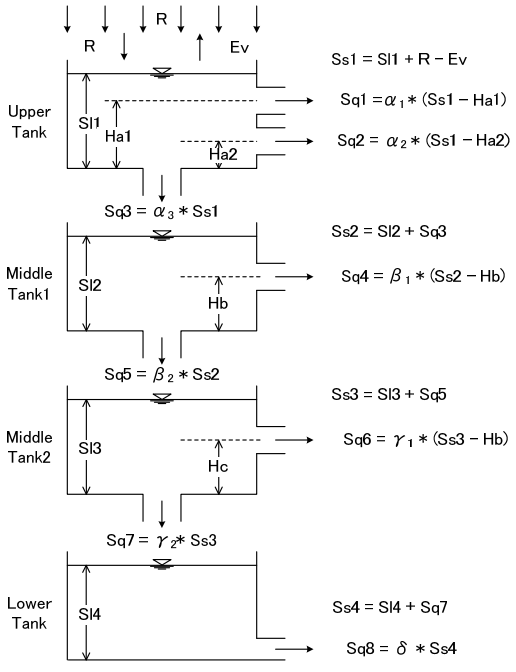
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
2025	RegHCM-PM	1.65	0.78	0.98	1.03	1.14	0.97	0.53	1.37	0.68	1.09	1.04	1.18	1.04
	PRECIS	0.95	0.88	0.97	1.05	1.10	1.10	1.00	1.13	1.03	1.09	1.09	1.01	1.04
	Average of GCMs	1.18	1.08	0.97	0.98	1.01	1.09	1.03	1.11	1.01	0.99	1.02	1.08	1.03
	Average	1.26	0.91	0.97	1.02	1.08	1.05	0.85	1.20	0.91	1.06	1.05	1.09	1.04
2050	RegHCM-PM	1.22	0.76	0.95	1.18	1.21	1.04	0.68	1.07	1.00	1.12	0.88	0.90	1.00
	PRECIS	0.92	0.80	0.95	1.09	1.17	1.17	1.01	1.22	1.06	1.15	1.16	1.02	1.07
	Average of GCMs	1.31	1.14	0.95	0.97	1.02	1.15	1.04	1.19	1.01	0.98	1.03	1.14	1.05
	Average	1.15	0.90	0.95	1.08	1.13	1.12	0.91	1.16	1.02	1.08	1.02	1.02	1.04

Evapotranspiration

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
2025	RegHCM-PM	1.14	1.14	1.01	1.07	1.07	1.01	0.74	1.18	0.91	1.05	1.07	1.11	1.05
	PRECIS	1.02	1.03	0.96	0.98	0.94	0.98	1.05	1.02	1.00	0.99	1.02	1.02	1.00
	Average of GCMs	1.03	0.98	0.99	1.02	1.01	1.01	1.00	0.99	0.97	1.00	1.02	1.02	1.00
	Average	1.06	1.05	0.99	1.02	1.01	1.00	0.93	1.06	0.96	1.01	1.04	1.05	1.02
2050	RegHCM-PM	1.07	1.03	1.00	1.12	1.20	1.02	0.89	1.06	1.15	1.10	1.06	0.98	1.06
	PRECIS	1.03	1.05	0.94	0.96	0.90	0.97	1.09	1.03	1.00	0.98	1.03	1.04	1.00
	Average of GCMs	1.05	0.97	0.98	1.04	1.02	1.02	1.00	0.98	0.95	1.00	1.04	1.04	1.01
	Average	1.05	1.02	0.98	1.04	1.04	1.00	0.99	1.03	1.03	1.03	1.04	1.02	1.02

(2) Runoff Analysis

Four-layer tank models as shown in **Figure 4.3.5** were applied to convert rainfalls to runoff discharges. Observed rainfall data of 1999-2008 and potential evapotranspiration obtained from observed meteorological data of the same period were the inputs to the runoff simulation under the current conditions without Climate Change. For the future simulation cases with Climate Change the incremental ratio of respective month obtained in the above was multiplied to rainfall and potential evapotranspiration used for that of the current conditions.



Parameters

	Muar(1)	Segamat	Muar(2)
α_1	0.4	0.175	0.4
α_2	0.15	0.05	0.15
α_3	0.065	0.225	0.065
β_1	0.09	0.08	0.09
β_2	0.017	0.04	0.017
γ_1	0.05	0.012	0.05
γ_2	0.0025	0.0105	0.0025
δ	0.00025	0.002	0.00025

Initial condition

	Muar(1)	Segamat	Muar(2)
Ha1(mm)	30	50	30
Ha2(mm)	20	5	20
Sl1(mm)	30	10	30
Hb(mm)	10	30	10
Sl2(mm)	15	30	15
Hc(mm)	26	10	26
Sl3(mm)	27	70	27
Sl4(mm)	300	400	300

Figure 4.3.5 Schematic View of the Tank Model and Its Parameters

Figure 4.3.6 shows 10 year simulation results of discharges under the current and future conditions. **Figure 4.3.7** compares three duration curves at the Muar River Mouth for the current condition (without Climate Change), the year 2025 condition (with Climate Change) and the year 2050 condition (with Climate Change). According to these figures, generally the river mouth discharge will slightly increase in the future, although it will decrease a little bit in February, March and July relative to the current condition. The river mouth discharge during low flow will slightly increase. This slight increase of the river mouth discharge is expected to deter sea water intrusion, although the effect may be very small.

