No.

DEPARTMENT OF PUBLIC
WORKS AND HIGHWAYS
THE REPUBLIC OF THE
PHILIPPINES

THE STUDY
ON
THE NATIONWIDE FLOOD RISK ASSESSMENT
AND
THE FLOOD MITIGATION PLAN
FOR THE SELECTED AREAS
IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME II
-MAIN REPORT-

MARCH 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI Engineering International Co., Ltd.

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COMPOSITION OF FINAL REPORT

VOLUME I	SUMMARY REPORT
VOLUME II	MAIN REPORT
VOLUME III	SUPPORTING REPORT
VOLUME IV	DATA BOOK

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(as of 31st October 2007)

PREFACE

In response to a request from the Government of the Philippines, the Government of Japan decided to conduct the Study on the Nationwide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas in the Republic of the Philippines and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA selected a study team of CTI Engineering International Co., Ltd. headed by Mr. Yoshiharu MATSUMOTO. The team was dispatched to the Philippines five times between September 2006 and March 2008.

The team held discussions with the officials concerned of the Government of the Philippines and conducted field surveys and studies in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and also to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the Study.

March 2008

Norio MATSUDA

Resident Representative

Japan International Cooperation Agency Philippine Office

March 2008

Mr. Norio MATSUDA

Resident Representative

Japan International Cooperation Agency Philippine Office

LETTER OF TRANSMITTAL

Dear Sir,

It is our great pleasure to submit to you the final report of "the Study on the Nationwide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas in the Republic of the Philippines". The report contains the results of the Study undertaken by the study team of CTI Engineering International Co., Ltd. with the counterpart team of the Department of Public Works and Highways (DPWH) of the Government of the Philippines from the beginning of September 2006 through the middle of March 2008.

The report presents the selected prioritized areas based on the flood risk assessment and the prepared flood mitigation plans for these selected areas.

We hope that the results of our Study will contribute to the promotion of the nationwide flood risk assessment and the preparation of flood mitigation plans in the Philippines. We also deeply hope that the report will contribute to the enhancement of friendly relations between our two countries.

We wish to express our sincere gratitude to the personnel concerned of your Agency for the guidance and support given throughout the Study period. Our deep gratitude is also expressed to the DPWH and other concerned agencies of the Government of the Philippines, Japan Bank for International Cooperation (JBIC) and the Embassy of Japan in the Philippines for their close cooperation and assistance extended during the course of the Study.

Very truly yours,

Yoshiharu MATSUMOTO

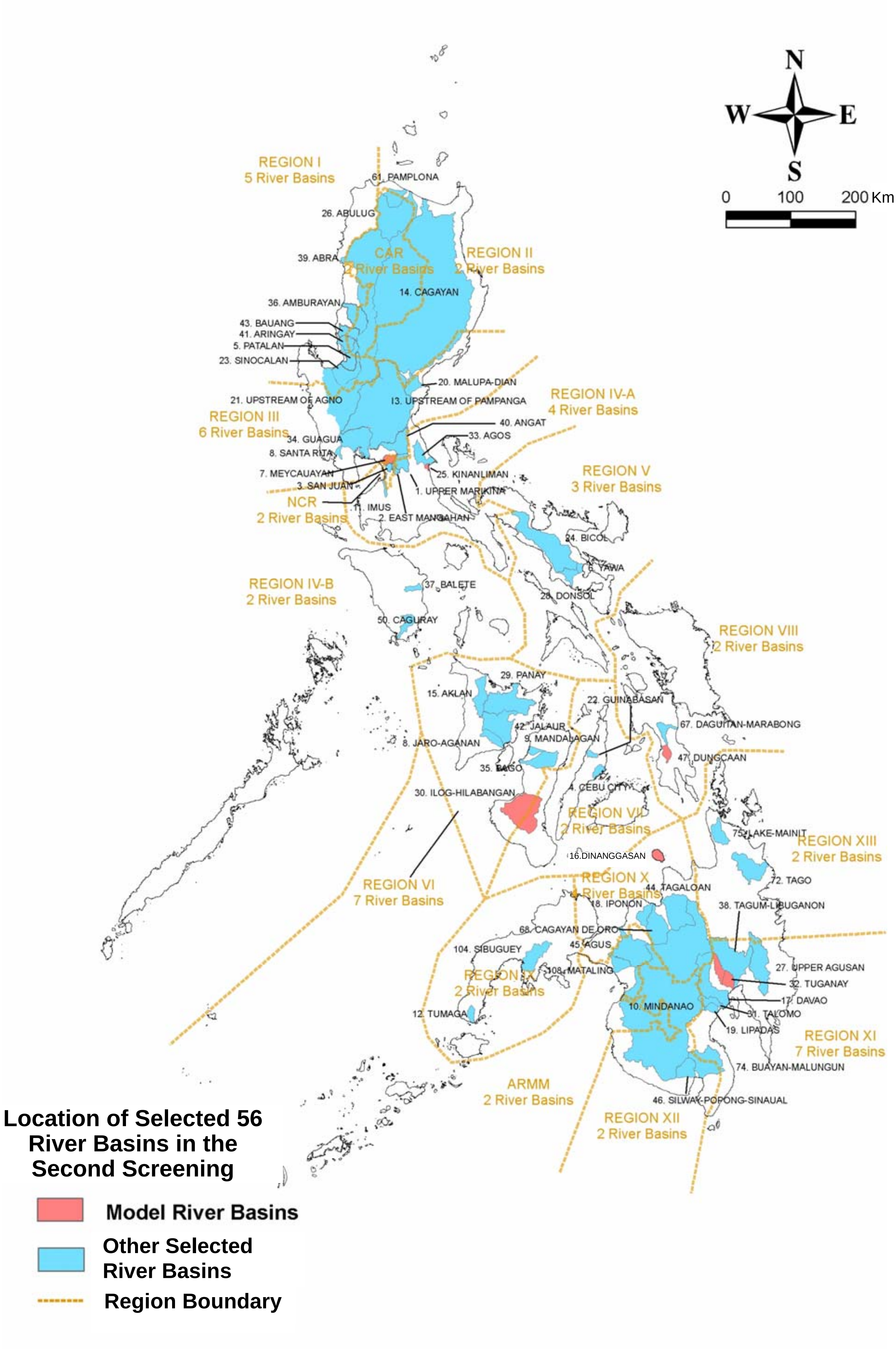
Team Leader

The Study on the Nationwide Flood Risk Assessment and

the Flood Mitigation Plan for the Selected Areas

in the Republic of the Philippines

LOCATION MAP



Executive Summary

1. INTRODUCTION

1.1 Objectives of the Study

The objectives of the Study are:

(1) To select prioritized areas based on the flood risk assessment and to prepare flood mitigation plans for these selected areas; and

(2) To conduct technology transfer to DPWH counterpart personnel during the course of the Study.

1.2 The Study Area

The Study covers the 947 flood-prone cities/municipalities identified by the National Disaster Coordinating Council.

1.3 The Study Schedule

The Study was started in the beginning of September 2006 in a manner of Home Work and continued until the middle of March 2008.

1.4 Basic Conditions for Conducting the Study

To conduct the Study, the following conditions were discussed and confirmed; (1) Target Year for Prioritization until 2034 and (2) Safety Level of 20-year Return Period for the Formulation of Flood Control Projects.

2. FIRST SCREENING OF RIVER BASINS

2.1 Procedure of the First Screening

2.1.1 Identification of River Basins

The objective river basins for the First Screening are identified, to which 947 flood prone cities/municipalities belong. As the results, it has been identified that the total number of river basins covering the flood prone areas is 1,164 river basins including major river basins as shown in the following table:

Table 2.1 Total Number of River Basins

River Basins	Number	Remarks
Independent Principal River Basins	376	Including 75 Tributaries of Major Rivers
Major River Basins	18	
Other River Basins	770	
Ground Total	1,164	Covering the Flood Prone Areas

Note: In this table, Principal River Basin and Major River Basin are based on the definition by NWRB and the river basins excluded from the definition are defined as Other River Basins.

2.1.2 Confirmation of Methodology of the First Screening

The methodology of the First Screening was confirmed considering the previous practices on similar undertakings. The proposed methodology was, in principle, the scoring of evaluation indexes, and a screening guideline where some other factors were taken into account was also provided.

2.1.3 Selection of Evaluation Indexes

Based on the confirmed methodology, evaluation indexes of 14, which represent flood damage potential from the view points of socio-economic and natural conditions, were selected.

2.2 Results of the First Screening

As the result of the First Screening, a total of 120 river basins were selected and designated as the objective river basins for the Second Screening.

3. SECOND SCREENING OF RIVER BASINS

3.1 Procedure of the Second Screening

3.1.1 Ranking of River Basins with Score

The prioritization of river basins for project implementation was in principle given by ranking with the total score based on the economic efficiency in addition to the score obtained in the First Screening.

3.1.2 Setting-up of Possible Investment Amount

For the above prioritization, the number of river basins was first be narrowed down considering the amount of possible investment by the DPWH in the target period of 26 years from 2009 to 2034 assuming the DPWH budget growth rate.

3.1.3 Consideration of Regional Distribution

Development of the country should be promoted equally for every region without any discrimination. From this point of view, it is necessary to arrange infrastructures such as flood control projects for every region. In this context, at least a few river basins for each of the 17 administrative regions were arranged in the list for the Second Screening.

3.1.4 Strategic Significant River Basins

Besides the above, some river basins, which are generally recognized as significant for the provision of flood control projects like the major river basins, were included in the list regardless of rank.

3.2 Results of the Second Screening

In accordance with the above-mentioned procedure, finally the following number of river basins was selected as the results of the Second Screening:

- Number of Selected River Basins : 56 river basins
- Investment Amount (2009-2034) : 236 billion pesos
- DPWH Budget Growth Rate : 8.2%

3.3 Prioritization and Arrangement of Implementation Schedule

For the selected 56 river basins, prioritization was examined and arranged in a manner of the implementation schedule dividing the river basins into two groups: (1) foreign-assisted projects and (2) locally funded projects.

4. GROUPING AND SELECTIOIN OF MODEL RIVER BASINS

4.1 Grouping

As mentioned in the previous section, 56 river basins have been selected as the results of the Second Screening. In this section, these 56 river basins are classified into several groups by flood damage type [Overflow (O), Flash Flood (F), Bank Erosion (B), Inland Flooding (I), and Lahar and/or Debris Flow (L)], and one model river basin is selected from each group.

As a result, the following six river basins were selected as model river basins:

Table 4.1 Model River Basins

Group	Name of River Basin	Region	Catchment Area (km^2)	Ranking
F+O+B, F+B Type	Ilog-Hilabangan	VI and VII (Visayas)	2,162	30
O+B Type	Dungcaan	VIII (Visayas)	176	47
F+O, O, F Type	Meycauayan	III and NCR (Luzon)	201	7
F+O+B+I, F+I Type	Kinanliman	IV-A (Luzon)	10	25
F+O+I, F+I+B, F+I Type	Tuganay	XI (Mindanao)	747	32
F+O+B+I+L Type	Dinanggasan	X (Mindanao)	29	16

** F: Flash Flood, O: Overflow, B: Bank Erosion, I: Inland Flooding, L: Lahar and/or Debris Flow*

5. FORMULATION OF FLOOD MITIGATION PLANS FOR MODEL RIVER BASINS

5.1 Basic Conditions for Formulation of Flood Mitigation Plan

Flood mitigation plans for the model river basins were formulated under the following conditions:

(1) Objective River Basins

The objective river basins for the formulation are the selected six (6) model river basins; namely, Ilog-Hilabangan, Dungcaan, Meycauayan, Kinanliman, Tuganay and Dinanggasan.

(2) Safety Level and Area to be Protected

In principle, flood control projects for these river basins were formulated with the safety level of 20-year return period. However, if previous plans were already prepared for certain river basins like the Ilog-Hilabangan, the safety level of the previous plan was applied.
As for the area to be protected, it was in principle based on the current flood damage area, which was finally adjusted in due consideration of economic efficiency, i.e., the ratio between benefit and cost.

(3) Applicable Measures and Selection of Optimum Measures

As the applicable measures, both structural and non-structural measures were examined. The optimum measures for the structural measures were selected through a comparison study for several alternatives prepared in principle with the combination of such structural measures. On the other hand, for the non-structural measures, their direction of improvement was examined independently among several conceivable measures.

(4) Project Evaluation

The adequacy of projects was evaluated considering the aspects of technical feasibility, economic viability, social acceptance and environmental acceptance. In this connection, economic viability was evaluated only for the structural measures, since the benefit of non-structural measures was preliminary estimated for flood warning system only for the direct damages to examine appropriate system for the target river basin.

(5) Accuracy of the Study

The study on the formulation of flood control plans for the six (6) model river basins was conducted in a very limited time (3 months), so that the accuracy is very rough and the level is supposed to be a pre-master plan. Therefore, for implementation of the flood control projects for the model river basins, further studies such as master plan and feasibility studies are absolutely necessary.

5.2 Results of Formulation of Flood Mitigation Plans for the Model River Basins

Although the level of the Study is very rough, the following results are in common obtained for the formulation of flood mitigation plans for the six (6) model river basins:

5.2.1 Flood Condition

As the flood condition for the model river basins, the following points are commonly specified while each river basin has individual flood problems:

- Floods habitually occur almost every year and severe ones are once every ten years;

- Flow capacity is very poor compared with the design discharge;
- Flood damage type which causes severe damages is in principle overflow and bank erosion type, while flash flood and/or debris flow causes casualties; and
- Flood damages in every river basin are observed in built-up areas as well as agricultural areas and fishponds including casualties in some river basins.

5.2.2 Optimum Flood Control Measures

As the optimum flood control measures which are composed of structural and non-structural measures, the following measures are finally employed (refer to Tab.-1):

(1) Structural Measures

As the structural measures, river channel improvement including revetment and/or spur dike is commonly applied to cope with the flood type of overflow and bank erosion. In addition to river channel improvement, drainage facilities are applied to some river basins, which have flood problem of the inland flooding type, while sediment control facilities are introduced in some river basins to cope with the flood damage type of flash flood or debris flow.

(2) Non-structural Measures

As the non-structural measures, the following measures are in common applied:

- Flood warning system;
- Watershed management; and
- Other measures such as enhancement of disaster management activities and preparation of hazard map.

5.2.3 Project Evaluation

Project evaluation was made from the technical, economical, social and environmental points of view. As the conclusion, flood control projects for the model river basins were evaluated in principle as technically and economically feasible and identified as they will be socially and environmentally accepted.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In due consideration of objectives of the Study, it is concluded that the selection and prioritization of the flood risk areas through the flood risk assessment and the preparation of flood mitigation plans for the selected model river basins are adequate for the implementation of flood control projects by the Philippine Government in the years to come.

6.2 Recommendation

The recommendations on the following points were specified:

1. To assure the 8.2% growth rate of DPWH budget to cover the flood control projects for selected 56 river basins;
2. To utilize the proposed implementation schedule for preparation of a medium-term plan as well as a long term plan in the flood control sector;
3. To review the adequacy of sharing 95% and 5% of investment amount between foreign assisted projects and locally funded projects;
4. To make a package for projects, the costs of which are expected to be small and classified into the group of locally funded projects, to facilitate early implementation with international funds;
5. To review the basin boundaries using more precisely scaled maps like 1/50,000;
6. To renew the evaluation of flood vulnerability of the 1,164 river basins updating flood damage data and other statistical data;
7. To make further discussions to clarify the definition of river basins and responsibility of administration by agencies concerned to realize more effective river basin management including flood control;
8. To enhance the accuracy of hydraulic analysis by applying more precise hydraulic model and satellite images in the future;
9. To renew the relation between design discharge and unit price for river channel improvement using additional data whenever the other studies on flood mitigation are conducted;
10. To review the cost and dimension of sediment facilities examined for some of the model river basins in the further project stage;
11. To renew rates such as damage rate and conversion rate from flood damage to benefit whenever the other studies on flood mitigation projects are examined in the future;
12. To maintain and upgrade GIS database and systems developed in this Study, so that DPWH including FCSEC can use them as more effective tools for policy-making in the flood control sector;
13. To utilize and reference the flood mitigation plans for model river basins considering the similarity of flood damage types and DPWH-FCSEC should support to develop the formulation of such plans;
14. To conduct further study with additional or more data to upgrade the accuracy of outputs for model river basins;
15. To review the necessity of sediment control facilities with enough dimensions to cope with the sediment disaster from the social view points in the future; and

16. To request the dispatch of short-term experts to assure the continued transfer of knowledge used in the Study and to upgrade, modify/or adjust the outputs of the Study by DPWH counterpart personnel.

Tab. -1 Outline of Flood Control Plan for Model River Basins

Name of River Basin	Catchment Area (km^2)	Flow Capacity (m^3/s)	Design Discharge (m^3/s)	Safety Level (Return Period)	Major Flood Types	Flood Damage Area	Optimum Measures		Economic Evaluation			Overall Evaluation
							Structural Measures	Non-Structural Measures	Cost (mil. Pesos)**	Benefit (mil. Pesos/ year)	EIRR (%)	
Ilog-Hilabangan	2,162	250	3,690	25-year	Overflow and Bank Erosion	Built up Area, Agricultural Area and Fish Pond	River Channel Improvement*	Flood Warning System, Watershed Management and Others	1,537	208	18.9	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.
Dungcaan	176	290	655	20-year	Overflow and Bank Erosion	Built up Area and Agricultural Area	River Channel Improvement*	Flood Warning System, Watershed Management and Others	154	21	18.8	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.
Meycauayan	201	400	990	30-year	Overflow and Inland Flooding	Built up Area, Agricultural Area and Fish Pond	River Channel Improvement* and Drainage Facilities	Flood Warning System, Watershed Management and Others	4,985	850	23.3	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.
Kinanliman	10	190	380	25-year	Flash Flood (Debris Flow) and Overflow	Built up Area	River Channel Improvement* and Sabo Dam	Flood Warning System, Watershed Management and Others	107	13	17.3	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.
Tuganay	747	175	540	25-year	Overflow and Inland Flooding	Built up Area, Agricultural Area and Fish Pond	River Channel Improvement* and Retarding Basins	Flood Warning System, Watershed Management and Others	1,948	266	19.1	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.
Dinanggasan	29	180	296	20-year	Flash Flood (Debris Flow) and Overflow	Built up Area and Agricultural Area	River Channel Improvement*, Sabo Dam and Sand Pocket	Flood Warning System, Watershed Management and Others	108	12	15.7	At present, it is identified that the project is technically and economically feasible and will be accepted socially and environmentally.

*: River channel improvement including provision of revetment, spur dyke or concrete wall. **: Cost means economic cost.

THE STUDY ON THE NATIONWIDE FLOOD RISK ASSESSMENT AND THE FLOOD MITIGATION PLAN FOR THE SELECTED AREAS IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT
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ABBREVIATIONS AND ACRONYMS

A&D	:	Alienable and Disposable
AO	:	Administrative Order
ARC	:	Agrarian Reform Community
ARMM	:	Autonomous Region of Muslim Mindanao
B/C	:	Benefit/Cost Ratio
BRS	:	Bureau of Research and Standards, DPWH
BSWM	:	Bureau of Soils and Water Management
CAR	:	Cordillera Administrative Region
CBFEWS	:	Community-Based Flood Early Warning System
CDCC	:	City Disaster Coordinating Council
CHB	:	Concrete Hollow Block
CPI	:	Consumer Price Index
CR	:	Cross Section
DA	:	Department of Agriculture
DAO	:	Department Administrative Order
DAR	:	Department of Agrarian Reform
DCC	:	Disaster Coordinating Council
D/D	:	Detailed Design
DEM	:	Digital Elevation Model
DENR	:	Department of Environment and Natural Resources
DEO	:	District Engineering Office, DPWH
DND	:	Department of National Defense
DOF	:	Department of Finance
DOST	:	Department of Science and Technology
DPWH	:	Department of Public Works and Highways
DSWD	:	Department of Social Welfare and Development
ECA	:	Environmentally Critical Areas
ECC	:	Environmentally Compliance Certificate
ECP	:	Environmentally Critical Projects
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impact Statement
EMB	:	Environmental Management Bureau, DENR
FCSEC	:	Flood Control and Sabo Engineering Center

FMB	:	Forest Management Bureau, DENR
FMC	:	Flood Mitigation Committee
FVI	:	Flood Vulnerability Index
F/S	:	Feasibility Study
GDP	:	Gross Domestic Product
GIS	:	Geographic Information Systems
GNP	:	Gross National Product
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
I/A (I/P)	:	Implementing Arrangement (Implementing Program)
IEE	:	Initial Environmental Examination
JBIC	:	Japan Bank for International Cooperation
IWRM	:	Integrated Water Resources Management
JICA	:	Japan International Cooperation Agency
KAMANABA	:	Kaloocan, Malabon, Navotas and Valenzuela
L/A	:	Loan Agreement
LGU	:	Local Government Unit
MDCC	:	Municipal Disaster Coordinating Council
MGB	:	Mines and Geosciences Bureau, DENR
MHW	:	Mean Monthly Highest Water Level
MP	:	Master Plan
MPDC / MPDO	:	Municipal Planning and Development Coordinator / Municipal Planning and Development Office
MRB	:	Major River Basin
MTPDP	:	Medium Term Philippine Development Plan
MTPIP	:	Medium Term Public Investment Program, DPWH
NAMRIA	:	National Mapping and Resource Information Authority, DENR
NCR	:	National Capital Region
NDCC	:	National Disaster Coordinating Council
NEDA	:	National Economic and Development Authority
NFMC	:	National Flood Management Committee
NFMFP	:	National Flood Mitigation Framework Plan
NGO	:	Non-Government Organization
NHRC	:	National Hydraulic Research Center, UPERDFI
NIA	:	National Irrigation Administration

NPV	:	Net Present Value
NSCB	:	National Statistics Coordination Board
NSO	:	National Statistics Office
NWRB	:	National Water Resources Board, DENR
NWRC	:	National Water Resources Council
O&M	:	Operation and Management
OCD	:	Office of Civil Defense
ODA	:	Official Development Assistance
OECF	:	Overseas Economic Cooperation Fund
PAF	:	Project Affected Family
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration, DOST
PAP	:	Project Affected People
PAR	:	Philippine Area of Responsibility
PCA	:	Philippine Coconut Authority
PD	:	Presidential Decree
PENRO	:	Provincial Environment and Natural Resources Office
PHIVOLCS	:	Philippine Institute of Volcanology and Seismology, DOST
PMO	:	Project Management Office
PRB	:	Principal River Basin
PRS	:	Philippine Reference System
PTM	:	Philippine Transverse Mercator
RDC	:	Regional Development Council
RA	:	Republic Act
ROW	:	Right-of-Way
RS&RDAD	:	Remote Sensing and Resource Data Analysis Department
SRTM	:	Shuttle Radar Topography Mission
STM	:	Stakeholder's Meeting
STW	:	Stakeholder's Workshop
TOR	:	Terms of Reference
TSP	:	Total Suspended Particulates
TWG	:	Technical Working Group
UDHA	:	Urban Development and Housing Act
UP	:	University of the Philippines
UPERDFI	:	U.P. Engineering Research and Development Foundation Inc.
USEPA	:	United States Environmental Protection Agency

UTM	:	Universal Transverse Mercator
VOM	:	Valenzuela, Obando and Meycauayan

MEASUREMENT UNITS

(Length)

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)

(Time)

s, sec	:	second(s)
min	:	minute(s)
h, hr	:	hour(s)
d, dy	:	day(s)
y, yr	:	year(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)

(Volume)

cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)
l, ltr	:	liter(s)
MCM	:	million cubic meter(s)

(Weight)

kg	:	kilogram(s)
ton	:	ton(s)

(Velocity)

m/s	:	meter per second
km/h	:	kilometer per hour

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Approximately, 20 typhoons a year occur on the sea around the Caroline and Mariana Islands and most of them pass through the Philippines. These typhoons bring about so much rainfall that causes floods with serious flood damage to flood prone areas of the country. According to the flood damage records from 1980 to 2003, an average of 645 people die every year, or 1,772 people every year if the missing and injured were included. The number of damaged households and people was estimated at 686,000 per annum and 3,535,000 per annum, respectively. On the other hand, the number of damaged houses was 284,000, out of which 77,000 were destroyed completely. The total damage amount to about 7.9 billion pesos a year, and once in every 6 years the damage from typhoons reaches to more than 10 billion pesos.

The criteria adopted by the National Water Resources Board (NWRB) of the Philippines defines a major river basin as one with catchments of more than 1,400 km^2, and a principal river basin as one with catchments of more than 40 km^2. Based on these definitions, there are 18 major river basins and 421 principal river basins in the whole country. As for flood control works, feasibility studies have been conducted for major river basins following the formulation of master plans in 1982. However, the flood control works have so far been implemented for only four (4) major river basins.

In case of a large river system, flood damage tends to be very severe and lasts for a long time once flooding occurs. Therefore, it is necessary to initiate flood control works as early as possible. However, the works would require large investments and long periods of implementation. Considering the limited budget for flood control, the implementation of flood control works would have to be prioritized based on population, property and economic activities, and not on the size of each basin alone.

At present, however, a majority of the river basins in the country have no defined inundation areas. Therefore, there exists no structured data/information to relatively evaluate flood control projects as to cost-benefit ratio. Consequently, the Department of Public Works and Highways (hereinafter referred to as "DPWH") of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), which is mandated to implement flood control projects nationwide, could not formulate strategic policies on flood control nationwide that could be accountable to both donors and taxpayers.

To initiate the formulation of flood control strategies, the GOP had requested the Government of Japan (hereinafter referred to as "GOJ") to extend technical assistance for "The Study on the Nationwide Flood Risk Assessment and the Flood Mitigation Plan for Selected Areas" (hereinafter referred to as "the Study").

In response to the request, the GOJ dispatched to the Philippines through the Japan International Cooperation Agency (hereinafter refer to as "JICA"), a preparatory study team headed by Mr. Hiroyasu Tonokawa (hereinafter referred to as "the Study Team"), to discuss with the Philippine authorities concerned the Implementing Arrangement (I/A) on the Study from 26 February to

17 March 2006. The I/A was finally agreed upon between the GOP and the Team, as spelled out in the Minutes of Meeting, which is hereto attached in Annex 1 and Annex 2.

1.2 Objectives of the Study

The objectives of the Study are:

(1) To select prioritized areas based on flood risk assessment and to prepare flood mitigation plans for these selected areas; and

(2) To conduct technology transfer to DPWH counterpart personnel during the course of the Study.

1.3 The Study Area

The Study covers cities/municipalities containing 947 flood-prone areas as identified by the National Disaster Coordinating Council (NDCC).

1.4 The Study Schedule

The schedule of the Study is as shown in Figure 1.1. The Study was started in the beginning of September 2006 in a manner of Home Work and continued until the middle of March 2008.

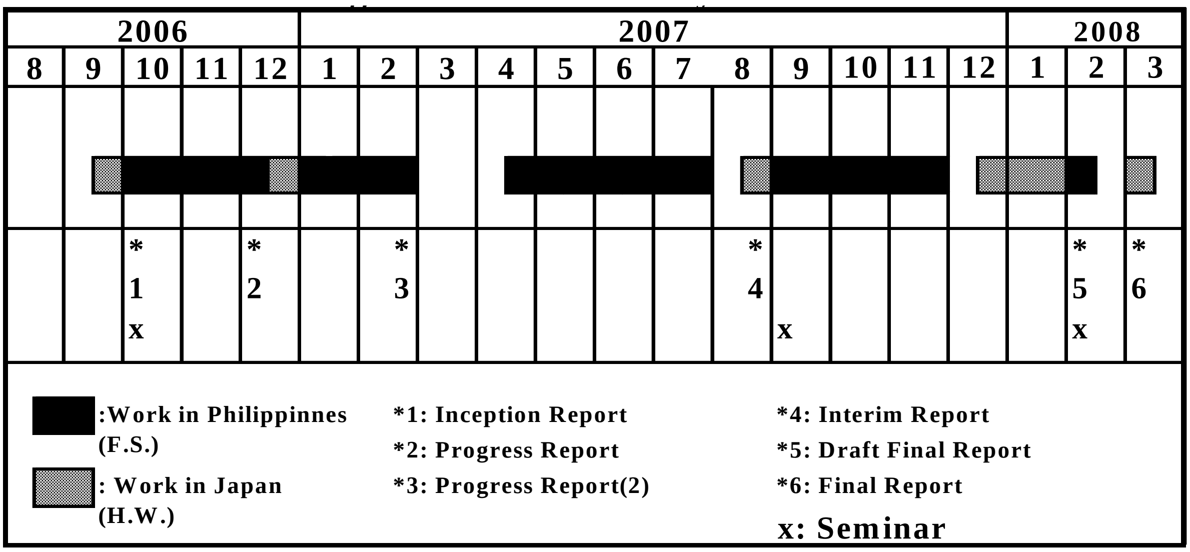

Figure 1.1 Study Schedule, JICA, 2006-2008

1.5 Basic Conditions for Conducting the Study

For the Study, the following conditions have been discussed and confirmed: 1) Target Year for Prioritization; and 2) Safety Level for Formulation of Flood Control Projects.

1.5.1 Target Year

One of the main purposes of the selection of prioritized areas was to narrow down the number of areas where flood control projects should be provided within a certain period. In this context, it was necessary to set up the target year to confirm that 'certain period'. Therefore, at the discussion in the First Steering Committee Meeting on 26th September 2006, the Philippine Side and the Study Team agreed that the target year should be 2034, which corresponds to the final year of the four (4) Medium-Term Philippine Development Plans that will start from 2011 after termination of the current Medium-Term Plan.

1.5.2 Safety Level

For prioritization, it was necessary to examine and compare the economic efficiency of flood control projects for several areas based on the same level of safety, which has to be set up for the comparison. Therefore, at the discussions in the First Steering Committee Meeting mentioned above, it was also agreed that the safety level for a 20-year return period flood should be applied for the comparison of economic efficiency of the flood control projects.

CHAPTER 2 PRESENT CONDITIONS IN THE PHILIPPINES

2.1 River Basins

(1) Water Resources Regions

For purposes of comprehensive planning of water resources development including flood damage mitigation, the National Water Resources Council (NWRC) has divided the Philippines into 12 water resource regions (WRR), as shown in Fig.2-1 and listed in Tab.2-1. Major considerations taken into account in this regionalization were the hydrological boundaries defined by the physiographic features and homogeneity in climate of the different parts of the country.

Drawn up from institutional considerations, the Philippines has been divided into 17 political regions; namely, Regions 1 to 12, NCR, CAR, ARMM and CARAGA. These 17 regions are further subdivided into smaller political units; namely, province, city/municipality and barangay, the smallest unit. The NCR covers Metro Manila.

Actually the water resource regions generally correspond to the existing political regions, except Ilocos, Cagayan, Central Luzon and Northern Mindanao where there are minor deviations dictated primarily by hydrological boundaries.

(2) Classification of River Basins

Large rivers, some of which are navigable, traverse the principal islands of the Philippines. The longest is the Cagayan River in northern Luzon. Other important rivers of Luzon include the Agno and Pampanga, crossing the Central Luzon Valley; the Abra, flowing through the Cordillera Central and irrigating the mountainside rice terraces; the Pasig, a commercially important artery flowing through the City of Manila; and the Bicol, the primary river of the Bicol Peninsula. The major rivers of Mindanao are the Mindanao (Cotabato), which receives the waters of the Pulangi, and the Agusan.

In the report “Principal River Basins of the Philippines” published by NWRC in October 1976, NWRC identified the principal river basins (PRBs) of the Philippines with these objectives: 1) To delineate and codify the PRBs for hydrologic purposes; 2) To determine the physical characteristics of each basin; 3) To generate interest on the minor river basins with potential for development; 4) To define the major river basins (MRBs) in the country and trigger national interest in water resources development; 5) To prepare water resources regional maps showing the principal rivers and their respective basin boundaries to aid in the preparation of regional water resources plans and programs; and 6) To initiate an extensive, continuous program for collecting and organizing data on these basins for the complete characterization of each basin.

For the purpose of identification, principal river basins are defined as those with at least 40 km^2 of drainage area. River basins with areas of at least 1,400 km^2 are classified as major river basins, as shown in Tab.2-2. The locations of major river basins are as shown in Fig.2-2.

The identification included not only drainage areas but also other physical characteristics of the river basin, such as location and elevation of the headwater and outlet, extent of built-up area, cultivated area, grassland area, soils, channel gradient, drainage density and extent of level area, where these information were considered then as sufficient for subsequent framework studies but necessary to update them since they were made more than 30 years ago.

Among the PRBs listed in the above-said report, 421 principal river basins have been identified with drainage areas varying from 41 km^2 to 25,649 km^2. However, 79 of these are parts of major river basins where the rivers are tributaries of major rivers, and the rest are independent PRBs.

2.2 Floods

2.2.1 Flood Conditions

The vulnerability of the Philippines to flooding is more pronounced in the 421 principal river basins scattered all over the Philippine archipelago with an average of 20 typhoons each year. Under intense rainfall, overflowing of waterways, inundation and deposition of sediment in flood plains, extensive flood damages often result. Monsoons also bring heavy rains that cause flooding. Flood-prone areas are extensively located in Eastern Mindanao, Northern Samar, Central Luzon and the Bicol Region. Approximately, there is a total of about 1,316,230 hectares susceptible to flooding nationwide, of which almost 423,000 hectares or 32% are located in Central Luzon alone.[1]

(1) Types of Flooding Condition

1) Flashflood including Debris, Mudflow and Lahar Floods

The tragic flash flood on 05 November 1991 that claimed the life of almost 8,000 people in Ormoc City, Leyte Province, is a classic example of a flashflood. Flashfloods are local floods of great volume sometimes including massive sediment and short duration. A flashflood generally results from torrential rain or "cloudburst" on a relatively small and widely dispersed stream. Runoff from intense rainfall results in high flood and sediment waves. Discharges quickly reach a maximum and diminish almost as rapidly. Flash floods are particularly common in mountainous areas but are also a potential threat in any area where the terrain is steep, surface runoff rates are high, streams flow in narrow canyons, and severe thunderstorms prevail.

1 Source: Philippine Flood Control 1977, NWRC

2) Overflow Type Flood

Frequently experiencing typhoons, overflow from the bank of the Agno River had caused damaging floods in the Pangasinan Plain. It has been estimated that a total area of 180,000 to 200,000 ha are prone to flooding in the provinces of Pangasinan and Tarlac. The population in these areas has been conservatively estimated at 700,000. In 1972, Agno River inundated almost its entire flood-prone area with damages estimated at 2 billion pesos, making it the largest flood ever recorded (Source: Water and Flood, DPWH/JICA, 2004).

Overflow type floods such as those in the Agno River are caused by rainfall over large areas. These floods differ from flashfloods in their extent and duration. Whereas flashfloods are of short duration in small streams, overflow type floods take place in river systems whose tributaries may drain large geographic areas. Floods on large river systems may continue for periods ranging from a few hours to days.

3) Inland Flood

The overflow of flood discharge from a river channel causes riverine floods. On the other hand, rainfall in areas which are, in principle, protected by river or coastal dike is difficult to drain from the inland, thus causing inland floods. Such areas are situated in flat, low land along river courses, and in coastal areas. Floods may not be severe, but flood occurs very frequently and cause severe economic damage relatively over time.

4) Flood by Bank Erosion

In the Philippines, bank erosion could be observed in many places, especially at the foot of volcanoes where the soil is made up of volcanic ash. In such areas, the river channel is prone to meander and change course when flooding occurs. The bank is easily scoured, and houses and public facilities alongside are seriously damaged.

5) Others

There may be other natural disaster types such as coastal erosion and landslide. However, these natural disaster types may not be directly related to floods. In principle, these natural disasters are not included in the Study.

(2) Flood Damage

From 1990 to 2003 alone, the Philippines experienced an average of 3.5 destructive typhoons a year with damage costing up to 96.6 billion pesos, mostly incurred from flood-damaged properties, infrastructures and crops. From damage figures of the Office of Civil Defense (OCD) and the National Disaster Coordinating Council (NDCC), most typhoons entering the PAR undoubtedly take the heaviest toll on lives and properties. This incurs a heavy cost on the economy of the Philippines, especially, upon the agriculture sector. It has been reported that an average of 900 persons have died, and the estimated cost of approximately 8 billion pesos is assumed to be due to typhoons and associated flooding events over the period covered.

The loss of human lives and damage to agricultural crops and private properties, as well as the interruption of business operations, tend to hinder economic development and the efficient delivery of basic social services. Flood damage has been estimated at 2% of the national budget, and almost double the yearly budgetary allocation of the DPWH for flood control.

Tab.2-3 lists the amounts of flood damage incurred in the last 26 years (1980-2005) in the Philippines, while Figure 2.1 shows the annual behavior of casualties.

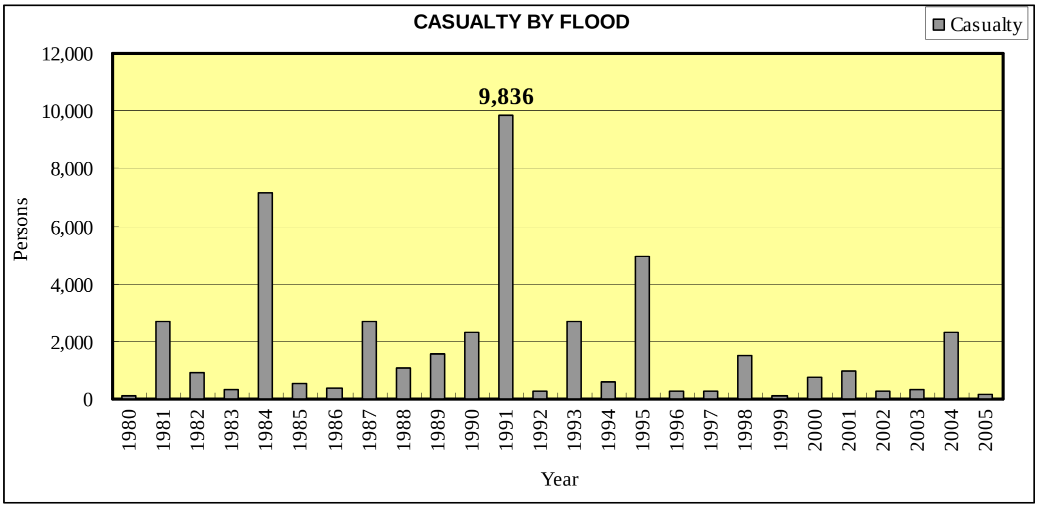

Figure 2.1 Annual Casualties by Flood

Tab.2-4 summarizes the tropical cyclones, whose casualties exceeded 100 persons in total.

2.2.2 Flood Control Projects

In Butuan City, Phase I of the Lower Agusan Development Project, which involve the construction of 10.6 km of embankment levee, 5.28 km of concrete floodwall, including related structures such as floodgates and drainage sluices and dredging works at the Agusan River, was completed in 1999. The list of previous and ongoing flood control projects is shown in Tabs.2-5, 2.6 and 2.7.

In the Medium-Term Philippine Development Plan (MTPDP) 2001-2004, the medium-term targets for flood control and drainage infrastructure are the following:

(a) Implementation of desirable flood control and drainage projects in major river systems, including the provision of adequate structural schemes especially against flooding in Metro Manila and other highly urbanized industrial centers.

(b) Projected total accomplishment of 1.4 million ha over the plan period 2001-2004. Controlling the flow of rivers and the provision of drainage is the main priority. In covering this additional area, the total area with flood control and drainage facilities would reach about 1.70 million ha, or 87.57% of total coverage for river control and drainage by 2004. Total investment requirement for the program is about 34.79 billion pesos.

(c) Implementation of priority flood control projects in the following areas: Agno, Laoag, Lower Cagayan, Mt. Pinatubo Rehabilitation, Iloilo, Lower Agusan, Lower Cotabato, West Mangahan, KAMANAVA (Kaloocan, Malabon, Navotas and Valenzuela), and Pasig River.

2.3 Related Flood Control Projects

By the end of 2000, the total area provided by the DPWH with river control and drainage facilities reached about 305,725 ha. This represents 62.03% of the total potential coverage area of 492,831 ha. Extensive networks of flood control measures (such as dikes, river walls, river and channel improvement/dredging) have been undertaken in the major river basins of Agno, Cagayan, Pampanga, Bicol and Agusan. Likewise, major components of the flood control and drainage program in Metro Manila have been built; particularly, additional drainage mains, pumping stations (including the recently completed Balut, Vitas and San Andres pumping stations), estero (creek) improvement works, dredging and related facilities.

Sabo and flood control projects have been implemented under foreign assistance, mostly from the Government of Japan. The projects under GOJ assistance can be classified into: 1) GOJ grant aid projects; 2) JICA studies; and 3) OECF/JBIC projects, as shown in Tabs. 2-5, 2-6 and 2-7, respectively. Based on these tables, during the last 34 years from 1971 to 2004, 53 projects and studies with the total amount of 138,173 million yen (excluding costs of JICA studies) have been implemented. The salient features of these projects by category are as described below.

(1) Grant Aid Projects of GOJ

Nine (9) grant aid projects with the total cost of 9,198 million yen have been implemented during the last 34 years (see Tab.2-5). The implementation agencies were PAGASA, University of the Philippines (UP) and DPWH.

PAGASA implemented two projects with the total cost of 101 million yen (1% of the total amount) relating to the flood forecasting and warning systems in the Pampanga River Basin. UP implemented one project relating to the National Hydraulic Research Center. On the other hand, the DPWH implemented six projects with the total cost of 9,037 million yen (98%) relating to:

- Retrieval of flood prone areas in Metro Manila;
- Equipment procurement for Mt. Pinatubo;
- Flood mitigation works in Ormoc City;
- Rehabilitation of the flood control and warning system in Metro Manila; and
- Construction of Hydraulic Laboratory.

In Ormoc City, the first phase of the JICA-assisted Flood Mitigation Project has already been completed. This involved the construction of three (3) slit dams and the reconstruction of five (5) bridges.

(2) JICA Studies

Seventeen (17) studies have been implemented during the last 34 years and two (2) studies are ongoing (see Tab.2-6). The implementation agencies were PAGASA and DPWH.

PAGASA implemented one study (6% of the total number of the studies) on flood forecasting system. On the other hand, DPWH implemented 18 studies (94%), which are classified into:

- Flood Control and Sabo: Six (6) studies around Mt. Mayon, Mt. Pinatubo and Laoag;
- Flood Control: Five (5) studies in major river basins (Pampanga, Panay, Agno, Ilog-Hilabangan and Lower Cagayan);
- Flood Control and Drainage, or Drainage alone: Three (3) studies in Metro Manila; and
- Others (disaster prevention): Two (2) studies around Mt. Mayon and in Camiguin Island; one (1) study for nationwide (The Nationwide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas in the Republic of the Philippines); and one (1) study for a principal river basin (Comprehensive Flood Mitigation for Cavite Lowland Area in the Republic of the Philippines).