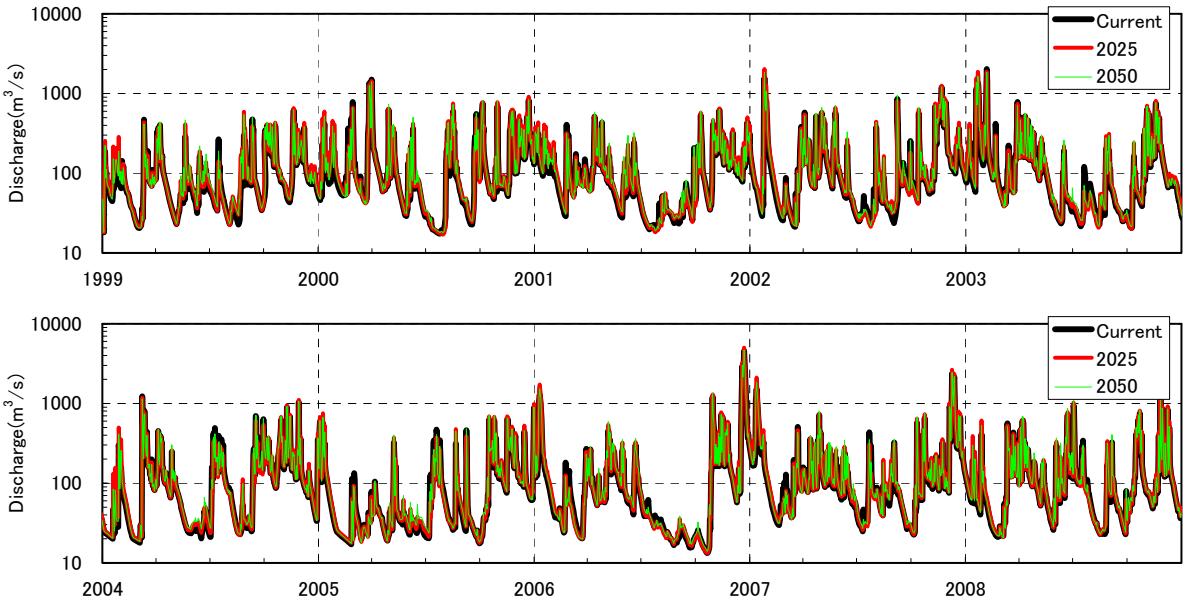


Figure 4.3.6 Temporal Plot of Simulated Daily Discharges at River Mouth

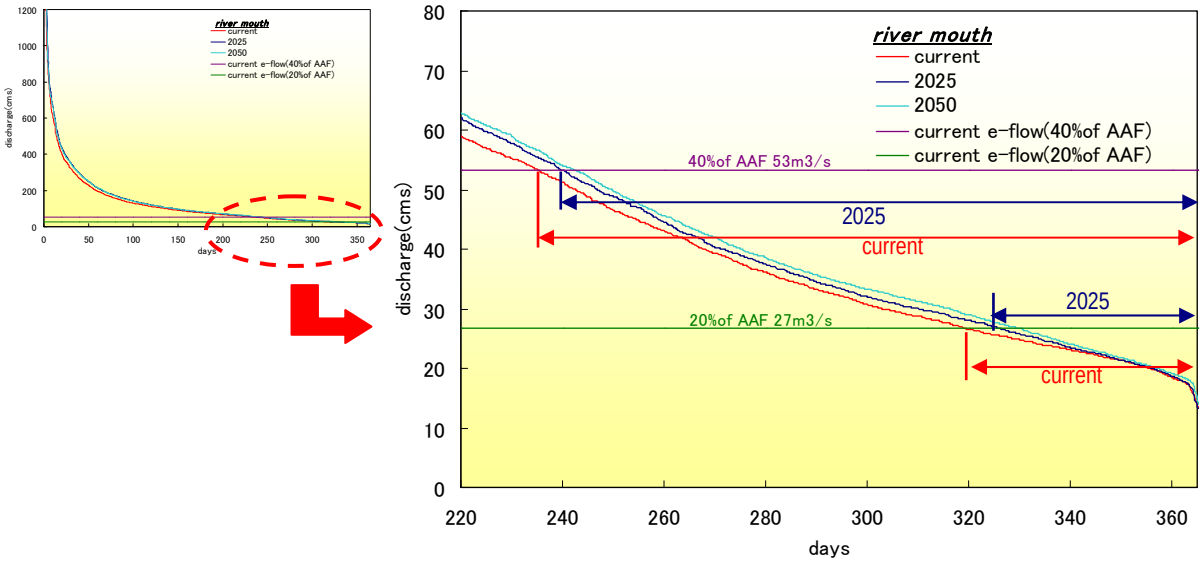


Figure 4.3.7 Flow Duration Curve

4.3.3 Sea Level Rise

Sea level is projected to rise as a result of global warming. There is no research paper about the sea level rise specifically along the Malaysian coasts available. **Table 4.3.4** shows model-based projection of global average sea level rise for 2090-2099 derived from the 4th Assessment Report of IPCC.

Table 4.3.4 Projected Global Average Sea Level Rise

Scenario	Sea level rise (m at 2090-2099 relative to 1980-1999)
B1 scenaio	0.18-0.38
A1T scenario	0.20-0.45
B2 scenaio	0.20-0.43
A1B scenaio	0.21-0.48
A2 scenaio	0.23-0.51
A1FI scenaio	0.26-0.59

Source: IPCC, AR4

4.4 Adaptation Measures

Mitigation and adaptation work together to cope with climate change impacts. The IPCC 4th Assessment Report clearly states that importance of both mitigation and adaptation: "There is high confidence that neither adaptation nor mitigation alone can avoid all climate change impacts. Malaysia government, for the first time, committed in the 10th Malaysia Plan to address climate change impacts, adopting a dual strategy: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce of green house gases.

In the 10th Malaysia Plan the following mitigation strategies are stated with a slogan "Reduce Malaysia's Carbon Footprint", although Malaysia has not any numerical targets for reducing green house gases (GHGs) emissions:

- Create stronger incentives for investments in renewable energy (RE);
- Promote energy efficiency to encourage productive use of energy;
- Improve solid waste management;
- Conserve forests; and
- Reduce emissions to improve air quality.

Not only developed countries but also many developing countries have already got aware of climate change impacts and are beginning to make efforts to reduce GHGs. However, it is projected that climate change impacts would continue over centuries even if such efforts are implemented. Effect is hardly expected from mitigation measures in these several decades at least. Considering that some signs of climate change are already beginning to appear, adaptation measures should be implemented as soon as possible. In addition, these measures should be so flexible as to respond to uncertainty of impacts of climate change.

4.4.1 Uncertainty of Impact of Climate Change[1]

When planning adaptation measures, it is necessary to recognize uncertainty that always accompanies the projection of climate change impacts. The uncertainty is generally caused by 1) Limitation of meteorology, 2) Limitation of projection by GCMs, 3) Uncertainty of future GHG emission and 4) Opacity of effects of mitigation measures.

The uncertainty by 3) and 4) are not important until around 2050 at least, and no significant difference will arise from them. 1) is inevitable and the uncertainty caused by 2) can be minimized by careful selection of models. In the example case of the Muar River Basin, 6 of the 19 GCMs of **Table 4.2.1** were excluded as a result of close examination of projection data from the reason that data are not reliable, and projection results of the remaining 13 GCMs and 2 RCMs were used as shown in **Figure 4.3.2**.

A future possible range of impact is obtained from projection results of several models that passed the above-said screening. This range may be usually very wide, as shown in the example of **Figure 4.3.2** that shows that the incremental ratio varies in the range of 0.96 to 1.98, depending on the model. This wide range is an outcome of the uncertainty of the projection models and gives the probable maximum and

[1] Derived from "Handbook of Adaptation Measures in Water Sector to Climate Change, May 2010, JICA"

minimum magnitudes of the impact that should be taken into consideration when planning adaptation measures. To avoid too many simulation cases, an arithmetic value is practically applied instead of applying all possible values in the same way as the Muar example. However, this wide range should be kept in mind. The range width will be narrowed in the progress of science and technologies.

4.4.2 Practices of Adaptation Measures in Foreign Countries[1]

Several developed countries have already implemented adaptation measures, while a few developing countries have developed adaptation strategies in their national strategies. Some examples are presented in **Table 4.4.1** and **Table 4.4.2** and summarized as below:

(1) Adaptation Measures against Flood and Storm Surges

In the UK, the flood safety level against storm surges are projected to drop from once every 1,000 years to once every 100 years by sea level rise due to recent climate change and rapid housing land development. Thus, the Thames Estuary 2100 (TE 2100), which is a flood risk management plan in England, is being planned as well as improvement of Thames tide embankment.

In the Netherlands flood risk management plan called "Room of the River," a total of approximately 7,000 ha are to be secured for retarding areas to cope with increase in discharge of the Rhine. The Maeslant Barrier along the Lek River is designed to cope with sea level rise in 50 years. Other storm surge barriers are also designed to cope with sea level rise during their service periods.

Adaptation strategies are also being promoted and reviewed in European nations, such as Germany and France, the US, and Australia. Korea has developed national strategies for water security and systems for assessing impacts on water resources. The least developing countries such as Bangladesh, Bhutan, and Cambodia are implementing the National Adaptation Programme of Action (NAPA) with the financial assistance of the Global Environmental Facility (GEF) and the cooperation of the United Nations Environment Program (UNEP) and the World Bank.

(2) Adaptation Measures against Droughts

California State of the United States of America is discussing the expansion of water management and water transfer systems, including water-saving enhancement, ground- and underground-water storage, water transfer facilities. The state is also working on mitigation strategies with the energy policy sector to reduce emission gases through effective water use by applying the trade-off between water and energy.

Canada is also planning or has already taken necessary adaptation strategies to droughts: water saving by users, prioritization of plans and preparation for droughts, state monitoring over the quantity and quality of water and climate conditions, establishment of procedures for fair water distribution which are also friendly to river ecosystems, modification of crop species with temperature resistance, development of irrigation systems.

In Australia, the south-western section of Western Australia State formulated the "Water Resources Development Plan 2005-2050" in 2005, which is a security strategy based on diversity. The plan was designed to adapt the section to future water demand increase and climate change through a broad range of adaptation measures, such as sea water desalination, reuse of recycled wastewater, water resources management, water trade, alternative water resources independent from rainfall, and revision of original implementation years.

In European countries, the following adaptation measures are being reviewed or have been already implemented: technological measures for water supply increase, promotion of effective water use (e.g. reuse of wastewater), reform of economic measures (water price setting), insurance systems, water use

[1] Source: Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Policy Report), Ministry of Land, Infrastructure, Transport and Tourism, Japan

limitation, national land development plans to improve water balance, forecasting/monitoring/information dissemination.

Table 4.4.1 Practices of Mitigation Measures against Floods and Storm Surges

	Examples of Measures Adopted by Other Countries			
U.S.A.	In New Jersey, one million dollars is allocated annually for revetment works. The state will not permit construction requiring revetment works in the future.	Four states adopted the "periodic easement" policy so that wetlands and beaches can be moved inland when sea level rises in the future.	New York City is considering the construction of flood control walls, etc. around sewage disposal plants located in lowlands as necessary infrastructure to address the impacts of climate change.	The water treatment plant located on Dear Island was sited at a higher location than originally planned, considering the necessity of constructing protection walls due to the impacts of sea level rise.
U.K.	On the Thames in the U.K., it is considered necessary to improve tidal barriers by 2030 in order to maintain the current flood control level for addressing the possible impacts of sea level rise due to climate change and the rapid estate land development in areas likely to suffer damage due to a storm surge. Therefore, Thames Estuary 2100 (TE2100) is being prepared as a flood risk management plan to protect London and the mouth of the Thames for the next 100 years.			
Netherlands	The tidal barriers and dams are designed assuming that the sea level will rise by 50 cm. The tidal barrier near Rotterdam was constructed in 1997 as the first construction built taking into account the impacts of sea level rise.	The technical Advisory Committee recommends ensuring safety for the next 200 years under the worst-case scenario of sea level rising by 85cm and the number of rainstorms increasing by 10% in the next 100 years.	The Flooding Defense Act, which establishes safety standards regarding all types of revetment structures, must be revised every 5 years by the minister. The latest data regarding climate change are incorporated into the design of revetment structures every 5 years.	
Australia	Regarding coastal development, the state government of New South Wales in Australia requests ensuring safety that can withstand coastal erosion that is expected to occur in the next 100 years, assuming that the sea level will rise by 30cm.			