Based on these, it is evident that JICA studies have been implemented in Metro Manila, major river basins (Pampanga, Panay, Agno, Ilog-Hilabangan and Lower Cagayan), principal river basins (Laoag and Cavite), Mt. Mayon, Mt. Pinatubo and Camiguin Island.

(3) OECF/JBIC Projects

Twenty-seven (27) OECF/JBIC projects (L/A base) with the total cost of 128,975 million yen have been implemented during the last 34 years (see Tab.2-7). The implementation agencies were PAGASA and DPWH.

PAGASA implemented four projects with the total cost of 12,390 million yen (10% of the total amount) relating to the flood forecasting and warning systems for dam operation, etc. On the other hand, DPWH implemented 23 projects with the total cost of 116,585 million yen (90%), which are classified into:

- Flood Control: 15 projects in Pampanga, Pasig-Marikina, Agusan, Agno and allied rivers, Iloilo City and Metro Manila;
- Flood Control and Drainage, or Drainage alone: 3 projects in Metro Manila;
- Flood Control and Sabo: 1 project in Laoag; and
- Others (volcano hazard mitigation, telemetering and small dams): 4 projects at Mt. Pinatubo and nationwide.

Based on these, it can be understood that OECF/JBIC projects have been implemented mainly in Metro Manila, major river basins (Pampanga, Pasig-Marikina, Agusan and Agno), selected urban centers (Laoag and Iloilo), and Mt. Pinatubo.

2.4 Policy and Direction for Flood Control

Several national development plans have been prepared to orient the policy and direction for economic and infrastructure development including flood control in the Philippines. Selected among them are the Medium-Term Philippine Development Plan (2004-2010), the Medium-Term DPWH Infrastructure Development Plan (2005-2010), the National Flood Mitigation Framework Plan, and the National Framework for Physical Planning (2001-2030).

2.4.1 Medium-Term Philippine Development Plan, 2004-2010 (MTPDP 2004-2010)

The Medium-Term Philippine Development Plan (MTPDP) is a detailed roadmap towards achieving the common goal of reducing poverty through job creation and enterprise.

As for natural disaster prevention, strategies are mainly divided into two; namely, Non-structural Measures and Structural Measures. Their strategies are excerpted as below:

1. Non-structural Measures
   a. Complete the geo-hazard mapping of the remaining 13 regions;
   b. Conduct soil stability measures (e.g., reforestation and planting in riverbanks) for landslide-vulnerable areas; and
   c. Ensure integration of disaster preparedness and management strategy in the development planning process at all levels of governance. This shall be done through the following activities, namely, among others: periodic risk assessments, updating of respective land use policy based on the assessment, conduct of disaster management orientation/training among LGU officials and concerned local bodies, institutionalization of community-based mechanisms for disaster management (e.g., inclusion of legitimate disaster management organization at various Disaster Coordinating Councils), and advocating for the bill on “Strengthening the Philippine Disaster Management Capability”.

2. Structural Measures
   a. Keep at the optimum the conveyance capacities of existing river channel floodways, drainage canals, esteros through riverbank protection, dredging/desilting, observance of river easements, relocation of informal settlers, proper disposal of garbage, and efficient maintenance in coordination with LGUs; and
   b. Provide adequate flood control and drainage facilities in all flood/sediment disaster prone areas to mitigate flooding as well as rehabilitate and improve existing facilities.

The points to be understood in the MTPDP 2004-2010 policy are as summarized below:

- Flooding shall be mitigated through complex enhancement between government policies, organizations, laws, physical countermeasures, etc., under the philosophy that flooding cannot be controlled by human techniques completely; and

- In addition, flood management shall be considered as one of Integrated Water Resources Management schemes.

In accordance with the policy, the following priority flood management projects are scheduled:

- Mt. Pinatubo Hazard Urgent Mitigation II;
- Iloilo Flood Control Project;
- Lower Agusan Flood Control Project Stage 1, Phase 2;
- Bicol River Basin and Watershed Management;
- Agno and Allied Rivers Flood Control;
- KAMANAVA Flood Control;
- Metro Manila Flood Control Project - West of Mangahan Floodway;
- Pasig-Marikina River Channel Improvement Project, Phase II;
- Cagayan River Flood Control Project;
- Panay River Flood Control Project; and
- Lower Cotabato River Flood Control Project.

2.4.2 Medium-Term DPWH Infrastructure Development Plan, 2005-2010

DPWH, which is mandated to administer flood control and sabo projects, has set the following nine (9) tasks to be solved or improved for the implementation of effective flood and landslide disaster mitigation since the previous Medium-Term Plan (1999-2004):

- Formulate an overall Master Plan for flood control program adopting the principle of management and river basin approach;
- Pursue comprehensive planning of prioritized major and principal river basins, giving priority to maintenance rather than new construction;
- Provide adequate flood control and drainage facilities in all flood/sediment-disaster prone areas to mitigate flooding within tolerable levels;
- Pursue non-structural measures to mitigate floods, such as flood forecasting and warning and monitoring system, evacuation plan, hazard mapping and reforestation;
- Keep optimum conveyance capacities of river channel floodways, drainage canals, esteros, etc., through riverbank protection, dredging/de-silting, observance or river easement, and efficient management in coordination with LGUs;
- Establish database on river information including existing flood control, drainage and Sabo structures;
- Strengthen and maximize the capacity of the Flood Control and Sabo Engineering Center (FCSEC) to conduct basic and applied researches and development, engineering programs and human resources development;
- Strengthen the flood management capabilities of DPWH, LGUs and other concerned agencies; and

- Establish the National Flood Management Committee (NFMC) as the inter-agency organization and policy governing body to integrate and lead all efforts on disaster mitigation and flood management, and formulate guidelines.

To sustain the policy on development since the previous Medium-Term Plan, the DPWH have the following investment programs:

Table 2.1 DPWH Medium-Term Investment Program, 2005-2010

(in mil. Pesos)

Project	Total Cost	Previous Year	Proposed Allocation (in thousand Pesos)							
			2005	2006	2007	2008	2009	2010	Total (2005-2010)	Later Years
National Roads										
Foreign-Assisted Project	353,770*	52,376	17,122	24,270	18,834	18,819	34,014	42,163	155,222	146,676
Locally Funded Project	142,522	1,353	9,081	11,285	18,454	37,841	30,681	33,827	141,169	
Total	496,293*	53,729	26,203	35,555	37,288	56,660	64,695	75,990	296,391	
Flood Control										
Foreign-Assisted Project	93,422	17,414	5,285	4,784	6,532	4,014	10,966	12,642	44,223	31,785
Locally Funded Project	4,900	-	-	-	1,500	1,500	900	1,000	4,900	-
Total	98,322	17,414	5,285	4,784	8,032	5,514	11,866	13,642	49,123	31,785
Other Locally Funded Project	70,650	-	7,232	7,380	17,342	12,132	8,892	8,640	61,618	9,032
Grand Total	665,265	71,143	38,720	47,719	62,662	74,306	85,453	98,272	407,132	

Note: (*) as shown in MTPIP

The river basins listed with requests for foreign-assisted projects in the DPWH Medium-Term Investment Program are as shown in Tab.2-8, together with the locally funded projects.

2.4.3 National Flood Mitigation Framework Plan (Draft: June 2006)

(1) Current Situation and Needs

1) Background

Flood and other water-induced disasters are becoming regular occurrences in the country. These recent occurrences have shown a rising trend of disasters nationwide coupled with the seemingly reactive postures of both government and the populace. Acknowledging the need to immediately address flood and flood/sediment related disasters which hamper the socio-economic development of the country, President Gloria Macapagal-Arroyo had directed the formulation of a National Flood Mitigation Framework Plan to facilitate the harmonious and coordinated efforts of the various government agencies and other stakeholders in mitigating flood and other water-induced disasters, at the same time rationalizing investments of other sectors.

2) Disaster Mitigation Framework

Disaster Coordinating Councils (DCCs) at different levels have been created under PD 1566, which provides the nation’s principles in disaster mitigation. Issues and concerns hampering the effective disaster mitigation in the country were enumerated (e.g., the local calamity fund is not available for pre-disaster activities).

3) Flood Mitigation Constraints

The existing constraints on flood mitigation have been identified, as follows:

- Limited budget; and
- Limited human resources/expertise and equipment.

(2) Goals and Objectives

1) Goals

The goal set in this National Flood Mitigation Framework Plan (NFMFP) is the protection of communities and environment, and the enhancement of their coping capacities from/against flood and other water-induced hazards (includes sediment hazards) through non-structural and structural measures.

2) Objectives

Specific objectives of the Framework Plan are, as follows:

- To reduce the impacts of flood and other water-induced hazards by integrating and harmonizing measures in the following areas: a) Major river basins; b) High-risk principal/small rivers; c) Areas within fault lines; d) Volcanic areas; and e) High-risk coastal areas; and
- To develop hazard mitigating measures, such as: a) Structural Measures, b) Non-structural Measures, and c) Response, Recovery and Development.

(3) Policies and Strategies

In the implementation of the NFMFP, the following policies are to be pursued:

- Composition of the framework on flood mitigation by the following approaches;
  - Structural Measures (Reducing Hazard Magnitude)
  - Nonstructural Measures (Reducing Vulnerability)
  - Response, Recovery and Development (Mitigating Impacts)
- Use of Integrated Water Resources Management (IWRM) principles in guiding the development of approaches;
- Rational and equitable implementation of mitigation measures, i.e., based on river basin master plans; and
- Establishment by LGUs of community-based rainfall and water level monitoring in coordination with PAGASA and BRS-DPWH, respectively.

(4) Strategies

In line with the goals, objectives and policies, the following strategies have been recommended:

- The concerned agencies shall cooperate and coordinate their responsibilities consistent with the framework of flood mitigation and in accordance with the Responsibility Matrix;

- A river basin management plan shall be formulated for each prioritized river basin, focusing on flood mitigation; and
- Countermeasures shall be suited to local conditions, culture and resources.

(5) Framework of Flood Mitigation

Various activities under the structural (reducing vulnerability), non-structural (reducing hazard magnitude) and response, recovery and development (mitigating impacts) approaches are to be listed including those for institutional strengthening.

(6) Implementation Plan

Government agencies, LGUs and other stakeholders are to implement the mitigation programs and measures described. This will require the commitment of the government to support the programs, and the understanding and support of the LGUs and beneficiaries.

The following non-structural and structural measures are to be implemented:

1) Nonstructural Measures

- NAMRIA Base Map Updating;
- Harmonization of Hazard Maps;
- Hydrological Information Dissemination;
- Watershed Management;
- Coastal Resources Management; and
- Community Disaster Management.

2) Structural Measures

- Ongoing Foreign-Assisted Flood Control Projects;
- River Basins Scheduled for Implementation until 2010;
- Feasibility/Detailed Engineering and Implementation of Priority Projects identified in the High Risk Flood and Sediment Disaster Prone Areas (DPWH);
- Feasibility/Detailed Engineering and Implementation of Sabo Projects in Identified Sabo Sites (DPWH);
- Master Plan for the Remaining seven (7) Major River Basins (No existing MP);
- Update of Completed Master Plans of four (4) Major River Basins (DPWH);
- SWIM/SWIP Projects (NIA/BSWM, DA/DPWH);
- River Improvement Projects and Drainage Projects under the District Engineering Offices of the DPWH Regular Funds;
- River Improvement Projects and Drainage Projects under the Local Government Units; and
- Provision of Structural Complement (i.e., check dams) for Erosion Control and Reforestation.

CHAPTER 3 FIRST SCREENING OF RIVER BASINS

3.1 Procedure of the First Screening

The procedure of the First Screening is as diagrammatically shown in Figure 3.1.

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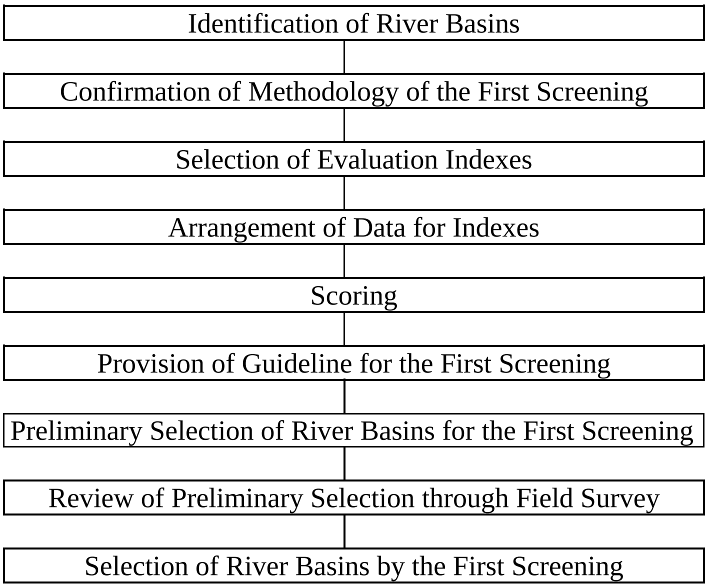


Figure 3.1 Procedure of the First Screening

The contents of these items are as explained below.

(1) Identification of River Basins

The objective river basins for the First Screening are identified, to which the 947 flood prone cities/municipalities belong.

(2) Confirmation of Methodology of the First Screening

The methodology of the First Screening is confirmed by referring to previously conducted studies. The proposed methodology is the scoring of evaluation indexes.

(3) Selection of Evaluation Indexes

Based on the confirmed methodology, evaluation indexes are selected. These evaluation indexes represent flood damage potential from the viewpoints of natural and socio-economic conditions.

(4) Arrangement of Data for Indexes

Based on the selection of the evaluation indexes, necessary data are collected, which data consist of administrative division level data (such as provincial, city and municipality) and GIS data.

Then, these administrative level data are converted from administrative division level into river basin data.

(5) Scoring

Based on the river basin data of the indexes for each river basin, the score of each index is given. Then, the total score is calculated for each river basin.

(6) Provision of Guideline for the First Screening

For the First Screening, some other factors together with the ranking by score were considered and arranged as a guideline.

(7) Preliminary Selection of River Basins for the First Screening

Based on the above guideline, 100 river basins, of which adequacy will be confirmed through field survey including discussion with DPWH regional offices, are preliminarily selected.

(8) Review of Preliminary Selection through Field Survey

To confirm the adequacy of the preliminarily selected 100 river basins, a field survey as well as the discussion with DPWH regional offices, were conducted.

(9) Selection of River Basins by the First Screening

Through the above mentioned procedure, river basins are finally selected as the output of the First Screening.

3.2 Identification of River Basins

The Study covers the cities/municipalities with 947 flood-prone areas identified by NDCC. In this connection, the identification of river basins, to which such cities/municipalities belong, has been conducted, as described below (refer to Tab.3-1).

3.2.1 Basic Data and Information for Identification of River Basins

The administrative boundary of the above provinces/cities/municipalities was derived from the information provided by the Philippine National Statistics Office (NSO) Census 2000. While, the identification of basin boundary of river basins related to the cities/municipalities with 947 flood-prone areas was mainly carried out on the topographic map of 1:250,000 in scale published by NAMRIA.

In the whole country of the Philippines, 421 river basins have been defined as principal river basins in the report “Principal River Basins of the Philippines” published by NWRC in October 1976. In the report, principal rivers are defined as those with more than 40 km^2 in catchment areas. Among these, 18 river basins with areas of more than 1,400 km^2 are classified as major river basins.

As to the identification of the principal river basins in the Study, both the above-said report prepared by NWRC and the topographic maps of 1:250,000 scale by NAMRIA were referenced to verify their locations, river names, main watercourses and catchment areas. Besides, the delineation of the principal river basin boundaries was carried out with GIS software and the digital elevation model data of the whole country of the Philippines prepared by NASA in 2000.

The principal and major river basins related to the targeted cities/municipalities in the respective water resources regions are listed in Tab.3-2, Tab.3-3 and Tab.3-4, respectively.

3.2.2 Other River Basins

The other river basins are the remaining river basins with the exception of the principal river basins. In the Study, such other river basins have been delineated and identified on the topographic map of 1:250,000 scale of NAMRIA. The other river basins amount to 770, as shown in Tab.3-5 and 3-6, and the catchments are in the range of about 3 km^2 to 982 km^2. Most of the other river basins are located along the narrow coastal area of each island.

As for the names of the other river basins, it was difficult to extract all river names from the map of 1:250,000 scale because there are some rivers whose names are not indicated on the map. In the Study, therefore, these other river basins temporarily adopt the name of the neighboring city/municipality.

3.2.3 River Basins Covering the Flood Prone Areas

Based on the results of delineation of principal and other river basins, it was identified that the total number of river basins covering the flood prone areas is 1,164 including the major river basins, as given in the following table.

Table 3.1 Total Number of River Basins

River Basins	Number	Remarks
Independent Principal River Basins	376	Including 75 Tributaries of Major Rivers
Major River Basins	18	
Other River Basins	770	
Total	1,164	Covering the Flood Prone Areas

Note: In this table, Principal River Basin and Major River Basin are based on the definition by NWRB and the river basins excluded from the definition are defined as Other River Basins.

The relationship between the river basins and the cities/municipalities in the NDCC list is shown in Fig.3-1.

3.3 Confirmation of Methodology of the First Screening

(1) Method Adopted in Previous Studies

There were two previously conducted studies related to flood risk assessment (refer to the Supporting Report C for details). The salient features of methods adopted in these studies are, as follows:

1) "Development of Method for Assessing Flood Vulnerability"

In this study, 11 FVI indicators were selected and each indicator was given a certain value. The value of each FVI indicator was then converted into non-dimensional value. On the other hand, the weights for indicators were decided in such that the calculated FVI values had high correlation with the flood damages. The FVI value for the objective basin was calculated, and the flood vulnerability of the river basin was evaluated.

2) "Natural Disaster Risk Management in the Philippines"

In this study, five (5) indexes were selected in order to identify the flood-problem areas. However, scoring and ranking were not considered.

(2) Selected Methodology of the First Screening

By referring to the concept adopted in the previous studies, the methodology for the First Screening has been decided considering 1) evaluation indexes and 2) scoring, as follows:

1) Evaluation Indexes

The evaluation indexes are built from the range of available data to represent the flood risk potential of the river basins.

2) Scoring

Score is decided for each river basin based on the evaluation results of the indexes, and the First Screening was, in principle, conducted on the basis of this score.

3.4 Selection of Evaluation Indexes

The evaluation indexes should express the flood risk or flood damage potential of the river basins. In this sense, the most essential evaluation indexes which can express the flood risk directly are flood casualties and damages.

However, such data of flood casualties and damages are limited in the period and accuracy, additional statistic data, which comparatively related to expression of flood damage potential, are considered in the two aspects, socio-economic and natural conditions. In the selection of indexes, the availability of data is also considered. Following to these, the evaluation indexes were selected, as described below.

3.4.1 Indexes for Socio-economic Conditions

From the viewpoint of the relationship to flood risk, the indexes for socio-economic conditions are classified into two groups, direct and secondary indexes. The direct indexes show the conditions on flood casualties and damages of river basins. On the other hand, the secondary indexes show the conditions on assets, flood vulnerability, etc. of river basins.

The selected secondary indexes were: (S1) poverty incidence; (S2) population; (S3) population movement; (S4) production; (S5) forest cover ratio; and (S6) built-up area ratio. On the other hand, the selected direct indexes were: (S7) flood casualties and (S8) flood damages. For the selection, it was considered that the indexes should not be disadvantageous to rural or poor areas. The details of these indexes are as shown in Table 3.2.

Table 3.2 Evaluation Indexes for Socio-Economic Conditions

Index		Explanation	Relation to Flood Risk
S1	Poverty Incidence	Poverty incidence is an index on protection areas from the viewpoint of poverty reduction.	Secondary
S2	Population	Population is an index for flood damages.	Secondary
S3	Population Movement	Population movement is an index for flood damages.	Secondary
S4	Production	Production can be an index for assets.	Secondary
S5	Forest Cover Ratio	Forest cover ratio has strong relationship with flood and sediment runoff.	Secondary
S6	Built-up Area Ratio	Built-up area ratio has strong relationship with flood runoff.	Secondary
S7	Flood Casualties	Flood casualties are one of the major indexes of flood damages.	Direct
S8	Flood Damages	Flood monetary damages are one of the major indexes of flood damages.	Direct

3.4.2 Indexes for Natural Conditions

As in the socio-economic conditions, the indexes for natural conditions are classified into two groups, direct and secondary indexes. The direct indexes show the flood frequency, while the secondary indexes show the flood susceptibility from the viewpoints of meteorology, hydrology, topography and geology of river basins.

The selected secondary indexes are: (N1) frequency of tropical cyclone; (N2) rainfall intensity; (N3) river gradient; and (N4) ratio of hazards zone of volcano. On the other hand, the selected direct indexes are: (N5-C) frequency of floods based on flood casualty data; and (N5-D) frequency of floods based on flood damage data. The table below shows the details of these indexes.