Source: Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Reference), June 2008, Ministry of Land, Infrastructure, Transport and Tourism, Japan

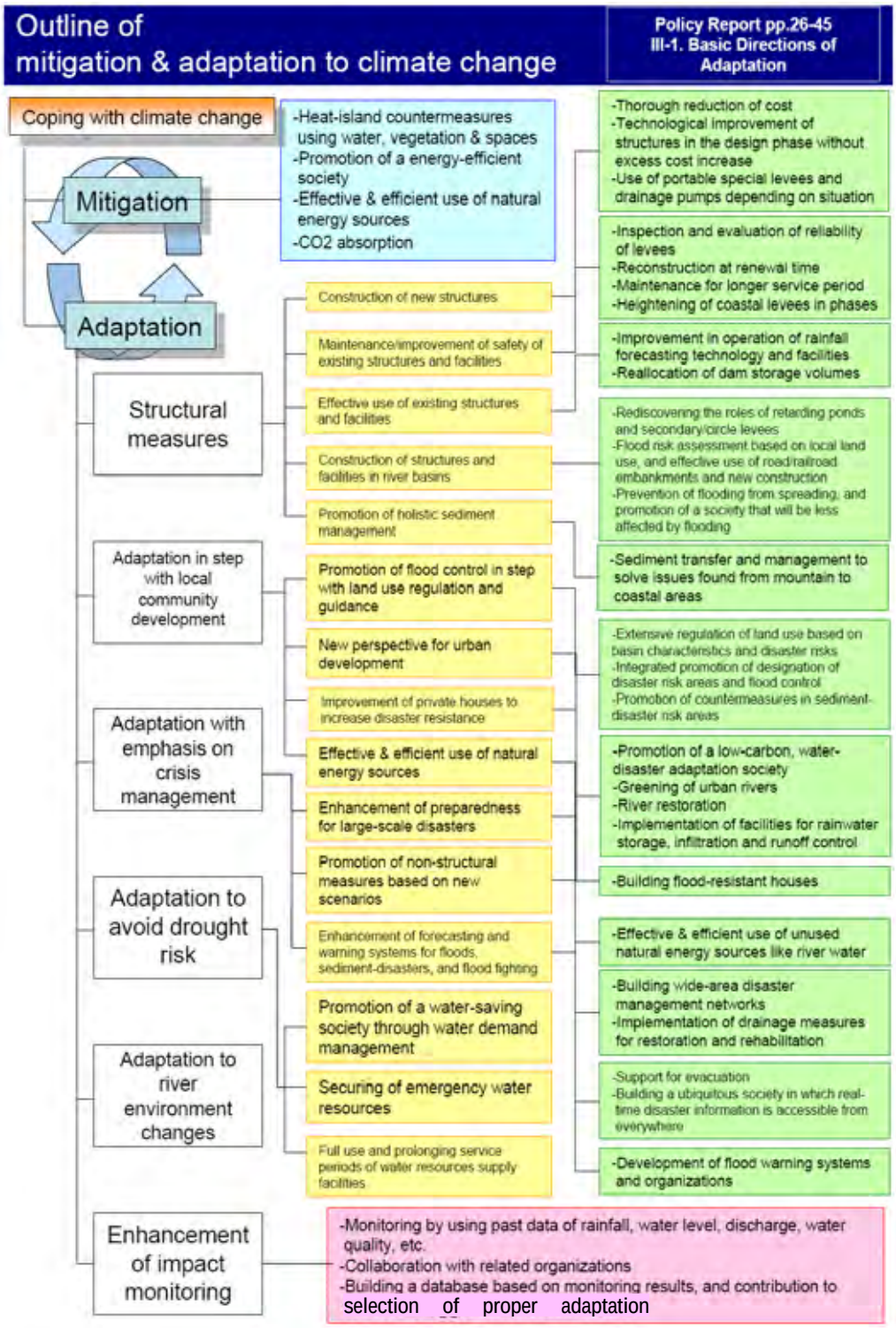
Table 4.4.2 Practices of Adaptation Measures in Water Resources Issues

Country	Emerging drought events	Future drought projection	Adaptation strategies (water resources)
U.S.A. [1]	✓ 20% of the nation constantly experience drought. ✓ 80% experience a mild to extreme drought when it wide spreads.	✓ Increase in evapotraspiration and drought risk due to global warming. ✓ Wetter winter and a longer dry summer in the west coast. ✓ 25% less snowfall in Sierras Mountain Range by 2050	✓ Impact assessment and adaptation option reviews by California Climate Change Center ✓ Enhancement of water-saving practice and water management/supply systems, including surface/underground water storage and water supply facilities
Canada [2]	✓ Drought (2001-2002) caused $ 5 to 6 billion loss for crop damage and insurance payment.	✓ More winter discharge, less summer discharge, lower water temperature	✓ Implementation of a comprehensive regional water policy to deal with climate change issues in British Columbia.
Australia [3]	✓ An extreme drought caused a decrease in 2002-2003 wheat production by more than a half to 10,100,000 tons.	✓ 15% less rainfall since the mid 1970s in southwestern West Australia ✓ Even less rainfall in the area due to future temperature rise	✓ Adaptation strategies have been developed to deal with global warming impacts on southwestern West Australia.
EU [4]	✓ EU countries experienced several severe droughts in the past 30 years. ✓ 10-40% more precipitation per year in the past 100 years in northern Europe; 20% less in southern and eastern Europe.	✓ 1-2% increase in annual precipitation per decade; less summer precipitation ✓ Less annual and summer precipitation in southern Europe, possibly resulting in more frequent extreme droughts	✓ The EU Commission published in 2007 a "Green Paper" and "Climate change and water adaptation issues" to emphasize the importance of adaptation.

Source: Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Reference), June 2008, Ministry of Land, Infrastructure, Transport and Tourism, Japan

4.4.3 Proposed Basic Directions of Adaptation Strategies

Here are introduced policies for the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan on adaptation measures derived from "Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Policy Report), June 2008, MLIT". Based on these policies, specific adaptation measures are listed in **Figure 4.4.1**.



Source: Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Policy Report), June 2008, Ministry of Land, Infrastructure, Transportation and Tourism, Japan

Figure 4.4.1 Mitigation and Adaptation Measures

(1) Basic Policy of Adaptation Strategies

When coping with climate change, it is important to have a perspective that society and culture which have been nurtured to date should be handed down to younger generations, as well as a safety perspective of protecting human lives. Adaptation to climate change should be promoted while working on other social issues, such as the falling birthrate and aging population and the lifestyle enhancing mass production, consumption and disposal. A sustainable "water-disaster adaptation society" should be built through an appropriate combination of adaptation and mitigation, while

revising the present social structure and aiming to build a society coexisting with nature and realizing high energy efficiency in addition to safety and security.

(2) Defining Clear Goals –Aiming for "Zero Victim"

Since it is difficult to totally protect everything from flood, sediment-related, storm-surge and other disasters of different scales, which are likely to be intensified by climate change, adaptation strategies for climate change need to be developed aiming for "zero victims." In areas, such as the Tokyo metropolitan area, where key functions are concentrated, it is also important to minimize damage by prioritizing the protection of state functions from paralysis.

(3) Coping with Intensified External Forces

As impacts of climate change, external forces such as magnitudes and frequencies of floods, debris flows, storm surges and droughts, etc. are projected to be intensified. To cope with these intensified external floods, adaptation policies are set up as shown in **Table 4.4.3.**

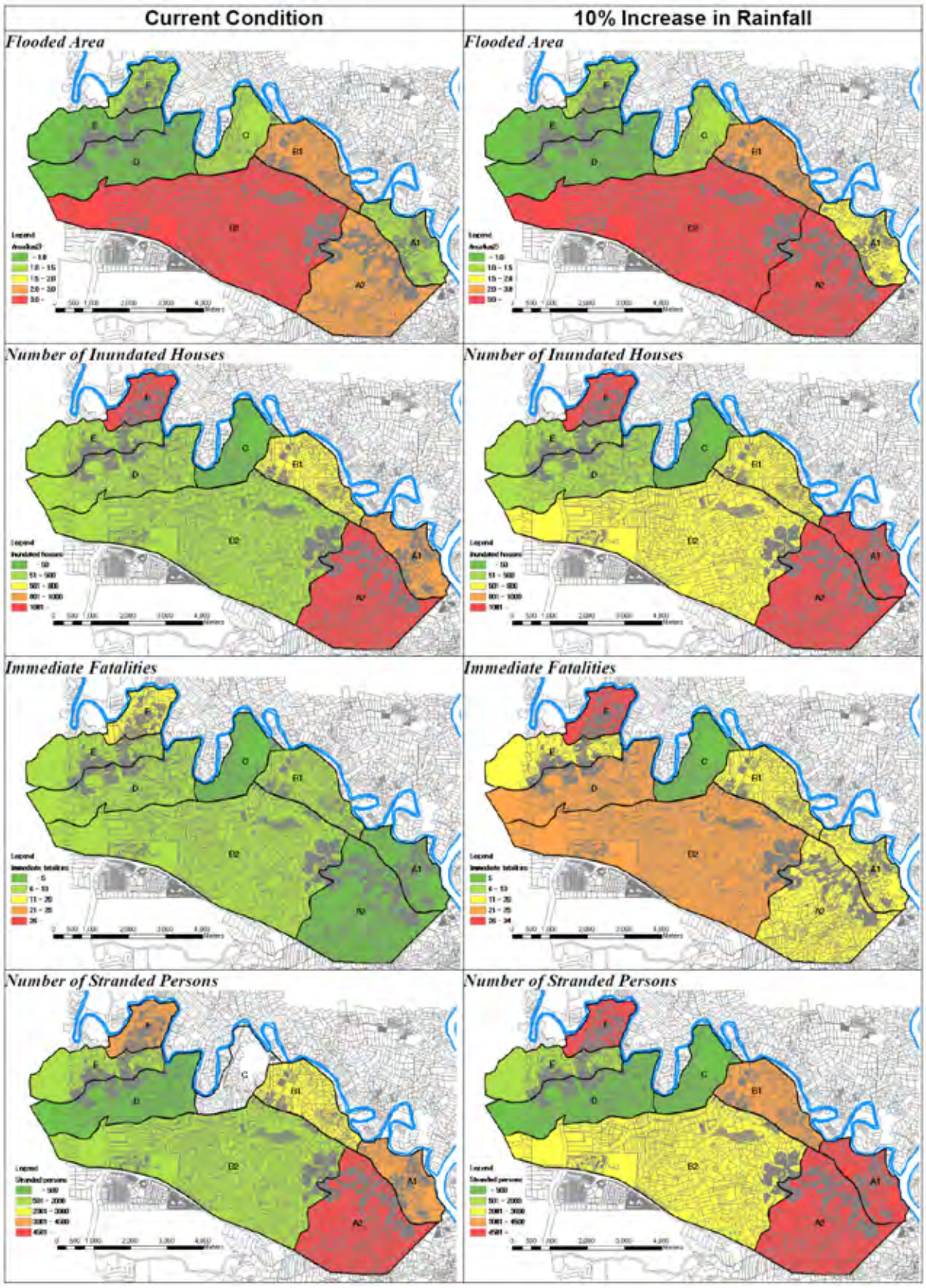
Table 4.4.3 Adaptation Policies against Intensified External Forces

Policies	Contents
Multilayered Flood Control Policies	In addition to traditional "flood control policies to secure safety at the river level", "flood control policies to secure safety at the basin level" through preparation for possible increase in excess floods should also be implemented. This concept is similar to IFM (Integrated Flood Management) of Malaysia.
Enhancing measures against intensified sediment-related disasters	The priority of structural measures should be set upon places with high risk of sediment-related disasters, where such structures can protect human lives. It is necessary to promote land use regulation, such as designation of sediment-related disaster danger zones. Comprehensive sediment control measures from mountain to coastal areas should be enhanced to cope with increased sediment runoff while balancing flood control, water use and environment in basins.
Staged measures against storm surges and enhancement of response measures for coastal erosion	To cope with sea level rise and intensified typhoons, storm surge barriers should be implemented in stages. Storm surge barriers should be designed so that they are hard to breach even if external forces are more powerful than expected due to sea level rise.
Coping with drought risk	Three pillars of effective use of water resources, integrated management of water quality and quantity, and crisis management to be able to cope with present issues of effective use of water resources should be promoted.
Coping with environmental changes in rivers and coasts	At present, it is still difficult to predict the impacts of climate change on ecosystems and water/material cycles. Continued efforts should be made to understand changes in river/coast environments as well as climatic changes.