Table 3.3 Evaluation Indexes for Natural Conditions

Index		Explanation	Relation to Flood Risk
N1	Frequency of Tropical Cyclone	Tropical cyclone is one of the major causes of floods.	Secondary
N2	Rainfall Intensity	Heavy rainfall is another major cause of floods.	Secondary
N3	River Gradient	River gradients have strong relationship with flashfloods, debris flows, mudflows and lahars.	Secondary
N4	Ratio of Hazards Zone of Volcano	Volcano has strong relationship with flashfloods, debris flows, mudflows and lahars.	Secondary
N5-C	Frequency of Floods based on Flood Casualty Data	Frequency of floods is one of the major indexes of floods.	Direct
N5-D	Frequency of Floods based on Flood Damage Data	Frequency of floods is one of the major indexes of floods.	Direct

3.5 Arrangement of Data for Indexes and Scoring

3.5.1 Data Collection

In line with the selected evaluation indexes, necessary data are collected. The collected data are shown in Tab.3-7. Data levels of the evaluation indexes are, as follows:

(1) City/Municipal Level Data: Population (S2 and S3) and Flood casualties (S7)

(2) Provincial Level Data: Poverty incidence (S1), Production (S4), Flood damages (S8) and Frequency of tropical cyclones (N1)

(3) Other Level Data: Forest cover ratio (S5), Built-up area ratio (S6)
(Nationwide GIS Data) Rainfall intensity (N2), River gradient (N3) and Ratio of hazards zone of volcano (N4)

3.5.2 Data Arrangement

As mentioned above, the data levels of evaluation indexes are: 1) city/municipal level data; 2) provincial level data; or 3) other level data (nationwide GIS data). Since the flood risk of identified river basins is to be assessed, the city/municipal level data (S2, S3 and S7) and provincial level data (S1, S4, S8 and N1) are to be converted into river basin level data. On the other hand, for the other level data (S5, S6, N2, N3 and N4), the river basin level data should be extracted directly from the GIS data. Details of the river basin data are shown in Tab.3-8, and the level of each index for each river basin is as shown in Fig.3-2 to 3-15.

For the conversion of city/municipal/provincial level data, GIS was utilized in principle. The major method used was the area weighted average, and its basic procedure is, as follows (for details, refer to Supporting Report B):

- Within one river basin, the areas of related provinces/cities/municipalities are estimated using GIS; and
- Based on the areas and the corresponding basic values, the index value of the river basin is calculated using MS Excel.

Regarding S7 index, it is hard to identify the occurrence locations of the casualties of all relating cities/municipalities. Under this condition, S7 index is prepared considering casualties per year and basin area. For the arrangement of other level data, direct overlay method, etc. is applied.

3.5.3 Determination of Maximum Score for Each Index

Through the discussions with the counterpart agencies for the Study, the ranges of score for each evaluation index were determined in the following manner, taking into account the features and significance of the evaluation index:

- In principle, a maximum of 5 points ranging from 1 to 5 is given to every index;
- Among these indexes, a maximum of 15 points ranging from 1 to 15 is given to the indexes of flood casualties and damages, since these indexes show the flood vulnerability directly while the other indexes show it indirectly except flood frequency; and
- As for flood frequency, this index can be evaluated in two cases indirectly: one is derived from the records of flood casualties and the other is from flood damage separately. Five (5) points is given for each flood frequency in two cases.

The proposed scores including ranges are shown in Tab.3-9.

3.6 Results of the First Screening

3.6.1 Scoring Results

(1) Order of River Basin by Score

Based on the respective evaluation indexes discussed in the above sections, the 1,164 river basins are indicated with scores on flood vulnerability. The scoring from the first place to the 100th place is shown in Tab.3-10, and the detail of scoring is tabulated in the Supporting Report C.

(2) Sensitivity Analysis

The sensitivity analysis in the First Screening was carried out to confirm the influence on ranking of the points for indexes S7 (flood casualties) and S8 (flood damages). Since both indexes directly show the flood damage potential of each river basin, the sensitivity analysis was conducted for three cases, as follows:

Case-1: 10 points is given for indexes S7 and S8

Case-2: 15 points is given for both indexes

Case-3: 20 points is given for both indexes

Tab.3-11 shows the results of the analysis, including the top 50 ranking under the three cases. The colors in the table indicate the existence of river basins under these cases. Based on this table, the following items were considered:

- Some river basins are replaced by other river basins due to change of score (from 15 points to 10 or 20 points) for the two indexes; and
- The number of such river basins with the score of 15 points is only around 3 to 8 among the top 50 river basins.

Hence, 15 points is applied since the influence is minimal.

3.6.2 Issues of Scoring

The results and remaining issues on scoring are as stated below:

(1) Outputs obtained through the Procedure

The outputs obtained through the procedure are, as follows:

- Relation between flood prone municipality and river basin has been identified;
- Basic data for evaluation of flood risk have been arranged;
- Flood risk areas on the river basin level have been identified; and
- System for evaluation of each river basin has been provided. Therefore, flood risk of each river basin can be easily re-evaluated by adding new flood damage data.

(2) Remaining Issues on Scoring

Data obtained through the Study are very limited and the accuracy of some data may not be so high, so that evaluation results do not always correspond to the recognition of flood risk by the agencies concerned.

Therefore, data on flood damage should be further collected as much as possible in the future, in addition to the already collected data, to enhance the reliability of scoring.

3.6.3 Guidelines on Preliminary Selection for the First Screening

Under the above circumstances, the guidelines on preliminary selection for the First Screening were prepared considering the following strategic points:

- Classification of river basins (major river basins, principal river basins, and other river basins);
- Dangerous river basins (although dangerous river basins are not clearly defined, they are generally understood to be the "river basins that have experienced severe flood damages, and are duly recognized as having a high risk of occurrence of devastating flood damage,

and necessity of provision of countermeasures within a short period of time by everyone concerned.”); and

- Regional distribution.

The prepared guidelines are as described below.

(1) Guideline 1

- From the 100 river basins in the list, those already implemented or whose implementation is scheduled by the DPWH such as Laoag, Pampanga and Pasig are replaced by the river basins listed above the 100 rank.
- The said river basins shall be extracted from “Water & Floods, March 2004” prepared by DPWH (GOJ Assisted Projects: 1971–Present). Tab.2-8 shows foreign-assisted projects as discussed before.

(2) Guideline 2

- Major river basins and dangerous river basins on flood events are selected regardless of rank (As for dangerous river basins, refer to “Water & Floods, March 2004” prepared by DPWH).

(3) Guideline 3

- At least a few river basins of higher rank shall be included in each of the 17 administrative regions.

(4) Guideline 4

- For the remaining number of the river basins, 80% and 20% of the river basins are allocated to “Principal River Basins” and “Other River Basins” respectively, judging from the significance of the principal river basins.

3.6.4 Preliminary Selection of River Basins for the First Screening

The 100 river basins have been selected preliminarily based on the guidelines mentioned above. Tab.3-12 gives a list of the selected 100 river basins. The composition of the 100 river basins is as described below.

(1) Viewpoint of Guideline for Preliminary Selection

Out of the 18 major river basins, 14 major river basins are selected excluding Pampanga, Agno, Pasig-Marikina-Laguna Bay and Agusan. As the dangerous river basins, 20 river basins are selected. On the other hand, 47 river basins are allocated for each region. The total number of the above river basins is 81, while the remaining 19 river basins are allocated as: 15 to principal river basins (80%), and 4 to other river basins (20%). The details are shown in the following Table 3.4.

Table 3.4 River Basins from Viewpoint of Guideline

River Basins	Number of River Basins
Major River Basin	14
Dangerous River Basin	20
Allocated River Basins for Each Region	47
Allocated Principal River Basins	15
Allocated Other River Basins	4

(2) Category of River Basins

Among those included in the 100 river basins mentioned above are 14 major river basins, 69 principal river basins and 17 other river basins, a very important aspect of the selection process. The details are shown in the table below.

Table 3.5 Category of River Basins

Category of River Basins	Number of River Basins
Major River Basin	14
Principal River Basin	69
Other River Basin	17

(3) Regional Distribution

The regional distribution of the 100 river basins is shown in Tab.3-13. In Guideline 3 of the First Screening, it is mentioned that a few river basins with higher rank are included in each administrative region. As a result, the average number per region becomes six (6) river basins.

3.6.5 Result of the First Screening

(1) Replacement of River Basins for Those by Preliminary Selection

To confirm the adequacy of the preliminary selection of 100 river basins, field surveys for the 100 river basins have been conducted and, finally, through the field surveys and discussions with the DPWH regional offices it was clarified that the following replacements among the 100 river basins are necessary:

1) Exclusion of Two River Basins

It was identified that two river basins (Lubayat and Daraga) have less flood damage and are not required to be provided flood control projects with high priority.

2) Inclusion of Six River Basins with regard to Major River Basin Treatment (Guideline 1)

Some of river basins such as Laoag, Pampanga and Pasig are excluded, since flood control project of these river basins have been implemented or scheduled the implementation soon.

However, even in such river basins, there are areas of upstream or tributaries which are not included in the objective areas for the implementation.

The following river basins designated as the dangerous river basins, which are upstream or tributaries of major river basins but out of the objective areas for the above mentioned implementation, are identified the necessity of inclusion judging from the severe flood damage conditions: Upstream of Pampanga and tributaries; Upstream of Agno and tributaries; Upstream of Marikina; East Mangahan; San Juan (tributaries of Pasig); and Upstream of Agusan.

3) Inclusion of 16 River Basins Newly Identified as Dangerous River Basins

The river basins shown in the following table are newly included in the list of dangerous river basins in accordance with the information and request from the respective regional offices.

Table 3.6 List of Newly Included Dangerous River Basins

Classification	Region	Name of River Basin	Number of River Basins
Principal River	VI	Cairawan, Sibalom, Dalanas, Tibiao, Sipalay, Jaro-Aganan	6
	VII	Managa, Guinabasan	2
	VIII	Dale, Cadac-an	2
	X	Balatukan	1
	XI	Lipadas, Talomo, Tuganay	3
Other River	III	Meycauayan	1
	VIII	Bantayan	1
Total			16

(2) Selection of 120 River Basins through the First Screening

As the results of the First Screening, a total of 120 river basins have been selected as the objective river basins for the Second Screening (refer to Tab.3-14 and Fig.3-16). The composition of these 120 river basins is, as follows:

1) Viewpoint of First Screening Guideline

As the results of the replacement, the number of dangerous river basins increased by 21, while the number of allocated ones for each region decreased by one as shown in the table below.

Table 3.7 Types of River Basin

River Basins	Preliminary 100 River Basins	By This Replacement	Selected 120 River Basins
Major River Basin	14	No change	14
Dangerous River Basin	20	+21	41
Allocated River Basins for Each Region	47	-1	46
Allocated Principal River Basins	15	No change	15
Allocated Other River Basins	4	No change	4
Total			120

2) Category of River Basins

As the results of replacement, the number of principal and other river basins increased by 19 and 1, respectively (refer to Table 3.8).

Table 3.8 River Basin Classification

Category of River Basins	Preliminary 100 River Basins	By This Review	Selected 120 River Basins
Major River Basin	14	No change	14
Principal River Basin	69	+19	88
Other River Basin	17	+1	18
Total			120

CHAPTER 4 SECOND SCREENING AND SELECTION OF MODEL RIVER BASINS

4.1 Objective and Procedure of the Second Screening

4.1.1 Objective of the Second Screening

The objective of the Second Screening was to further narrow down the 120 river basins selected in the First Screening to those that could be implemented within the target year 2034 starting from 2009 (26 years) and the safety level of 20-year return period in principle.

4.1.2 Procedure of the Second Screening

(1) Key Points to be considered for the Second Screening

In the selection of 120 river basins during the First Screening, the following points have been considered:

- Ranking by scoring of the 14 evaluation indexes of flood vulnerability based on statistical data;
- Strategic significance of river basin, such as major river basin and high flood risk river basin (dangerous river basin); and
- Regional distribution of flood control projects.

For the Second Screening, the following key points have been further considered:

- Ranking of river basins with newly obtained scores;
- Consideration of the possible investment amount;
- Regional distribution of flood control projects; and
- Strategic significance of the river basin.

(2) Procedures of the Second Screening

In due consideration of the above key points, the Second Screening has been conducted in the following procedure:

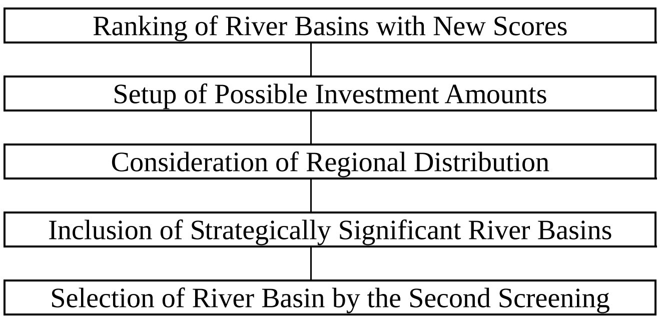


Figure 4.1 Basic Procedures of the Second Screening

1) Ranking of River Basin with New Score

The prioritization of river basins for project implementation has been, in principle, given by ranking based on the new score. As for the new score, the scores based on economic efficiency, which is one of the essential points to identify the viability of projects, was newly examined, and finally, the aggregated score of those based on economic efficiency and that obtained in the First Screening was applied.

2) Setup of Possible Investment Amount

For the above prioritization, the number of river basins has been first narrowed down considering the amount of possible investment by the DPWH until the target year 2034 starting from 2009 (26 years).

3) Consideration of Regional Distribution

Development of the country should be promoted equally for every region without any discrimination. From this point of view, it was necessary to arrange infrastructure such as flood control projects for every region. With regard to flood control, at least a few river basins for each of the 17 administrative regions should be arranged in the list of the Second Screening.

4) Strategic Significance of River Basin

Besides the above, some river basins which are generally recognized as strategically significant for the provision of flood control projects like the major river basins should be included in the list even the rank by the score is low.

4.2 Basic Analysis for the Second Screening

4.2.1 GIS Data Setup

Geophysical data collected for the GIS database are in various scales of mapping. The most detailed digital map coverage is the 1:100,000 scale Land Use/Land Cover map. Besides, the topographic elevation data is in digital grid format (90 x 90 m). Based on this database, 120 river basins have been selected through the First Screening. It is required that the Second Screening should be based on more detailed database. Therefore, the following GIS data setup has been carried out:

(1) Topographic Map of 1:50,000 Scale

There is an availability of 1:50,000 scale topographic maps in JPG format at FCSEC library. As the main supplementary geophysical data, these geo-located topographic maps have been imported to create the necessary topographic database. The topography sheets, which overlap with the 120 river basins have been used.

(2) Data Extraction for the 120 River Basins

Broad categories and items of the GIS database for the Second Screening are identified. These data are collected and compiled in the GIS database for the 120 river basins. The major extracted data for each river basin are, as follows:

- Name of City/Municipality;
- District Boundary;
- Main Road and Bridges inside the Basin;
- Population; and
- Detailed Land Use/Land Cover.

4.2.2 Analysis for Cost Index

(1) Methodology

For the Second Screening, economic efficiency (cost and benefit) was examined for the selection of 120 river basins. However, it was virtually impossible to precisely estimate such cost for each river basin in this study stage. Under the circumstances, such cost as an index was obtained in the following manner:

- It was assumed that river improvement would be applied as the flood control measure for each river basin, since no flood control measure could be examined individually for each river basin at this stage, while river improvement would be the principal measure applied for flood mitigation. For only the river basins that have experienced debris flow damage, the cost of sediment control dam was included.
- Then, the relation between unit project cost (C_0) for river channel improvement and design discharge (Q_0), which was derived from the results of previous studies on flood control projects was examined (refer to item 2 below and Figure 4.2).
- River channel improvement stretch (L_1) for the selected river basin was derived from the flood inundation analysis by the HEC-RAS and HEC-GeoRAS model as discussed later. For the HEC-RAS model, design discharge (Q_0) was also calculated.
- Based on the results of river channel improvement stretch (L_1) and design discharge (Q_1), unit cost (C_1) was obtained by the above relation and, finally, cost index (C) was obtained by multiplying (L_1) by (C_1), i.e., $C = (L_1) \text{ x } (C_1)$.

The previous study results (refer to Tab.4-1) were referenced in obtaining the relation between project cost (C_0) for river channel improvement and the design discharge (Q_0).

(2) Relation between the Project Cost and Design Discharge

1) Conditions for Project Cost Estimate

The conditions for the project cost estimate are as listed below:

- The estimated project cost is composed of main construction cost, compensation cost, administration/engineering services cost and project contingency.
- The project costs by previous studies are revised using the consumer price index (CPI) published by the National Statistic Office (NSO) in order to define the price level for the respective existing project costs. All such project costs are upgraded to the price level in 2006. Tab.4-2 is shown as the annual averaged CPI by NSO.
- In the geo-economic aspect, due to the degree of property concentration, the river basins for the existing projects are classified into “Urban River Basin” and “General River Basin” based on production, which corresponds to index S4 of the First Screening, per square kilometer of the respective river basins. “Urban River Basin” has been defined as a river basin having the production of 11 million pesos/km^2 and above in the First Screening stage, while a “General River Basin” has the production below 11 million pesos/km^2.
- Especially, the river basins related to the studies on “Flood Control and Drainage Project in Metro Manila (1990)” and “Flood Control for Rivers in the Selected Urban Centers (1995)” are classified as “Urban River Basin.”

Examples of “Urban River Basin” are shown in the table below.

Table 4.1 Examples of Urban River Basin

Urban River Basin	Production (Index: S4)
River Basins in Manila (excluding Pasig-Marikina River)	288.1 mil. Pesos/km^2
Pasig-Marikina River (Manila)	126.5 mil. Pesos /km^2
River Basins in Cebu City	15.0 mil. Pesos /km^2
Jaro River (Iloilo City)	11.4 mil. Pesos /km^2

2) Results of the Relation between Project Cost and Design Discharge

The result with the recurrence analysis is as graphically presented below.

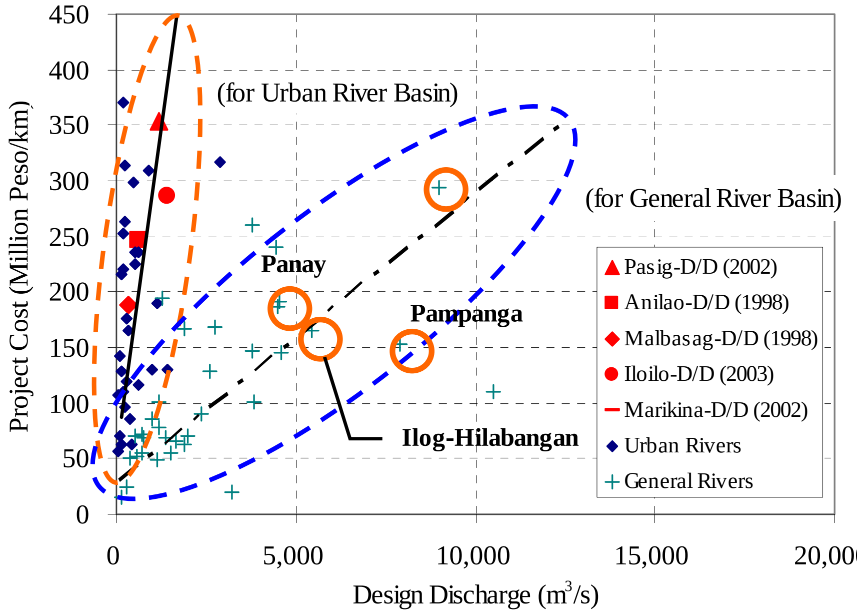


Figure 4.2 Estimated Line with Relationship between Design Discharge and Project Cost

In the above figure, the estimated lines with relationships between design discharge and project cost are proposed for the urban river basin and general river basin. These lines are set at approximately the middle position, taking account of the respective plotting points.

Since these relations (or equations) on the above figure were provided with limited data for 65 rivers only, they should be reviewed with the additional sample data for the other river improvement projects by the DPWH (refer to Tab.4-3).

4.2.3 Analysis for Benefit Index

The basic analysis for the benefit index consists of: 1) hydrological analysis; 2) flood damage analysis; and 3) benefit index estimation for flood control. The contents of these analyses are as described below (for details, refer to Supporting Report C).

(1) Hydrological Analysis

The hydrological analysis aims at identifying the flood area of the 120 objective river basins for the flood magnitude of 20-year return period. The analysis consists of:

- Flood inundation analysis by simulation model; and
- Field and related study survey.

Flood areas were estimated using the simulation model. The simulated flood areas were then compared with the field survey results and the existing studies, and the flood areas were finally determined.

The adopted simulation model, outline of the input and output data of the model, and the estimation of flood areas are as described below.

1) Simulation Model

The adopted simulation model is HEC-RAS and HEC-GeoRAS. HEC-RAS is the software that performs one-dimensional steady and unsteady flow calculations. HEC-GeoRAS is an ArcView GIS extension specifically designed to process geospatial data for HEC-RAS.

HEC-GeoRAS creates a geometric file for import into HEC-RAS, containing river, reach and station identifiers, cross-sectional cut lines, etc. Once the hydraulic calculations were performed, water surface and velocity from HEC-RAS were exported to HEC-GeoRAS for the spatial analysis.

2) Input Data of the Model

As input data for the model, a) design discharges; b) water level of river mouth; c) Manning's roughness coefficients; and d) river cross-sectional data were determined, as described below.

a) Design Discharges

The Specific Discharge Formula was employed for this analysis. By this method, the design discharges were estimated based on the specific discharge curves, as shown below.

$$q = c \cdot A^{(A^{-0.048}-1)}$$

Where, q : Specific discharges ($m^3/sec/km^2$)

c : Constant depending on return period and regions

A : Basin area (km^2)

The design discharges have been determined for the river mouth and other major confluence points (minimum 3 points for each river).

b) Water Level of River Mouth

As the starting water level at the river mouth, the mean monthly highest water level (MHW) was input based on the Manual on Flood Control Planning, FCSEC, March 2003, etc.

c) Manning's Roughness Coefficient

Manning's roughness coefficients were determined based on the Manual on Flood Control Planning, FCSEC, March 2003, etc. The applied values are, as follows:

- Stream channel : 0.035
- Flood plains : 0.055

d) River Cross-Sectional Data

River cross sectional data used in the simulation were based on the DEM (Digital Elevation Model) with 90 m grid. HEC-GeoRAS creates a file of cross-sectional cut lines for import into HEC-RAS.