(4) Disaster Risk Assessment

To discuss adaptation strategies, the impacts imposed on society and economy by water-related disasters due to climate change should be presented to the general public and related organizations in an easy-to-understand form. It is increasingly important to inform people of the vulnerabilities of land structure and social systems through risk assessment. The selection of appropriate adaptation strategies will be possible only after people sufficiently understand those vulnerabilities.

Figure 4.4.2 is an example of flood risk maps, which were prepared for the Temerloh-Mentakab Conurbation under this Preparatory Survey. These maps show four risk indicators, flood area, number of inundated houses, immediate fatalities and number of stranded persons caused by 50-year ARI flood under two climate conditions of with and without Climate Change.



Numbers in parenthesis are figures estimated assuming 80% for prior evacuation rate

Figure 4.4.2 Flood Risk Maps of Temerloh-Mentakab Conurbation

CHAPTER 5 IRBM PLANNING

5.1 Procedures of Planning

In the Preparatory Survey the IRBM plans were elaborated in the following sequence:

(1) Data/information collection,

(2) Identification of Issues and Problem Analysis

(3) Confirmation of Federal and State Policies on IRBM,

(4) Setup of Proposed Policies, Strategies and Measures

(5) Preparation of Roadmap

Data/information collection was first vigorously made to understand the existing conditions of the target river basins. Referring to lots of previous study reports, interviews to officials concerned and discussions at the working group meetings and site visits were main measures for the data/information collection. Discussions on issues related to IRBM also began in an early stage of this survey.

Out of the identified issues, four core issues that could cover almost all of the significant issues were selected. For each of the selected four core issues, a problem analysis was conducted to dig up direct and indirect causes of the core issue. Results of the problem analysis were presented in a so-called problem tree.

Based on the problem trees, policies, strategies and measures to address the core issues were proposed, referring to the policies of the federal government and the relevant state governments. Specific projects/actions were further proposed for strategies that hardly have been implemented so far or are necessary to be drastically strengthened. A set of the proposed policies, strategies, measures and specific projects/actions is regarded as the IRBM plan, of which implementation plan with time horizon was formed into an IRBM road map.

Actual processes made in the Preparatory Survey for problem analysis, setup of proposed policies, strategies and measures, and preparation of roadmap are further explained in the following Subsections:

5.2 Core Issues and Problem Analysis

5.2.1 Core Issues

It seems that a lot of IRBM issues can be identified for any river basin. If they are carefully categorized, most of them could be converged into some core issues. Following four issues were found in case of the Muar and Pahang River Basins:

- Weak institutional framework for IRBM/IFM,
- Insufficient Water Utilization,
- Deterioration of Water Quality, and
- Flood Damage.

5.2.2 Problem Analysis

In order to clarify the cause-effect relationship hierarchy among issues, a problem analysis is made for each of the four core issues. In the problem analysis, first the core issue is placed at the top of the problem hierarchy called ‘Problem Tree’. Second issues that could be direct causes of the core issue are placed at the second level. Similarly those that could be direct causes of the direct causes of the core issues are

placed at the third level. In this way, the problem tree is built downward, clarifying the cause-effect relationship among the issues.

Figure 5.2.1 is a Problem Tree with the core issue, "Flood causes damages" that was prepared for the Muar and Pahang River Basin under this Preparatory Survey.

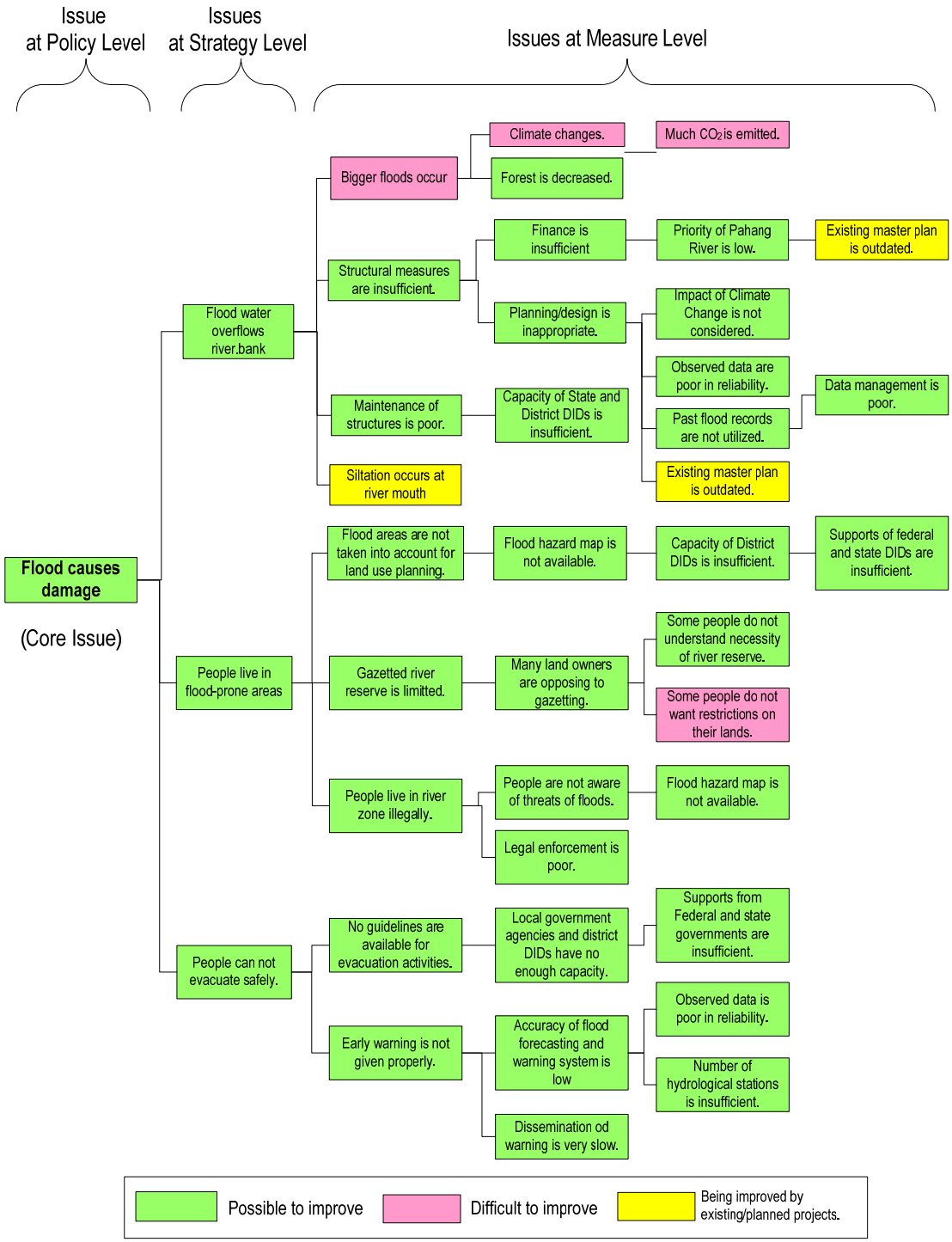


Figure 5.2.1 Problem Tree with Core Issue, "Flood Causes Damage"