As samples of the output, the flood area maps of the Bicol, Panay and Jalaur river basins are shown in Fig.4-1, 4-2 and 4-3.

3) Estimation of Flood Area

Considering the accuracy and limitation of available data for the simulation, the simulated flood areas are better to be compared with the flood areas of the existing studies and the field survey.

Tab.4-4 shows the flood areas of the simulation, existing studies and field survey, and Figure 4.3 shows the relationship among them. Based on these, the following points were understood:

- The total flood area of the existing studies is 1.4 times greater than that of the model. In the case of field survey, it becomes 1.3 times; however, its total flood area is far smaller than that of the existing studies. As the result, the total flood area of the studied/surveyed is 1.4 times greater than that of the model; and
- There is no clear relationship between the ratios and the basin areas.

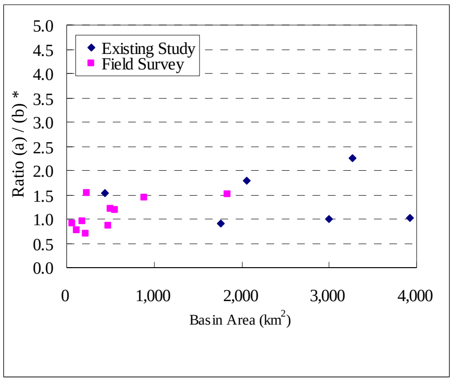


Figure 4.3 Flood Area Ratio and Basin Area

Based on these, it was considered that the flood area by the model should better be multiplied by 1.4 in order to adjust to the area by the existing study results.

(2) Flood Damage Analysis

1) Methods for the Analysis

The basic methods for the flood damage analysis are as described below.

a) Items for Flood Damage Estimation

Flood damages have been estimated for five major items: i) built-up area; ii) crop; iii) fishpond; iv) infrastructure; and v) indirect damage.

b) Estimation of Flood Damage

Flood damages of the built-up area, crop and fishpond have been calculated by multiplying the damageable value by the damage rate. On the other hand, the infrastructure and indirect damages have been estimated by multiplying the sum of damages or the other damage by ratio.

c) Estimation of Damage Rates

The damage rate in this Study has been estimated as the average rate when flood occurs. The damage rates including infrastructure and indirect damages are developed from the previous study results.

The ratios of damageable values to gross incomes, the damage rates, and the ratios for the infrastructure and indirect damages are shown in Tab.4-5 and Tab.4-6, respectively.

(3) Benefit Index Estimation for Flood Control

The benefit indexes have been estimated based on the following procedure: 1) estimation of annual average benefit; and 2) estimation of total benefit. These are as explained below.

1) Estimation of Annual Average Benefit

To facilitate the estimation of annual average benefit, the ratios of annual average benefits to flood damages of 20-year return period are examined based on the previous study results and, as the results, the average ratio of 0.38 is obtained (refer to Tab.4-7). Hence, the annual average benefit is estimated by multiplying 0.38 with the flood damage of 20-year return period.

2) Estimation of Total Benefit

The total benefit is estimated based on the annual average benefit covering the entire project life. In this estimation, the future benefits are converted with discount rate in order to calculate the present values. In addition to this, increase of the future benefits is considered until 2034 assuming the damageable values will increase in proportion to the growth of GNP per capita. The total benefit is estimated for each river basin under the same condition, as follows:

- Implementation period is preliminarily assumed at 4 years;
- Project Life is assumed at 50 years;
- Discount rate is considered at 15% based on the NEDA guideline; and
- Growth rate of GNP per capita is assumed at 3.35% per annum.

3) Calculation of Benefit Index

Based on the study described above, the benefit indexes derived from flood control are calculated. Tab.4-8 shows the benefit indexes of the 120 river basins, and Tab.4-9 shows the benefit indexes for Sabo dams which are calculated in the same manner mentioned above.

4.2.4 Scoring and Ranking of 120 River Basins

(1) General

As discussed in the previous sections, cost index (C) and benefit index (B) have been obtained for the 120 river basins. In this section, the scores for 120 river basins are examined from the economic efficiency point of view on the basis of these costs and benefit indexes. Furthermore, ranking of the 120 river basins is arranged based on the score of economic efficiency in addition to the score obtained in the First Screening stage.

(2) Score for Economic Efficiency

1) Indexes to Evaluate Economic Efficiency

For the evaluation of economic efficiency, the following two indexes, which are generally applied for economic evaluation of the project together with EIRR, have been considered:

- Net Present Value [Benefit Index (B) - Cost Index (C)]; and
- Ratio between Benefit Index and Cost Index (B/C).

2) Maximum Score given to Two Indexes

As the maximum score given to the two indexes, 90 is applied from the following reasons:

- In the First Screening, the score of 90 was given in total for the 14 indexes; and
- Since economic efficiency index is one of the very significant factors for decision-making on project implementation, the same score as the First Screening (90) is given to the economic efficiency index, i.e., 90 for (B)-(C) and 90 for (B)/(C).

3) Distribution of Score

As shown in Fig.4-4, the values of (B)-(C) and (B)/(C) for 120 river basins are widely distributed. Under this situation, if the score is given dividing 90 from the lowest values to the highest values of (B)-(C) and (B)/(C), most of the river basins with the average values may have the same score and thus, the difference of the score of each river basin cannot be identified easily. To avoid this situation, the score given to each river basin is as shown in Fig.4-5 and Table 4.2:

Table 4.2 Distribution of Score

Index	Maximum Score		Lowest Score		Remarks
	Value of Index	Score	Value of Index	Score	
B-C	> 5,000 mil. Peso	90	< 0 Peso	1	Scores of 2-89 are given, dividing the stretch between 0 and 5,000 mil. Pesos equally.
B/C	> 5	90	< 1	1	Scores of 2-89 are given, dividing the range between 1 and 5 of B/C equally.

4) Sensitivity Analysis

For the scoring mentioned above, sensitivity analysis was also conducted in the following two cases in order to assure the results of scoring:

Case-1: Maximum score is 70; and

Case-2: Maximum score is 45.

(3) Ranking Results of 120 River Basins

As discussed earlier, ranking was arranged by the total score of two indexes for economic efficiency in addition to the score obtained in the First Screening. The ranking of 120 river basins by total score is shown in Tab.4-10, and the ranking of river basins up to 50 by sensitivity analysis is shown in Tab.4-11 and Fig.4-6.

Based on the sensitivity analysis, the following conditions were identified:

- Some river basins were replaced by the other river basins due to the change of maximum score from 90 to 70 and 45;
- The number of such river basins was only 3 among the 50 river basins and thus, no significant change was observed due to the change of maximum score; and
- As the conclusion, it was identified that the case of 90 is applicable.

4.2.5 Analysis for Investment Amount

(1) Comparison of Medium-Term Investment Program and Actual Investment Amount

It is virtually impossible to implement flood control projects for the 120 river basins during the limited target period of 2009-2034 considering the availability of funds. Since the funds for flood control projects is in principle provided from the DPWH budget, the expected budget amount for a flood control project was examined under several DPWH budgetary growth rates (hereinafter referred as "growth rate") based on the previous practices, the Medium-Term Investment Program prepared by DPWH and the Actual Investment Amount.

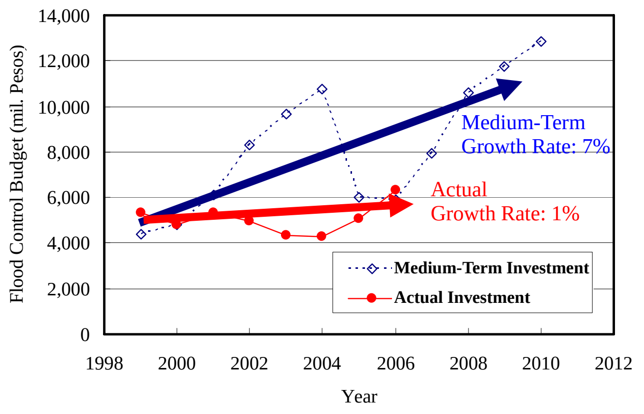


Figure 4.4 Comparison between Medium-Term Investment Program and Actual Investment Amount

The Medium-Term Investment Program is shown in Tab.4-12 and the Actual Investment Amount is shown in Tab.4-13. Comparison between the Medium-Term Investment Program and the Actual Investment Amount is shown in Figure 4.4. The growth rate under the Medium-Term Investment Program for the period between 1999 and 2010 is around 7%. On the other hand the growth rate of the Actual Investment Amount for the same period is around 1%, while that is about 11% for only the period from 2006 to 2008. Furthermore, the growth rate for the period between 2006 and 2010 reaches about 29%.

Based on these conditions, the growth rate for the target year can be considered in the wide range from 1% up to 29%.

(2) Expected Investment Amounts

Fig.4-7 shows the expected investment amounts under several growth rates.

4.3 Selection of River Basins through the Second Screening

4.3.1 Key Points Considered for the Second Screening

As discussed earlier, the following points have been considered for the Second Screening:

- Ranking of river basins with score;
- Consideration of possible investment cost;
- Regional Distribution; and
- Strategic significance of river basin.

4.3.2 Process for the Second Screening

(1) Ranking by Score

The ranking of river basins by score has been arranged, as shown in Tab.4-10.

(2) Consideration of Possible Investment Cost

As discussed earlier, several scenarios on the growth rate of the budget of DPWH has been considered in terms of possible investment cost, as mentioned below:

- 1% growth rate based on actual investment from 1999 to 2006;
- 7% growth rate based on the average Medium-Term Investment Program from 1999 to 2010;
- 8% growth rate based on higher Medium-Term Investment Program from 1999 to 2010;
- 11% growth rate based on recent actual investment from 2006 to 2008; and
- 29% growth rate based on the Medium-Term Investment Program from 2006-2010.

Among these growth rates, the 8% growth rate scenario is tentatively proposed from the following reasons:

- It is not realistic to apply the 1% growth rate considering the significance of investment to flood control projects;
- Likewise, 29% is also not realistic to consider sustainability for the long term investment covering 26 years, even though this figure applied to a part of the previous Medium-Term program;
- It may be possible to apply 11%, which can cover almost all 120 river basins. However, it seems to be too high to sustain this growth rate, and it is not realistic to cover 120 river basins judging from the previous practices of implementation of flood control projects for

the past 20 years, during which those for only about 20 river basins could be implemented; and

- Among the cases of 7% and 8% scenarios, both are applicable, but 8% is preferable to fulfill the requirement of early implementation of flood control projects from the local side, reflecting habitual occurrence of recent natural disasters.

Table 4.3 Relationship between DPWH Growth Rate, Available Budget and Number of Achievable Projects

DPWH Growth Rate	Available Budget (mil. Pesos)	Number of Achievable Projects
1 %	82,006	13
3 %	108,569	13
5 %	145,235	23
7 %	196,117	33
8 %	228,718	47
9 %	267,257	111
11%	367,035	more than 120

Assuming that 8% growth is applied, the total investment amount will be 228 billion pesos, by which flood control projects for 47 river basins can be implemented (refer to Table 4.3 and Tab.4-14).

(3) Regional Distribution

From the viewpoint of regional distribution of flood control projects, it is proposed that at least a few river basins for each of the 17 regions should be included in the list of the Second Screening.

On the other hand, among 47 river basins, only one river basin is allocated to five (5) regions (Region II, IV-B, VIII, IX and ARMM), while no river basin is included in one (1) region (Region XIII).

In this situation, for the above 6 regions, it is proposed that at least two (2) river basins in total are allocated, as shown in Tab.4-15. To fulfill this condition, it is necessary to add under the above 8% growth scenario of possible investment amount seven (7) river basins (47+7=54) requiring an additional amount of 6.4 billion pesos.

(4) Strategic Significance of River Basin

In the Philippines, flood control projects have been implemented putting high priority to strategically significant river basins, especially the 18 major river basins, considering magnitude of regional socio-economic influence. For this point of view, in the list of the above 54 river basins, two (2) major river basins were not included. In this connection, it is proposed to include these two (2) major river basins (54+2=56) in the list of the Second Screening. To fulfill the condition, it is necessary to increase the investment amount by 1.3 billion pesos.

4.3.3 Selection of River Basins through the Second Screening

Through these procedures, the selected river basins together with the investment amount are as listed below (refer to Tab.4-14 and Fig.4-8):

- Number of Selected River Basins : 56 river basins
- Investment Amount (2009-2034) : 236 billion pesos
- DPWH Budget Growth Rate : 8.2%

4.4 Prioritization and Arrangement of Implementation Schedule

For the selected 56 river basins, prioritization was examined considering not only ranking by score but also other factors and then the implementation schedule was arranged under the conditions discussed in the following subsections.

4.4.1 Implementation Period

It was assumed that the implementation of flood control projects for the 56 river basins is completed within the target period starting from 2009 to 2034. For the implementation of one project, it was assumed that 8 years is required in principle, including the period for feasibility study and detailed design. However, it was also assumed that some projects which require a huge fund like the Cagayan river basin with the project cost of about 50 billion pesos will be implemented by dividing the implementation period into several phases.

4.4.2 Classification of River Basins

For prioritization and arrangement of implementation schedule, the selected 56 river basins are classified considering the financial source:

(1) Financial Source

For project implementation, 236 billion pesos, which is composed of international funds and local funds, is proposed in accordance with the previous experiences.

(2) Classification of Projects

According to the Medium-Term Investment Program, flood control projects are broadly classified into: 1) foreign-assisted projects, which are financed by international funds and local funds; and 2) locally funded projects, which are financed by only local funds. In the Study, projects are also classified into these two groups.

(3) Allocation for Foreign-Assisted Projects and Locally Funded Projects

In the Medium-Term Investment Program, it was proposed that 95% of the total investment amount is allocated to foreign-assisted projects and 5% is allocated to locally funded projects. In the Study, it is assumed that the same rates of 95% and 5% would be applied for future investments (refer to Tables 2.1 and 4.4).

Table 4.4 Medium-Term Investment Program (2005-2010)

Item	Amount (billion Pesos)	Rate (%)
Foreign-Assisted Project	93.4	95.0
Ongoing Project	*38.6*	*39.3*
Newly Proposed Project	*54.8*	*55.7*
Locally Funded Project	4.9	5.0
Total	98.3	100.0

(4) Classification of River Basins

Under the above situation, out of the 56 river basins, 26 are classified into foreign-assisted projects while 30 river basins are classified into locally funded projects (refer to Table 4.5).

The amount of fund allocation for international funds is 223 billion pesos, while that for local funds is 13 billion pesos, as shown in the table below.

Table 4.5 Classification of River Basins

Classification	No. of River Basins	Total Project Cost (billion Pesos)	Share (%)
Foreign-Assisted Project	26	223	95
Locally Funded Project	30	13	5

4.4.3 Prioritization

The prioritization, which is classified into two groups, foreign-assisted projects and locally funded projects, was arranged separately through the following procedure:

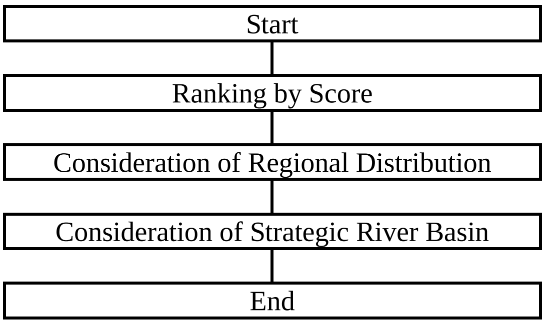


Figure 4.5 Procedure of Prioritization

(1) Ranking by Score

As the first step, the foreign-assisted projects of 26 river basins and the locally funded projects of 30 river basins were arranged according to score, as shown in Tab.4-16.

(2) Consideration of Regional Distribution

According to the ranking by score, most of the river basins located in Luzon could be placed in the higher rank (refer to Tab.4-16); however, complaints may be raised from the other regions. To avoid such a situation, rotation of arrangement of river basins from each region, like the order of Luzon, Visayas and Mindanao, was considered. In case of river basins with foreign-assisted projects, the number of river basins in the three regions are: 15 in Luzon, 4 in Visayas and 7 in Mindanao; while, those with locally funded projects are: 12 in Luzon, 6 in Visayas and 12 in Mindanao (refer to Tab.4-17).

Based on the above situations, the following rotations have been arranged: 2 river basins in Luzon, 1 in Visayas and 1 in Mindanao for foreign-assisted projects and 2 river basins in Luzon, 1 in Visayas and 2 in Mindanao for locally funded projects.

Tab.4-18 shows the arrangement of river basins, considering regional distribution together with the ranking by score in each region.

(3) Consideration of Strategic River Basin

Before the Study was started, the DPWH Medium-Term Investment Program had listed several strategic river basins with foreign-assisted flood control projects or locally funded flood control projects for early implementation (refer to Tab.4-19). Since the early implementation of these river basins projects has already been announced and thus expected by the stakeholders, it has been difficult to disregard them in the Study. The arrangement of river basins, considering such strategic river basins as well as score and regional distribution is shown in Tab.4-20.

(4) Prioritization

The prioritization for 56 river basins, which were classified into two groups; namely, foreign-assisted projects of 26 river basins and locally funded projects of 30 river basins, was set considering the ranking by score, regional distribution and strategic river basin as shown in Tab. 4.20.

4.4.4 Implementation Schedule

The implementation schedule of projects for the 56 river basins has been arranged for the period from 2009 to 2034 as shown in Fig.4-9. As reference, the implementation schedule of the 120 river basin has been also arranged as shown in Fig. 4-10.

4.5 Grouping and Selection of Model River Basin

In the previous section, 56 river basins have been selected as the results of the Second Screening. In this section, these 56 river basins are classified into several groups by flood damage type, and one model river basin is selected from each group as shown in the following diagram:

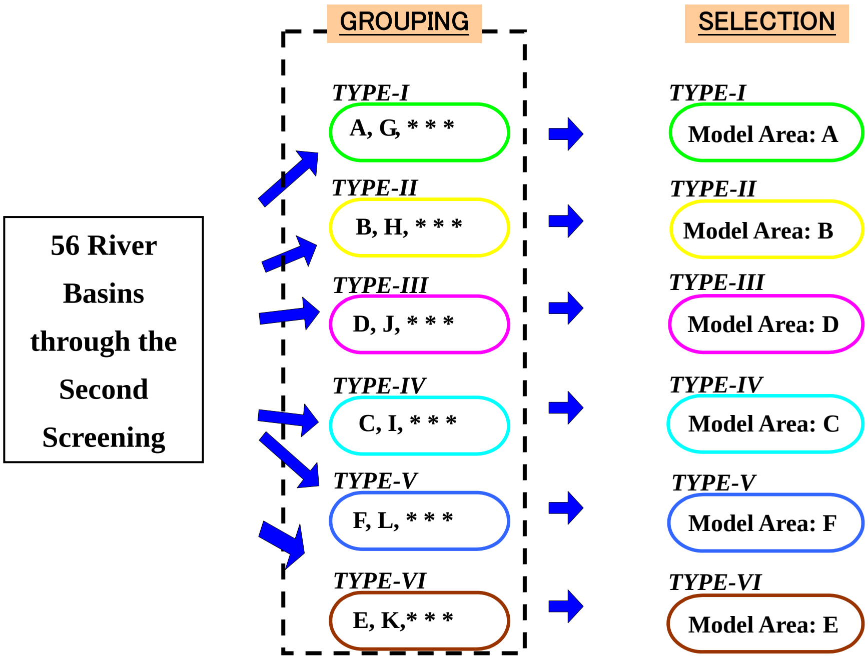


Figure 4.6 Grouping and Selection of Model River Basin

4.5.1 Grouping of 56 River Basins

In principle, grouping was made on the basis of flood damage type. However, as identified in the field survey results for the 120 river basins (refer to the Supporting Report D, Major Findings of Field Survey), most of the river basins suffer from not only one flood damage type but also a combination of plural flood damage types such as debris flow and flash flood in the upstream, bank erosion and overflow in the middle and downstream, and inland flooding in the downstream, which could be classified into the following three groups (refer to Fig.4-11):

(1) Combination of flash flood type (F), overflow type (O) and/or bank erosion (B): F+O+B type for 85 river basins (some of these river basins have only one or two flood damage types);

(2) Inland flood type (I) in addition to the combination under the above item (1): F+O+B+I type for 26 river basins; and

(3) Lahar type including debris flow (L) in addition to the combination in the above item (2): F+O+B+I+L type for 9 river basins.

Among these combinations, the first combination (F+O+B type) is dominant for 85 river basins, and the second combination (F+O+B+I) includes 26 river basins.

For grouping, these first and second combinations were further classified into three (3) and two (2) combinations, finally making six (6) groups in total, as shown in Figure 4.7:

Consequently, the above 56 river basins were classified into six groups, as shown in Tab.4-21.

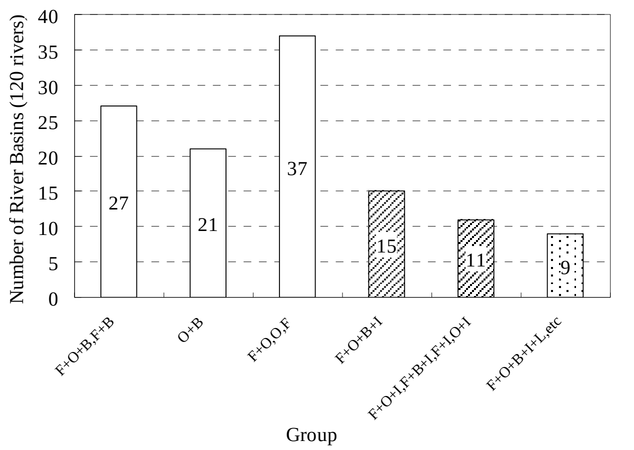


Figure 4.7 Classified 120 River Basins in Terms of Six Flood Damage Types

4.5.2 Selection of Model River Basins

Six (6) model river basins have been selected; one from each of the six groups under the following principle:

- Two (2) model river basins are selected from each region (Luzon, Visayas and Mindanao);
- In principle, high priority is given to higher-ranking river basins; and
- Also, high priority is given to a river basin with enough data and information.