5.3 Setup of Proposed Policies, Strategies and Measures

5.3.1 Proposed Policies

Proposed policies can be obtained by transforming each of the four core issues into a positive statement. Moreover, special attention is paid to the wording of the policies, so that broad implications covering almost all the significant issues could be included in the policies. The core issues and their corresponding policies for the Muar and Pahang River Basins are presented in **Table 5.3.1**. All the policies should comply with the federal and state policies.

Table 5.3.1 Core Issues and Proposed Policies

No.	Core Issue	Proposed Policies
1	Weak institutional framework	Strengthen Institutional Setup
2	Insufficient Water Utilization	Ensure Sustainable Water Utilization
3	Deterioration of water Quality	Create a Sustainable and Pleasant River Environment
4	Flood damage.	Build a Resilient Society to Floods

5.3.2 Proposed Strategies and Measures

Once the problem tree is made ready, strategies and measures are easily set up. Proposed strategies are positive statements of the direct causes of the core issue. In the same way proposed measures are positive statements of the issues at the lower levels. The proposed strategies and measures for the Pahang River Basin are presented in **Table 5.3.2**.

Table 5.3.2 Proposed Policies, Strategies and Measures

Policies	Strategies	Measures
Strengthen Institutional Setup	I-1 Establish Coordination Framework	I-1.1 Enhance RBC (River Basin Committee)
		I-1.2 Formulate National Water Policy & Nation Water Resources Law
	I-2 Implement Proper River Management	I-2.1 Authorize River Management Agency
		I-2.2 Determinate River Management Area
	I-3 Integrate River Basin Information	I-3.1 Establish Integrated Information System for River Basin Management
Ensure sustainable water utilization	W-1: Ensure sufficient water resources	W-1.1: Monitor impact of Climate Change
		W-1.2: Review water resources development plan
		W-1.3: Incorporate environmental flow with water resources development plan
		W-1.4: Establish response and coordination mechanism to droughts
		W-1.5: Explore alternative water resources
	W-2: Ensure sustainable water services industry	W-2.1: Complete restructuring of water services industry
		W-2.2 Reduce Non Revenue Water (NRW)
	W-3: Ensure sufficient irrigation water	W-3.1 Manage irrigation facilities properly
Create a sustainable and pleasant river environment	E-1: Reduce pollution load to ensure achievement of at least NWQS Class II water quality.	E-1.1Reduce wastewater discharge
		E-1.2: Implement integrated waste management by reducing waste as source, increasing recycling rate and ensuring efficient and clean disposal.
		E-1.3: Minimize siltation of river by reducing erosion at source and controlling runoff of eroded soil particles into rivers.
		E-1.4: Minimize runoff of agrochemicals into rivers.
	E-2: Maintain the natural biodiversity of Basin.	E-2.1: Control large scale agricultural development
		E-2.2: Control logging activities
		E-2.3: Proper planning and management of Environmental Sensitive Areas.
	E-3: Protect the catchment areas for water intake to avoid contamination and reduction of water resource.	E-3.1: Proper management of all catchment areas for water intake.
	E-4: Make use of river as an asset for townscape and recreational activities.	E-4.1 Integrate rivers into the townscape and recreational facilities.
Build a resilient society to floods	F-1: Manage flood water	F-1.1: Implement appropriate structural measures
		F-1.2: Upgrade data management procedures
		F-1.3: Monitor and review impacts of climate change
		F-1.4: Conserve forests
	F-2: Create flood-flexible land use	F-2.1: Prepare flood hazard maps
		F-2.2: Promote gazetting of river reserve
	F-3: Ensure safe evacuation	F-3.1: Upgrade flood forecasting and warning system
		F-3.2: Prepare community-based flood management plan

5.4 Preparation of Road Map

In the Preparatory Survey, specific projects/actions were further proposed for strategies that hardly have been implemented so far or are necessary to be drastically strengthened. A roadmap for the implementation of the specific projects/actions with their responsible agencies was prepared for the Pahang River Basin as shown in **Table 5.4.1**.

Most of the proposed projects/actions were fixed in the first five years until 2015. Based on the project results, the IRBM plan should be reviewed and updated at least every five years. Depending upon the project outputs, if necessary, new projects/actions should be proposed for the next five years. In this way, as likened to an upward spiral process, the IRBM for the Pahang River Basin will be continuously improved.