As the result, the following river basins have been selected as model river basin (refer to Table 4.6 and Tab.4-21).

Table 4.6 Model River Basins

Group	Name of River Basin	Region	Catchment Area (km^2)	Ranking
F+O+B, F+B Type	Ilog-Hilabangan	VI and VII (Visayas)	2,162	30
O+B Type	Dungcaan	VIII (Visayas)	176	47
F+O, O, F Type	Meycauayan	III and NCR (Luzon)	201	7
F+O+B+I, F+I Type	Kinanliman	IV-A (Luzon)	10	25
F+O+I, F+I+B, F+I Type	Tuganay	XI (Mindanao)	747	32
F+O+B+I+L Type	Dinanggasan	X (Mindanao)	29	16

CHAPTER 5 FLOOD MITIGATION PLAN FOR MODEL RIVER BASINS

5.1 General

5.1.1 Basic Procedure for Formulation of Flood Mitigation Plan

Basic procedure for the formulation of flood mitigation plan for the model river basins is shown below.

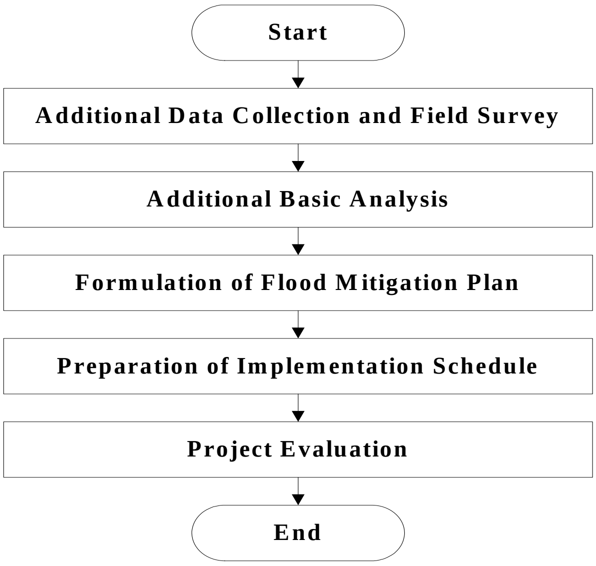


Figure 5.1 Basic Procedure of the Planning

The contents of the respective item are described below.

(1) Additional Data Collection and Field Survey

The contents of additional data collection and field survey are, as follows:

1) Data Collection

Data on socio-economic and natural conditions, flood damage data, land use plan and others are collected from the relating offices, e.g., Regional Offices and DEOs of the DPWH, and offices of LGUs.

2) Field survey

In the field survey, interview survey, river cross sectional survey and Initial Environmental Survey (IEE) are conducted, as follows:

a) Interview Survey

The DPWH and the Study Team conducted a survey to collect more detailed data and information on the basin conditions, flood damages and river conditions, etc for the respective river basins for a week. The survey includes (1) interview, (2) flood inundation area survey and (3) workshop. The details of the workshop are shown in the Data Book D "Record of Seminars and Workshops".

b) River Cross-Section Survey

The local consultant contracted by the Study Team conducted the river cross-section survey in the respective river basin. The total number of the surveyed cross sections was 30 sections. The surveyed cross-sections cover flood inundation area of the basin.

c) Initial Environmental Survey (IEE)

The local consultant contracted by the Study Team conducted the IEE survey in the respective river basin. The specification of the IEE follows the JICA Guidelines for Environmental and Social Considerations, and the contents of IEE correspond with the master plan level.

(2) Additional Basic analysis

The additional basic analysis consists of (1) hydrologic analysis, (2) hydraulic analysis and (3) flood damage analysis, as described below.

1) Hydrologic Analysis

The hydrologic analysis is carried out in order to estimate the design flood discharges, etc.

2) Hydraulic Analysis

The hydraulic analysis is conducted based on the non-uniform flow method, for which HEC-RAS model is adopted. In this analysis, the fore mentioned river cross-sections are utilized. By this analysis, the following items are calculated:

- Calculation of the existing flow capacity of river channel; and
- Calculation of design high water level of river channel.

3) Flood Damage Analysis

The flood damage is estimated based on the flood damage area and the damage unit cost in each land use. The contents of these items are, as follows:

- The flood damage areas are estimated by HEC-RAS and HEC-GeoRAS models using the newly obtained cross-section data in principle. However, if the preceding studies are available for certain river basins, the flood damage areas of the preceding studies are referred as the basic information.
- The damage unit cost is estimated based on the method and values adopted in the Second Screening.

(3) Formulation of Flood Mitigation Plan

The flood mitigation plan is formulated considering (1) applicable structural and non-structural measures, (2) examination of appropriate measures and (3) estimation of cost and benefit, as follows:

1) Applicable Structural and Non-Structural Measures

The applicable structural measures are studied based on the flood type in due consideration of the field survey results and existing reports. On the other hand, the applicable non-structural measures are studied based on the field survey and self-evaluation conducted in the workshop and the preliminary studies.

2) Examination of Appropriate Measures

For the structural measures, the optimum case is selected through cost comparison study for several alternatives prepared by the combination of the structural measures in principle. On the other hand, for the non-structural measures, their direction of improvement is examined considering their applicability for each basin in principle.

3) Estimation of Cost and Benefit

The cost and benefit for the recommended structural measures are roughly estimated. On the other hand, the cost for the recommended non-structural measures is roughly estimated for flood warning system and watershed management as a reference. However, the benefit for the non-structural measures is estimated for the only flood warning system, as discussed later.

(4) Preparation of Implementation schedule

Implementation schedules are tentatively determined considering those of the similar projects. Working period is preliminary determined at eight (8) years in total, including one (1) year for feasibility study, two (2) years for detailed design and five (5) years for implementation.

(5) Project Evaluation

The project feasibility is evaluated based on (1) technical feasibility, (2) economic viability and (3) social and environmental acceptance. The project evaluation is carried out for structural measures in principle.

5.1.2 Basic Conditions for Formulation of Flood Mitigation Plan

(1) Objective River Basins

The flood mitigation plans are formulated for the six (6) model river basins, the Ilog-Hilabangan, Dungcaan, Meycauayan, Kinanliman, Tuganay and Dinanggasan River Basins.

(2) Safety Level

In principle, the safety level of the plan is 20-year return period. However, if the preceding plans are available for certain river basins, the safety levels of the preceding plans are adopted. The safety level of the respective river basin is shown below.

Table 5.1 Safety Levels of the River Basins

River Basin	Safety Level (Return Period)	Preceding Plan
1. Ilog-Hilabangan	25	Master Plan Report, Ilog-Hilabangan River Basin Flood Control Project, July 1991
2. Dungcaan	20	None
3. Meycauayan	30 (O) 10 (I)	Feasibility Study on Valenzuela - Obando - Meycauayan (VOM) Area Drainage System Improvement Project, 2001
4. Kinanliman	25	Detailed Design Report for the Pilot Project for Kinanliman River, Real, Quezon, 2007
5. Tuganay	25	Report on Preliminary Design of Liboganon River Dike Extension, 1998
6. Dinanggasan	20	Basic Study on Disaster Prevention and Reconstruction Project for Camiguin Island, Mindanao, Philippines, 2003*

Note) O: Over Flow, I: Inland Flooding.
**: This Basic Study did not refer to the project scale for flood control.*

(3) Accuracy of the Study

This formulation of flood mitigation plan for the model river basins is conducted within the very limited time (three months), therefore, the accuracy of this Study is very rough and the level of the Study seems to be a pre-master plan. Therefore, for the implementation of the projects for the river basins, further studies such as master plan and feasibility study are indispensable.

5.1.3 Applicable Measures and Selection of Optimum Measures

(1) Structural Measures

1) Classification of Structural Measures

The applicable structural measures are classified into:

- River channel improvement;
- Dam and reservoir;
- Retarding basin;
- Diversion channel; and
- Drainage facilities.

In principle, the applicable structural measures for each flood type are, as follows:

Table 5.2 Applicable Structural Measures for Each Flood Type

Flood Type	Applicable Measures				
	River Channel Improvement	Dam and Reservoir and/or Sabo dam	Retarding Basin	Diversion Channel	Drainage Facilities
Lahar/Debris Flow	O	O			
Flash Flood	O	O			
Over Flow	O	O	O	O	O
Bank Erosion	O				
Inland Flooding	O				O

2) Selection of Optimum Measures

In principle, the optimum measures are selected based on the cost comparison among the possible alternative cases, which are formulated considering the combinations of the applicable structural measures.

(2) Non-Structural Measures

1) Purpose of Non-Structural Measures

Not only structural measures but also non-structural measures are important to reduce damage in natural disaster. The purpose of non-structural measures can be categorized as shown in the following table.

Table 5.3 Purpose of Non-Structural Measures

Purpose		Examples for Flood-Related Disaster
1	To ensure the effect of structural measures to mitigate hazard condition	• To prevent more severe runoff condition than a planned condition due to unregulated land use • To prevent severe sediment load condition as much as possible so that maintenance of structure is easier • To prevent severe clogging of channel by sediment and garbage
2	To reduce vulnerability against flood-related hazard	• Enhancement of preparedness • Enhancement of response and recovery activities

2) Menu of Non-Structural Measures

In the present Study, well-known cycle of disaster management is referred, which consists of mitigation, preparedness, response and recovery. For each stage of disaster management, several non-structural measures can be applied as shown in the following table:

Table 5.4 Menu of Non-Structural Measures for Each Stage of Disaster Cycle

Purpose 1: To ensure the effect of structural measures to mitigate hazard condition	
Mitigation	• Land use regulation • Afforestration and Reforestation • O&M supported by local residents including preventive activity against encroachment
Purpose 2: To reduce vulnerability against flood-related hazard	
Mitigation	• Flood proofing structures
Preparedness	• Emergency, evacuation and post-flood plan • Hazard map • IEC • Monitoring/Flood forecasting and warning
Response	• Information dissemination • Flood fighting • Evacuation • Reporting of disaster condition • Rescue activity • Supporting from neighboring LGUs
Recovery	• Post-flood damage assessment • Rehabilitation • Insurance

3) Recommended Measures

In principle, the recommended measures are proposed based on the results of the field survey, i.e., interview, self-evaluation of the existing non-structural measures in the workshop, other information, and preliminary studies on flood warning system and soil loss related to reforestation. The study methodology and detailed results are described in Supporting Report H.

4) Preliminary Estimation of Cost and Benefit

a) Cost Estimation

The cost for non-structural measures is preliminary estimated for flood warning system and baseline activities on watershed management based on the preliminary studies (For details, refer to Supporting Report H).

i) Flood Warning System

Cost for the flood warning system is estimated for initial setting cost and O/M cost based on the information of the PAGASA and others.

ii) Watershed Management

Cost for the baseline activities on watershed management is estimated for cost for preparation and revision of watershed characterization and watershed management plan, reforestation cost and supporting cost of River Basin Council based on the information of the DENR and others.

b) Benefit Estimation

The benefit for non-structural measures is preliminary estimated for flood warning system to examine appropriate flood warning system for the target river basin. This benefit is estimated considering possible reduction in tangible damage on movable assets (For details, refer to Supporting Report H).

5.1.4 Implementation Schedule and Responsible Agencies

(1) Implementation Schedule

Implementation schedule is formulated considering the working period, as before mentioned. In this Study, the implementation schedule is preliminary determined at eight (8) years in total, comprising one (1) year for feasibility study, two (2) years for detailed design and five (5) years for implementation.

(2) Responsible Agencies for Implementation, Maintenance and Operation

The proposed structural and non-structural measures shall be implemented, maintained and operated properly in order to realize the expected benefits. In this regards, the following agencies cover the works for the implementation, maintenance and operation of the proposed measures in principle, referring to the National Flood Mitigation Framework Plan (DPWH), the Manual on Maintenance of Flood Control and Drainage Structure (DPWH) and the Local Government Code of 1991 (RA7160), as summarized in Table 5.5.

Table 5.5 Responsible Agencies for Implementation, Maintenance and Operation

Proposed Measures		Major Responsible Agency
Structural	River Channel Improvement	DPWH and LGUs
	Retarding Basin	DPWH and LGUs
	Sabo Dam	DPWH and LGUs
Non-Structural	Flood Warning	PAGASA and DCCs
	Watershed Management	DENR and LGUs
	Other Measures including Disaster Management	OCD and LGUs

5.1.5 Estimation of Cost and Benefit

In this section, the estimation methods of the cost and benefit for structural measures are described.

(1) Cost Estimation

1) Basic Conditions

a) Unit Cost

Most unit costs applied in this Study are basically derived from the related projects implemented by the DPWH.

b) Price Level

All the costs are estimated on the Philippine Peso basis using the currency conversion rate of US$1.00 = 44.93 Peso = ¥ 115.55 prevailing as at October 2007.

c) Items of Cost Estimation

In the cost estimation for the economic evaluation, costs are estimated for project cost, O/M cost and replacement cost.

2) Project Cost

a) Constitution of Project Cost

Financial project cost consists of construction cost, administration cost, engineering services, compensation cost and physical contingency.

b) Construction Cost

The construction cost consists of preparatory works and main construction cost.

i) Preparatory Works

The cost of preparatory works is estimated at 15% of the main construction cost.

ii) Main Construction Cost

The cost for main works is computed by multiplying the unit cost with the work quantity.

c) Administration Cost

The administration cost is computed at 5% of the construction cost.

d) Engineering Services

The cost of engineering services is to cover detailed design and construction supervision. 16% of the construction cost is adopted to the engineering services cost, which cost consists of 10% for the detailed design and 6% for the construction supervision.

e) Compensation Cost

The compensation cost is divided into land acquisition and house evacuation. These costs are estimated for the respective river basins.

f) Physical Contingency

The physical contingency is estimated at 10% of the sum of the construction cost, administration cost, engineering services cost and compensation cost.

3) O/M and Replacement Cost

The operation and maintenance (O&M) cost of the structural measures is practically estimated at 1.5% annual of the construction cost for the Ilog-Hilabangan, Dungcaan, Meycauayan, Kinanliman and Tuganay River Basins. For the Dinanggasan River Basin, which flood type is mainly flash flood with a large amount of sediment, it is assumed at 2.0% of the construction cost considering damages on the structural measures.

A replacement cost of pump equipment and floodgate is estimated at 70% of their construction costs with replace at least every 15 years.

4) Economic Cost

Financial construction cost consists of construction, compensation, administration, physical contingency and engineering service costs. To simplify the procedure of conversion from financial to economic cost, the conversion rates are standardized deriving from the existing studies of related projects.

(2) Benefit Calculation

1) Flood Damages

Benefits attributable to proposed public investment include direct and indirect flood damages as well as intangible flood damages (e.g., increase of health hazards, water borne diseases, environmental degradation, etc.). Direct damage refers to loss of building assets and private properties caused by inundation of floodwater. Indirect flood damage includes interference to traffic and resulting loss of retail and industrial outputs, losses due to interruption in utility services. Although intangible flood damages are substantial, its quantification is difficult. Hence, intangible flood damages are not considered as part of benefits in the project evaluation.

2) Estimation of Flood Damage

Flood damage is calculated as a product of damageable asset value and damage rate. The flood damage in economic terms is estimated using the standard conversion factor of 0.85. Because the detailed assessment of economic values is not conducted due to the limited period of this Study, this conversion factor is applied for all items. The damageable asset value and damage rate are considered, as follows:

a) Damageable Asset Value

In this Study, damageable assets are divided into three items, built-up area, crops (irrigated paddy, rainfed paddy, corn and sugarcane) and fishponds. However, the detailed assessment on the assets is not conducted due to the limited period of this Study. Therefore, the evaluation of the damageable assets is standardized, as follows:

i) Built-up Area

Damageable building assets are divided into two groups, immovable and movable. These should be further categorized into residential, commercial, industrial and public buildings and facilities. However, the detailed assessment on these assets is not conducted due to the limited period of this Study. Therefore, the same method and values adopted in the Second Screening are applied.

ii) Crops

Damageable value of crops is estimated considering expected net income and production cost already spent when damage occurred. With the same reason to the above, the same method and values adopted in the Second Screening are applied. However, for the model river basins, as the representative crop of respective basins can be identified, the value of the representative crop is applied.

iii) Fishponds

The method and value adopted in the Second Screening are applied with the same reason.

b) Damage Rate

i) Damage by Floods

The results of previous studies show that flood damage rates are too scattered to define certain value among factors of inundation duration, water depth and flood type. Therefore, the average damage rates derived from the Second Screening are employed for the damage estimation of the flooding area. The average damage rates are summarized below.

Table 5.6 Damage Rates

Assets	Damage Rate
Built-up Area	0.3
Paddy (irrigated)	0.5
Paddy (rainfed)	0.5
Sugarcane	0.1
Fishponds	0.9

ii) Damage by Sediment Disaster

The damage rate by sediment disaster due to debris flow is set at 1.0 for the all land uses.

c) Infrastructure and Indirect Damages

i) Damage by Floods

Flood damage to infrastructure is estimated at 30% of the above direct damage. On the other hand, indirect damage is estimated at 20% of the direct damage including infrastructure damage. These figures are derived from the Second Screening.

ii) Damage by Sediment Disasters

Flood damage to infrastructure is estimated at 40% of the above direct damage. On the other hand, indirect damage is estimated at 20% of the direct damage including infrastructure damage. These figures are derived from the Second Screening.

3) Annual Average Benefit

a) Benefit under Present Condition

Annual average benefit is calculated as the sum of products of the averaged damage and its corresponding occurrence probability. In order to simplify this calculation, the ratio of annual average benefit to flood damage under project scale is estimated based on the related past studies, and this ratio is applied in this Study.

b) Benefit under Future Condition

Present benefit is estimated with 2006 economic price level. On the other hand, the future benefit is considered with the thought that some improvement in productivity and property is brought about in proportion to growth of GNP per capita. In this Study, this growth rate is estimated at 3.35% per annum and applied until 2034.

5.1.6 Initial Environmental Examination

(1) Objective of the IEE Study

Initial Environmental Examination (IEE) is a very important and useful planning tool for development projects/programs at early stage. Original formulation of any projects/programs may be modified, if significant negative impact is predicted by the IEE. According to the JICA Environmental Guidelines, IEE is defined as “an examination undertaken at the outset of the development project planning stage to determine the environmental impacts that may be created by the particular project based on existing information and data.”

The IEE has the following two objectives:

(1) To evaluate whether EIA is necessary for the project and, if so, to define its contents, and (2) to examine from an environmental viewpoint, the measures for mitigating the impacts of the project, which requires environmental consideration but not a full-scale environmental impact assessment. For these objectives, the study on IEE was investigated (1) knowing the existing social and natural environmental conditions of the model river basins, (2) identifying constraints and problems for the master plan projects/programs on the proposed model river basins.

(2) Law and Registration in the Philippines

The Philippine legal framework for Environmental Impact Assessment (EIA) including IEE is called Environmental Impact Statement (EIS) System, which was established by the Presidential Decree 1586 in 1978. Under the decree 1586, environmental considerations must be incorporated into project development at its earliest stage and the EIS process requires disclosure of projects information and public participation.

For the classification of project, environmentally critical Projects (ECPs) and environmentally critical areas (ECAs) were provided by the Presidential Proclamation 2146 in 1981. For a set of conditions for constructing a facility in a project, Environmental Compliance Certificate (ECC) was prescribed by the Department of Environment and Natura1 Resource (DENR) Administrative Order No.12 in 1992. The Procedural Manual for DENR Administrative Order No.30 Series 2003 shall be referred to as a guideline in the Philippine EIS system.

There is no single comprehensive policy for involuntary resettlers in Philippines. The Philippine government should take necessary measures for compensation for lost assets and income, transfer and relocation assistance, and help to rehabilitate and restore their lives. For locally funded projects, Republic Act 8974 shall be referred, for foreign assisted projects with component involving right of way acquisition and resettlement, LARIP which addresses compensation.

(3) Competent Agency of EIS

The Environmenta1 Management Bureau (EMB) in the DENR is responsible for policies and programs for environmental management such as environmental conservation, condition of air, water and chemicals, pollution control, capability building and environmental education programs, EMB also administers EIS system, which requires all government agencies and private sectors to come up with EIS for ECPs, as well as projects that are located in an ECA. EMB examines EIS submitted by the proponent and ECCs is issued after the project is identified not to have a serious impact on the environment.

(4) Results of Consultation with EMB

Results of the consultation with the EMB on environmental and social consideration are, as follows:

- EIS is not necessary for the master plan study; moreover, Programmatic Environmental Impact Statement (PEIS) which is reflected the basic consideration of the strategic environmental assessment of view is not applied for this Study; and
- The IEE report on the Study doesn’t need to be submitted to the EMB regional office because the Study is the model study and preliminary stage of Master Plan.

Therefore the IEE study was conducted according to the JICA Guideline for Environmental and Social Considerations (April 2004). When the project is implemented, it will be required to confirm the regal frameworks applied to the stage once again.

(5) IEE Study Approach

The first level of the IEE is the scoping stage. This is the study when environmental and social issues and concerns are identified so that relevant issues can be evaluated in the next stage which is the environmental impact assessment stage. The result of the scoping activities shall be used to substantiate the IEE report by synthesizing the environmental elements for the prediction of impacts and identification of mitigating measures. The scoping items are house relocation, land acquisition, livelihood, disruption of infrastructures and regional conflict in the social environment, and ecological diversity for the natural environment addition to the pollution, like water quality and noise. The pre-construction phase, construction phase and operation phase are considered for each structural measure and mitigation and management measures are proposed to each impact. Finally, the monitoring plan is shown to reduce the significant potential impact of the proposed project into negligible and moderate levels.

To establish whether the proposed project is environmentally and socially feasible, the IEE survey is conducted by the local consultant in coordination with JICA Study Team.

5.1.7 Project Evaluation

The project feasibility is evaluated based on (1) technical feasibility, (2) economic viability and (3) social and environmental acceptance. The contents of these items are, as follows:

(1) Technical Feasibility

The technical feasibility is assessed from the viewpoint of the difficulty to be encountered in the actual construction of the recommended project.

(2) Economic Viability

The economic viability of the project is assessed for structural measures only. The economic viability of non-structural measures is not assessed based on the situation as discussed before.

The economic viability of the project (structural measures) is assessed by means of EIRR, B/C and NPV, which are calculated on the annual cost-benefit flow. Detailed design and construction periods are assumed at 2 and 5 years, respectively. The discount rate of 15% (the opportunity cost of capital in the Philippines referring to NEDA guideline) is applied for the calculation of B/C and NPV.

(3) Social and Environmental Acceptance

The social and environmental acceptance is assessed from the social and environmental impacts studied in the IEE survey in principle.

5.2 Ilog-Hilabangan River Basin

5.2.1 Basin Conditions

(1) Natural Conditions

1) Existing River System and Structures

The Ilog-Hilabangan River system is composed mainly of two major rivers; Ilog River with a length of about 120 km, and Hilabangan River with a length of 35 km. The Hilabangan River merges to Ilog River at around 17 km from the river mouth. Ilog River diversifies into Old Ilog River and other several branch rivers in the lower reaches. The basin has the total area of 2,162 km^2. The riverbed gradient of Ilog River (1/140 to 1/3,100) is relatively gentle compared with that of Hilabangan River (1/80 to 1/240).

During 1970-1990, the present Ilog River became the main outlet stream and the Municipality of Ilog was in danger of possible floods. In order to change this situation, Old Ilog River was dredged and utilized as a diversion channel with the construction of the diversion facilities. However, the facilities were destroyed with Typhoon Nanang in 2001. The existing river system of the Ilog-Hilabangan River Basin is shown in Table 5.7 and Figure 5.2.

Table 5.7 Rivers in the Ilog-Hilabangan River Basin

River	Catchment Area (km^2)	Length (km)	Remarks
Ilog	1,709	120.0*	*Excluding Hilabangan
Hilabangan	453	35.0	

The major river structures relating to flood control are, as follows:

- Revetment works have been constructed mainly around bridges;
- The construction of modular steel bridge has started at barangay 8 and 9 of the Kabankalan City with an 80 m revetment wall; and
- The flow capacity of Old Ilog River was increased with dredging with 19 million pesos in 1999, so that the floods flow down through Old Ilog River. In order to change the direction of a part of flood flow from Ilog River to Old Ilog River, diversion facilities were constructed at the diversion point, but the facilities were destroyed with Typhoon Nanang in 2001.

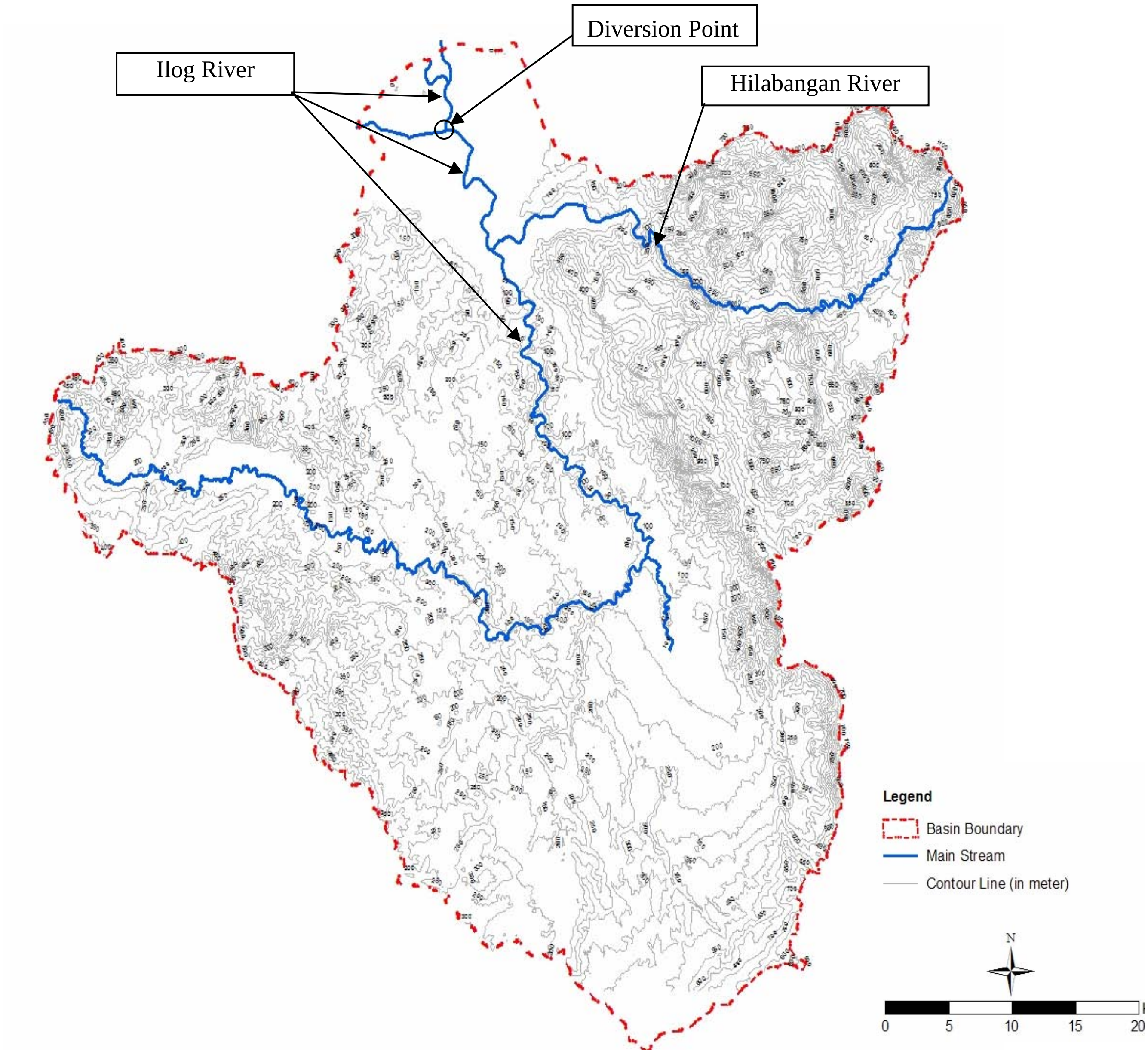


Figure 5.2 Topographic Map of the Ilog-Hilabangan River Basin

2) Meteorology and Hydrology

The Ilog-Hilabangan River Basin falls in Type I and Type III of the modified Corona's climate classification. Type III, in which the large part of the basin excluding the upstream reach of Ilog River lies, is characterized by not very pronounced seasons, relatively dry from November to April. While, Type I is characterized as two pronounced seasons, dry and wet. Monthly rainfall distribution at Kabankalan City is shown in Figure 5.3.

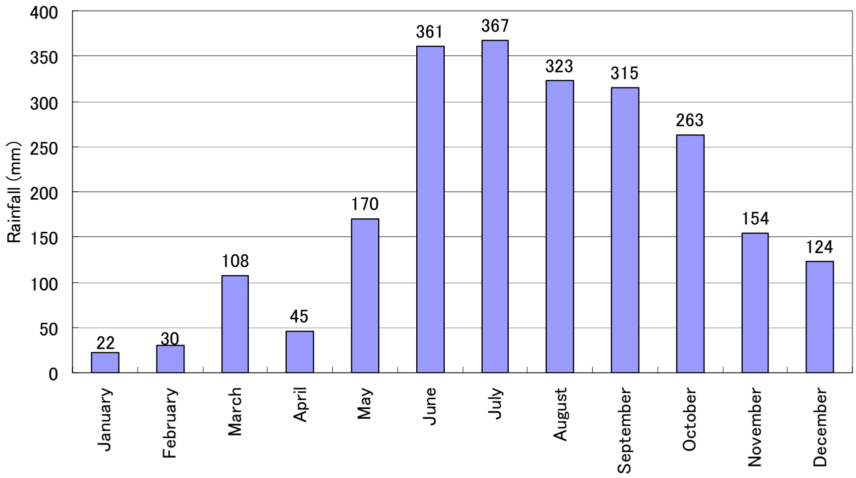


Figure 5.3 Monthly Rainfall Distributions at Hacienda Clementina, Kabankalan, 2000-2005

(2) Social and Economic Conditions

1) Population and its Growth

The total population of the Kabankalan City based on the 2000 NSO Census is 149,769, and 77.8% of the populace is found in the rural areas. The average annual growth rate from 1995 to 2000 is 1.46%. The average population density for the entire City is 215 persons/km^2.

On the other hand, for the Municipality of Ilog, the total population is 46,525 based on the 2000 NSO Census, and 27.3% of the population is in the urban areas. The average annual growth rate from 1995 to 2000 is 1.17%. The average population density for the entire Municipality is 152 persons/km^2.

2) Land Use

a) Existing Land Use

The City of Kabankalan covers a total land area of 69,735 ha. More than half of the land area is devoted to agriculture, while a little more than one-fourth is utilized for forest areas.

On the other hand, the Municipality of Ilog covers a total land area of 30,596 ha. More than half of the land area of the Municipality is devoted to agriculture, and nearly a third of the total land area is forest areas. Fishponds occupy a significant portion of the land use, which occupy nearly a tenth of the land. Figure 5.4 shows the existing land use map of the basin (2002/03).

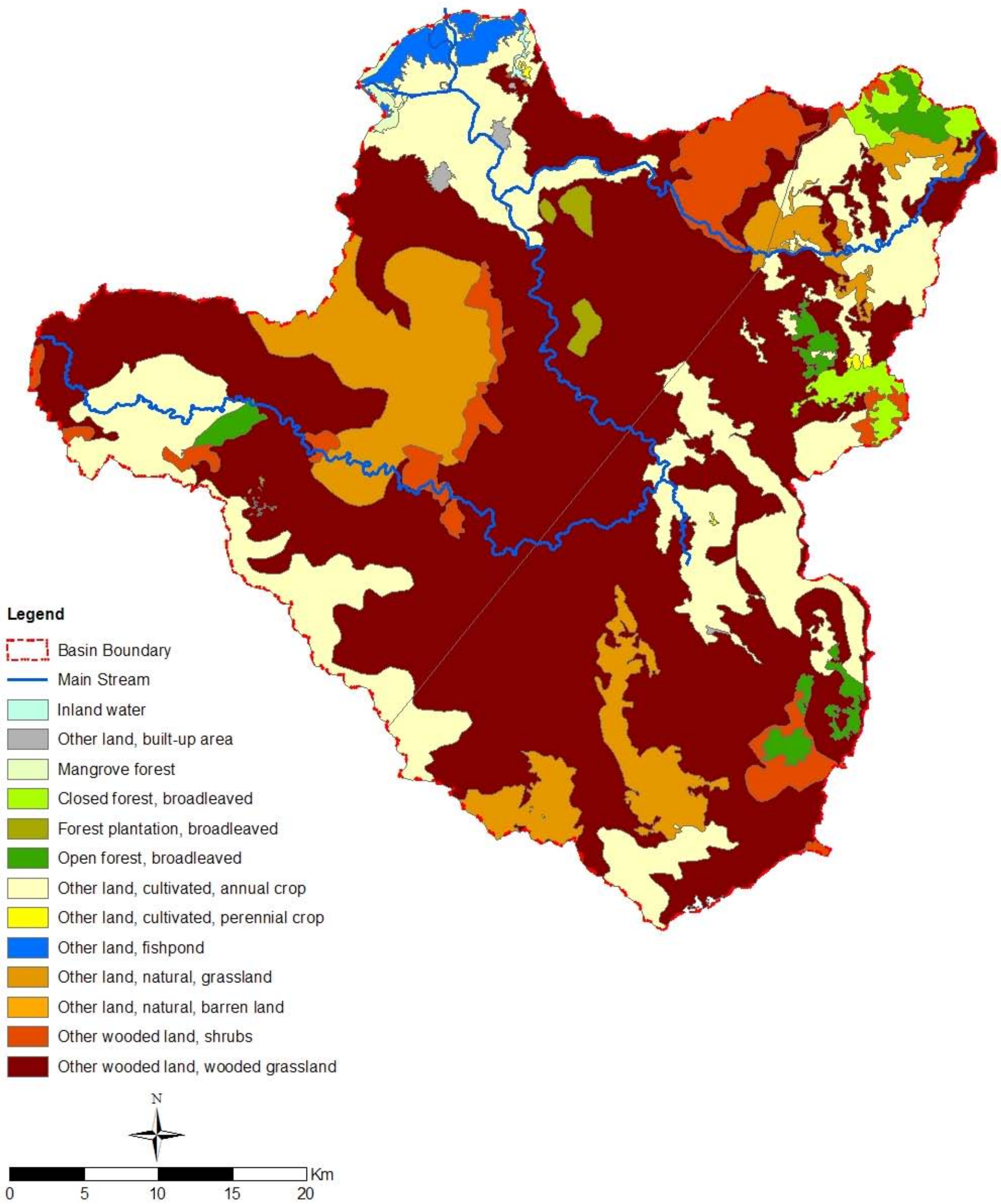


Figure 5.4 Existing Land Use in the Ilog-Hilabangan River Basin

b) Projected Land Use

The year of projection for the City of Kabankalan is 2014. The major changes in the land use are; increase of forestland (3,412 ha), built-up (302 ha) and infrastructure/utilities (89 ha): and decrease of open grassland (3,457 ha), agricultural (202 ha) and industrial (143 ha). On the other hand, the year of projection for the Municipality of Ilog is 2010. Significant increase is expected for built-up area (106 ha), buffer zone (71 ha) and mineral zone (13 ha). On the other hand, only agricultural area will be decreased (234 ha).

Table 5.8 and Table 5.9 show the existing and projected land use of Kabankalan City and Ilog Municipality.

Table 5.8 Existing and Projected Land Use in Kabankalan City

Land Use	Existing (2004)		Projected (2014)		Area Change (has)
	Area (has)	Percent to Total (%)	Area (has)	Percent to Total (%)	
Built-up	2,512.68	3.6	2,814.64	4.0	+301.96
Open Grassland/Cogonal	9,438.96	13.5	5,982.06	8.6	-3,456.90
Fishpond	802.94	1.2	802.94	1.2	0
Forest Land	18,035.00	25.9	21,446.67	30.8	+3,411.67
Industrial	1,869.27	2.7	1,725.85	2.5	-143.42
Rivers/Creeks	505.59	0.7	505.59	0.7	0
Infrastructure/Utilities	752.04	1.1	840.90	1.2	+88.86
Agricultural	35,819.01	51.4	35,616.83	51.1	-202.18
TOTAL	69,735.49	100.0	69,735.49	100.00	0

Source) Comprehensive Local Development Plan, 2005-2014, City of Kabankalan

Table 5.9 Existing and Projected Land Use in Ilog Municipality

Land Use	Existing (2000)		Projected (2010)		Area Change (has)
	Area (has)	Percent to Total (%)	Area (has)	Percent to Total (%)	
Built-up	302.48	1.0	407.99	1.3	+105.51
Industrial	1.02	0.0	5.00	0.0	+3.98
Agricultural	17,156.36	56.1	16,922.75	55.3	-233.61
Open Grassland/Cogonal	781.00	2.6	791.37	2.6	+10.37
Socialized Housing Site	0.00	0.0	7.02	0.0	+7.02
Cemetery	6.10	0.0	7.62	0.0	+1.52
Dumping Site	0.00	0.0	2.40	0.0	+2.40
Mangroves	291.80	1.0	291.80	1.0	0
Fishpond	2,618.71	8.6	2,618.71	8.6	0
Timberland	8,940.02	29.2	8,940.02	29.2	0
Tourist Zone	-	-	7.99	0.0	+7.99
Mineral Zone	-	-	12.50	0.0	+12.50
Roads	38.67	0.1	50.28	0.2	+11.61
Rivers/Creeks	459.84	1.5	459.84	1.5	0
Buffer Zone	-	-	70.71	0.2	+70.71
TOTAL	30,596.00	100.0	30,596.00	100	0

Source) Comprehensive Land Use Plan, CY 2000-2010, Municipal Planning and Development Office, Municipality of Ilog

3) Local Economy

a) Agriculture

The agriculture plays an important role in the economy of the City of Kabankalan. The sugarcane (15,187 ha) is leading and followed by cereals such as rice (3,861 ha), corn and livestock industries. The area of the brackish water fishpond is covering an area of 521 ha. In the coastal areas, fishing becomes the major source of livelihood.

The Municipality of Ilog is also considered as an agricultural municipality. Sugarcane (6,605 ha) is the leading and followed by corn (2,725 ha) and rice (1,176 ha). Ilog has a total fishpond area of 2,108.5 ha with an estimate production of 4,421 metric tons.

b) Commerce and Trade

Commercial establishments of the City of Kabankalan include department stores, appliance centers, drugstores, pawnshops/jewelry stores and sari-sari stores which are located in the urban area occupying 102 ha. In order to accommodate the increasing demand for a bigger commercial area, the City has allocated 107 ha.

The Municipality of Ilog has four public markets, two of which located at the urban center. The public markets being the center of commercial activities have an area of approximately 3 ha. Commercial activities in the Municipality considerably increased for the last five years.

c) Industry

The NEDA has identified the City of Kabankalan as the growth center and the site of People's Industrial Estate, an agro-industrial center of Southern Negros. The agro-industries include sugar mills, rice mills, corn mills, repair shops and other small and medium agro-based industries. A big percentage of the population is dependent on the sugar industry for their means of income and livelihood.

In the Municipality of Ilog, industrial activities are fast growing. In 1995 there were 14 registered establishments. These establishments are rice and corn mills, CHB making, saw mills (coco lumber), food processing (bakery) and machine shops (welding and repair shop).

(3) Floods and Flood Damage

1) Floods and Flood Damage

The Ilog-Hilabangan River Basin experienced severe floods by typhoons in 1949, Nitang-1984, Ruping-1990, Nanang-2001 and Ursula-2003. In the 1949 flood, the landside was inundated for 4 days causing 730 dead and 5.1 million pesos damage (1954 price level). On the other hand, by the 1984 flood, the Municipalities of Kabankalan and Ilog including the surrounding flat land were inundated resulting in 48 dead and 29 missing. The flood inundation area in 1984 flood roughly covered 125 km^2 in the lower reaches. By 1990 flood, rehabilitation costs of infrastructure in Regions VI and VII were estimated at 220 million pesos and 184 million pesos, respectively.

2) Major Causes of Floods

Heavy rainfall in the lower reaches of Negros Occidental as well as in the upstream of Negros Oriental causes flash floods in the tributaries and overflow in the lower reaches. These tributaries and main stream are lack of flow capacity. In addition, severe bank erosion in the lower reaches causes heavy siltation, and the shallow rivers and estuarine areas are also one of the factors of the flooding.

Up to the present, the basin has been changed in accordance with the economic and population growth, and correspondingly land use has been changed from agricultural and forestal to residential, commercial and industrial. These changes in the land use substantially increased the runoff discharge and thereby peak discharge. On the other hand, the urbanization in the lower reaches has taken place, and this increased the flood damages.

(4) Previous Related Study

Based on the severe floods in 1949, 1984 and 1990, the necessity of providing more effective countermeasures was recognized, and the "Study on Ilog-Hilabangan River Basin Flood Control Project, July 1991, JICA (the Master Plan)" was commenced to formulate a master plan of flood control, as follows:

1) Master Plan

The project scale for the Master Plan was 100-year return period. Based on the alternative study, a river channel improvement plan along the present river channel was selected. The major features of the river improvement works are summarized below.

Table 5.10 Major Works of River Improvement Proposed in the Master Plan for the Ilog-Hilabangan River Basin

River	Design Discharge (m^3/s)	Length (km)	Width (m)	Major Structures
Ilog	5,450	20.0	160-300	Embankment

2) Selected Urgent Project

The urgent project was selected within the framework of the Master Plan by narrowing down the area to be protected and/or by lowering the project scale. The project scale for the Urgent Project was 25-year return period. The proposed project was a river channel improvement for the same river stretch as the Master Plan.

5.2.2 Hydrologic Analysis

The design discharge is set with reference to the Master Plan. Distribution of the design discharge for 25-year return period is shown in Figure 5.5.