Table 5.4.1 Proposed Roadmap for IRBM for Pahang River Basin

Sector	Project/Action	Agencies	Cost (RM million)	Schedule		
				10th MP	11th MP	12th MP
				2015	2020	2025
Institution Setup	I-1.1: Enhancement of River Basin Committee (RBC)	RBC		●		
	I-2.1.1: Establishment of Federal and State Water Resources Department (WRD)	NRE			●	
	I-2.1.2: Establishment of River Basin Management Office (RBMO)	NRE				●
	I-3.2: Establishment of integrated information system	DID, MaCGDI		●●●		
	I-2.2: Determination of river management area (River Reserve)	DID, Land Office		●●●●●●●●●	●●●●●●●●●	●●●●●●●●●
	Review and Updating of IRBM plan	RBC		●	●	●
Water Utilization	W-1.1.1: Monitoring of impact of climate change	BKSA		●	●	●
	W-1.3.1: Study on environmental flow	BKSA	1-2	●●		
	W-1.4.1: Study on groundwater potential	BKSA, JMG	3-4	●●		
	W-2.2.1: Reduction of Non-revenue Water (NRW)	JBA, SAINS, SPAN, PAAB		●●●●●●●●●	●●●●●●●●●	●●●●●●●●●
Environment Management	E-1.1.1: Capacity development for establishment of a mechanism for developing and maintaining pollution load inventory	DOE	2-4	●●		
	E-1.1.2: Study on drinking water treatment sludge	Water Services Dept.	2-4	●●		
	E-1.1.3: Feasibility study and pilot project for wastewater treatment system for wet-markets	Dept. of local government	1-2	●●		
	E-1.3.1: Monitoring of sand dredging activities	DID		●●●●●●●●●	●●●●●●●●●	●●●●●●●●●
	E-1.4.1: Monitoring of agrochemicals	DOE		●●●●●●●●●	●●●●●●●●●	●●●●●●●●●
	E-2.3.1: Study on integrated ESA management plan	UPEN	2-4	●●		
Flood Management	Implementation of structural measures of IFM plan	DID	701	●●●●●●●●●	●●●●●●●●●	●●●●●●●●●
	Implementation of non-structural measures of IFM plan.	DID and others	39	●●●●●●●●●	●●●●●●●●●	●●●●●●●●●

CHAPTER 6 IFM PLANNING

6.1 Policy, Strategies and Measures

Guidelines for introducing IRBM

6.1.1 Manage Flood Water

This strategy aims to minimize flood inundation mainly in urban areas by appropriate structural measures associated with non-structural measures. In spite of past repeated flood disasters, the Pahang River Basin is deemed to have been left out of concern for a long time, and almost no major flood mitigation structure has been provided. Structural measures are definitely insufficient in the Pahang River Basin, even to protect important urban areas only. Appropriate structural measures, which should be planned and designed based on studies using reliable data, should be provided to the river basin.

Even if magnificent structural measures have been constructed through great efforts, all the efforts possibly come to nothing by impacts of Climate Change and/or devastation of the river basin. Adaptation to Climate Change and conservation of forest lands should be considered jointly with the structural measures.

6.1.2 Create Flood-flexible Land Use

"People live in flood prone area" is another problem. Disorderly land developments in flood plains increase flood damage potential as well as flood discharges. It is necessary to create land use that is flexible to floods.

For this purpose, flood hazard maps might be very effective. They are expected not only to raise awareness of people about floods, but also to serve as a reference when planning land use zoning. For more stringent management of river reserves, gazetting based on Sub-section 62 of Land Code should be also promoted.

6.1.3 Ensure Safe Evacuation

To save human lives is the first priority of the IFM plan. Appropriate response to floods is important to minimize flood damages. Flood forecasting and warning system with community-based flood management is a tool to lead people to safe places during floods.

6.2 Planning Conditions

6.2.1 Impact of Climate Change

In the Preparatory Survey, increase of rainfall intensity was considered for the IFM planning. As explained in Section 4.4.1, uncertainty always accompanies the projection of climate change impacts. Especially when planning a flood mitigation plan, it is a very important matter which model's projection data should be used or which emission scenario should be used. For example, as shown in **Figure 4.3.2**, the incremental ratio of rainfall intensity varies in the range of 0.96 to 1.98, depending on the model.

Fortunately, however, this IFM plan is a kind of master plan. Prioritization of conceivable measures is the most important output of the IFM planning. Details of the measure are formed gradually in the following consecutive studies, feasibility study and detailed design study. Therefore, for the IFM planning, an arithmetic mean value of all the models was simply applied as the incremental ratio of design rainfall.

6.2.2 IFM Approach

According to the Volume 1: Flood Mitigation of the DID Manual, IFM (Integrated Flood Management) includes 7 components, (1) Ensure a participatory approach, (2) Integrate land and water management,

(3) Manage the water cycle as a whole, (4) Adopt a best-mix of strategies, (5) Adopt integrated hazard management approaches, (6) Adopt environmental enhancement, (7) Introducing national flood management policy. This Preparatory Survey considers all the components, and makes much of three items, (1) Ensure a participatory approach, (2) Integrate land and water management, and (4) Adopt a best-mix of strategies in particular.

As part of the participatory approach, both of the stakeholder meeting and the steering committee meeting have been held frequently in the course of the Preparatory Survey, as explained in Section 3.4. The JICA Study Team collected opinions and data regarding flood issues and feedbacks on the planning from the participants.

The integrated management of land and water is very important for the Pahang River Basin. The IFM plan should aim to mitigate flood damage for all the flood inundation areas. However, the flood inundation of the objective river basin is too extensive to manage. Efficiency of large-scale structural measures that aim to deal with the extensive flood may be very low because the flood inundation areas are less developed and less populated. It might be avoidable that the IFM plan has to accept inundation in agriculture and forest areas, and to concentrate structural measures more in urban areas. Appropriate flood management made of a best mix of structural and non-structural measures should be applied to build a resilient society to floods.

6.2.3 IFM Plan

Under the above-said conditions, the IFM plans for the two objective river basin were formulated as a combination of proposed structural and non-structural measures with time horizon. **Table 6.2.1** is an implementation program of the IFM plan for the Pahang River Basin. The flood mitigation project for Temerloh and Mentakab Towns were subject to feasibility study under the Preparatory Survey.

Table 6.2.1 Tentative Implementation Program of IFM Plan

Structural/ Nonstructural	Project	Cost (10^6 RM)	10th MP	11th MP	12th MP
			2011 2015	2020	2025
Structural	Flood Mitigation Project for Pekan Town	280			
	Flood Mitigation Project for Sungai Bentong Basin	250			
	Flood Mitigation Project for Cameron Highland	3			
	Flood Mitigation Project for Temerloh and Mentakab Towns	72			
	Flood Mitigation Project for Maran Town	50			
	Flood Mitigation Project for Teriang Town	19			
	Flood Mitigation Project for Jerantut Town	20			
	Flood Mitigation Project for Kuala Lipis Town	7			
Non-structural	Capacity Development of District DIDs and Local Government Agencies for Flood Management	12			
	Flood Forecasting and Warning System Project	26			
	Updating of Projection of Impact of Climate Change	1			
	Total	740	282	302	156