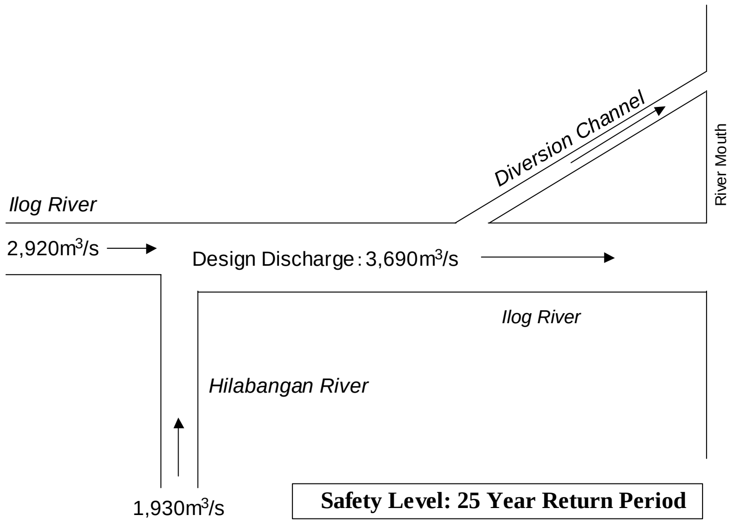


Figure 5.5 Design Discharge Distribution in the Ilog-Hilabangan River Basin

5.2.3 Flood Inundation Analysis

(1) Flow Capacity

Flow capacity of the existing river channel is analyzed with HEC-RAS. In the analysis, the newly obtained river cross sections are utilized. The flow capacities of the existing river channel are estimated as shown below.

Table 5.11 Flow Capacity of Existing River Channel in the Ilog-Hilabangan River Basin

Location of Calculation	Flow Capacity (m^3/sec)
Ilog River (upstream portion)	290-800
Ilog River (downstream portion)	250-2,650
Diversion Channel	250
Hilabangan River	100

(2) Flood Inundation Area

The flood inundation area is estimated with reference to the Master Plan. The flood inundation area is distributed over the whole low flat ground including built-up areas of Kabankalan and Ilog, fishpond area and annual crop area. The total inundation area is estimated at 10,402 ha with 25-year return period flood, as shown below. The flood inundation area is shown in Figure 5.6.

Table 5.12 Area of Flood Inundation of the Ilog-Hilabangan River Basin

(Unit:ha)

Land Use	Flood Scale (Return Period)
	25-year
Built-up Area	114.2
Fishpond	2,035.7
Cultivated, Annual Crop	6,710.7
Other	1,541.6
Total	10,402.1

5.2.4 Basic Layout of Main Structural Measures

(1) Applicable Structural Measures

The flood type of the Ilog-Hilabangan River Basin is F+O+B/F+B (Group 1). Comparing with the flood type of this basin, the following structural measures are considered as the applicable ones:

Table 5.13 Basic Applicable Structural Measures for Flood Type in the Ilog-Hilabangan River Basin

Flood Type	Applicable Measures				
	River Channel Improvement	Dam and Reservoir and/or Sabo dam	Retarding Basin	Diversion Channel	Drainage Facilities
Flash Flood (F)	O	O			
Over Flow (O)	O	O	O	O	O
Bank Erosion (B)	O				

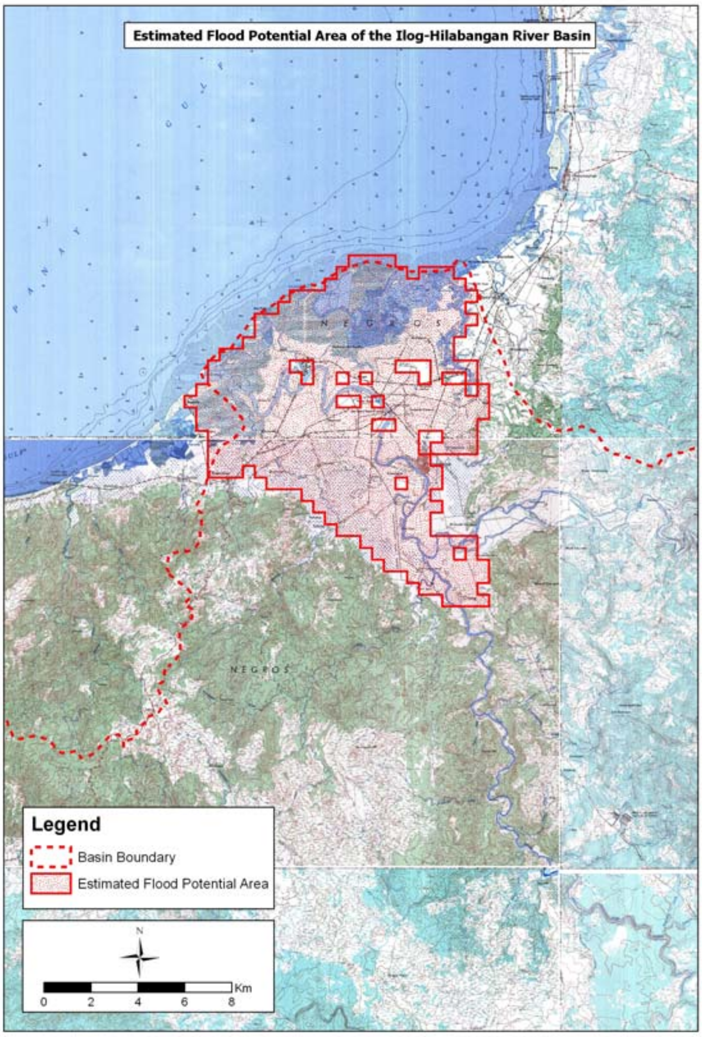


Figure 5.6 Flood Inundation Area of the Ilog-Hilabangan River Basin

In the Master Plan, several alternatives including dam and reservoir, retarding basin and drainage facilities were examined and the Ilog river channel improvement was selected as the optimum structural measures. Since then, flooding conditions have not changed so much except that the Old Ilog River was improved as the diversion channel of the Ilog River. Therefore, as the applicable structural measures for the flood damage mitigation, two (2) measures, river channel improvement and diversion channel, are studied for the basin.

1) River Channel Improvement

Based on the Master Plan, the river channel improvement following existing river alignment is adopted for the river channel improvement.

2) Diversion Channel

The old Ilog River is applicable as a diversion channel by expanding its river width and dredging riverbed.

Based on the above, the applicable structural measures are recommended as summarized below:

Table 5.14 Applicable Structural Measures in the Ilog-Hilabangan River Basin

Flood Type	Applicable Measures				
	River Channel Improvement	Dam and Reservoir and/or Sabo Dam	Retarding Basin	Diversion Channel	Drainage Facilities
F+O+B/F+B	O			O	

(2) Target Area of Flood Mitigation

The target area of flood mitigation is a potential flood area along Ilog and Hilabangan Rivers, as shown in Figure 5.6. The target reach has been set at 3 km and 2 km upstream from the confluence of the Ilog River and Hilabangan River, respectively.

(3) Basic Idea of Layout

At present, the floods flow through Ilog River and Old Ilog River. Based on this present condition, the basic layout is considered, as follows:

1) Utilizing Ilog River Only after the Diversion Point

In this case, closing facilities are to be constructed in Old Ilog River, but maintenance flow is released to Old Ilog River through the facilities.

2) Utilizing the Old Ilog River Only after the Diversion Point

In this case, closing facilities are to be constructed in Ilog River, but maintenance flow is released to Ilog River through the facilities.

3) Utilizing the Both Rivers after the Diversion Point

In this case, diversion facilities are required at the diversion point in order to control the discharges of the flood flows for the both rivers. For Old Ilog River, only bank protection works are considered without increasing its existing flow capacity.

(4) Possible Alternative Cases

Corresponding to the above idea, three alternative cases are conceivable as shown in Table 5.15 and Figure 5.7.

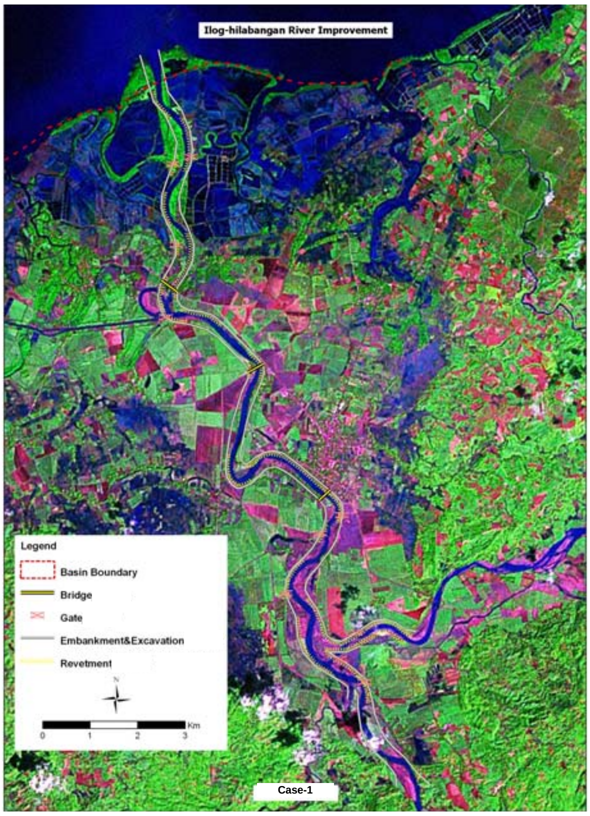
Table 5.15 Alternative Cases in the Ilog-Hilabangan River Basin

Alternative Cases	Basic Layout of Main Structural Measures
Case-1	• River channel improvement of Ilog River after the diversion point
Case-2	• River channel improvement of Old Ilog River after the diversion point as a diversion channel
Case-3	• River channel improvement of Ilog River and Old Ilog River after the diversion point

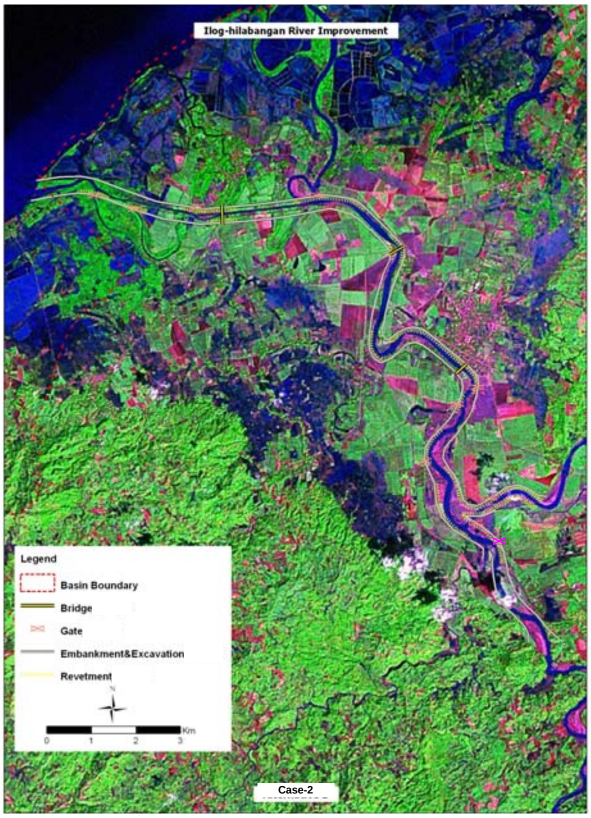
(5) Recommended Structural Measures

1) Optimum Case

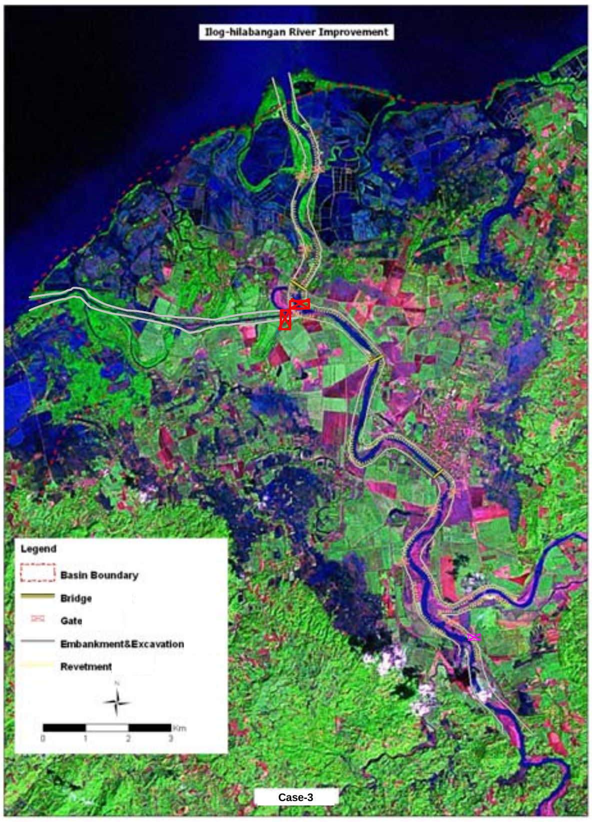
The optimum case is determined based on the cost comparison, assuming the benefit accrued from each alternative is the same. In line with this idea, cost for each alternative case is roughly estimated as shown in Table 5.16. Based on the estimation results, the cost difference between Case-1 and Case-2 is only 184 million pesos, around 9% of the Case-1 cost. Therefore, Case-1 is preliminarily recommended as the structural measures, which comprises the river channel improvement of Ilog and Hilabangan Rivers.



Case-1



Case-2



Case-3

Figure 5.7 Comparison of Alternative Cases in the Ilog–Hilabangan River Basin

Table 5.16 Result of Cost Comparison of Alternative Cases in the Ilog-Hilabangan River Basin

Alternative Cases	Cost (mil. Pesos)
Case-1	2,106
Case-2	2,290
Case-3	12,944

With the recommended structural measures, the design discharge of 25-year return period will be distributed as shown in Figure 5.8.

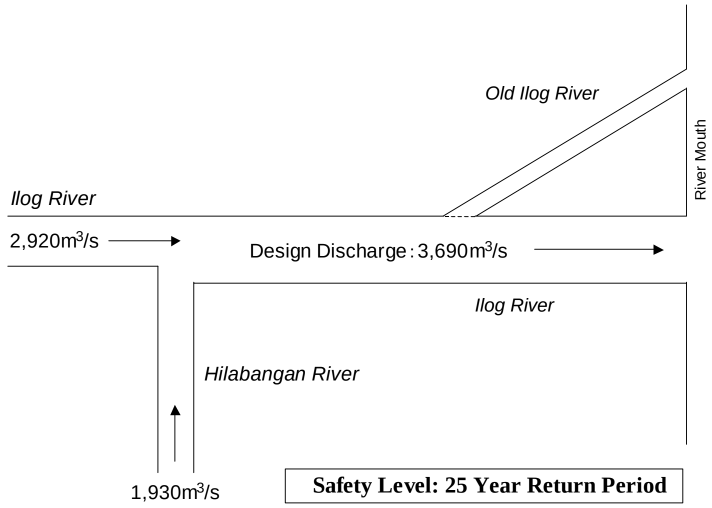


Figure 5.8 Design Discharge Distribution with Optimum Structural Measures in the Ilog-Hilabangan River Basin

2) Preliminary Design of Main Structural Measures

The preliminary design of the main structural measures, river channel improvement, is presented below.

a) River Channel Improvement

The improvement works will be required for the following rivers in order to attain the flood mitigation against the project scale of 25-year return period. The length and section for the improvement are tabulated in Table 5.17 and Table 5.18. On the other hand, longitudinal profile and typical cross sections of the improvement are shown in Fig.5-1.

Table 5.17 Improvement Plan of Ilog River

Stretch	Station Number		Design Discharge (m^3/s)	Length (km)	Width (m)
	From	To			
1	0	7.0	3,690	7.0	360
2	7.0	16.0	3,690	9.0	290
3	16.0	20.0	2,920	4.0	220
Total				20.0	

Table 5.18 Improvement Plan of Hilabangan River

Stretch	Station Number		Design Discharge (m^3/s)	Length (km)	Width (m)
	From	To			
1	0	2.0	1,930	2.0	120
Total				2.0	

Based on the above design, the basic layout of the main structure is presented in Figure 5.9.

(6) Estimation of Cost for Structural Measures

1) Construction Cost of Structural Measures

The construction cost of the recommended structural measures is estimated at 1,344.7 million pesos as shown below.

Table 5.19 Main Construction Cost for Structural Measures of the Ilog-Hilabangan River Basin

Work Item	Unit	Quantity	Unit Cost (thousand Pesos)	Amount (thousand Pesos)
1. Channel Excavation	m^3	4,382,700	150	657,405
2. Embankment	m^3	966,700	130	125,671
3. Revetment with FootProtection	m^2	102,100	2,300	234,830
4. Sodding	m^2	530,200	30	15,906
5. Re-Construction of Bridge	m^2	6,000	50,000	300,000
6. Sluice Gate	m^2	34	10,100	343
7. Drainage Facilities	unit	7	1,500,000	10,500
Total				1,344,655

2) Project Cost of Structural Measures

The project cost of the recommended structural measures is estimated at 2,105.9 million pesos as shown below.

Table 5.20 Project Cost for Structural Measures of the Ilog-Hilabangan River Basin

Description	Amount (thousand Pesos)
1. Construction Cost	1,546,354
(1) Preparatory Work	201,698
(2) Main Construction Cost	1,344,655
2. Administration Cost	46,391
3. Engineering Services	247,417
4. Compensation Cost	74,260
5. Physical Contingency	191,442
Total	2,105,863

3) Economic Cost

The economic project cost is estimated as shown below.

Table 5.21 Financial and Economic Cost of the Project of the Ilog-Hilabangan River Basin

	Financial (mil. Pesos)	Economic (mil. Pesos)
Project Cost	2,105.9	1,537.3

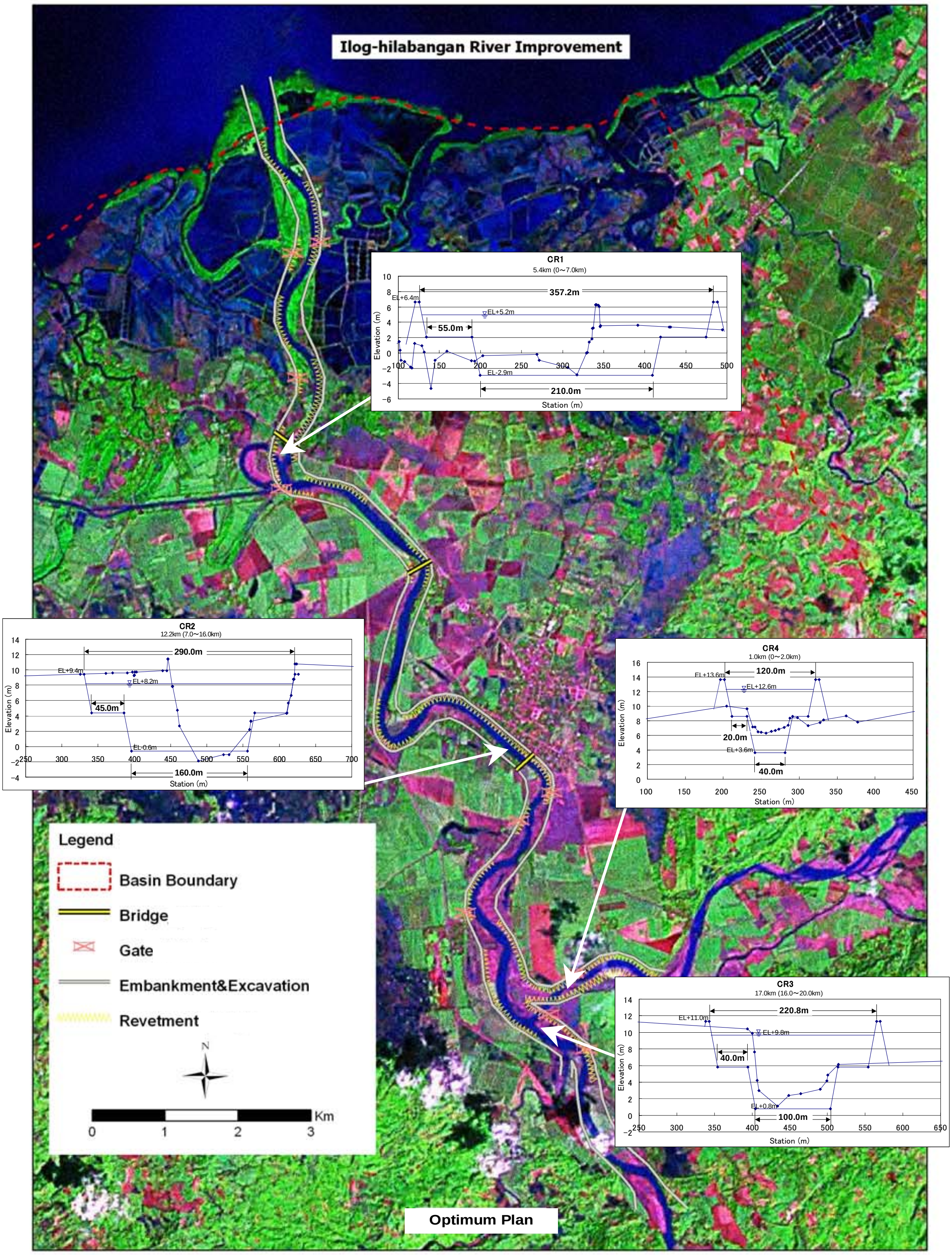


Figure 5.9 Proposed Works of the Optimum Plan of the Ilog-Hilabangan River Basin

(7) Estimation of Benefit of Structural Measures

1) Estimation of Flood Damage

Inundation areas under the project scale are calculated in the flood inundation analysis, and are applied to estimate the flood damage. The flood damage is estimated considering with and without project conditions as shown below.

Table 5.22 Flood Damage in the Ilog-Hilabangan River Basin

Item		Area Inundated (ha)	Assets Inundated (mil. Pesos)	Flood Damage (mil. Pesos)
I.	Direct Damage			551.6
	Built-up Area	114.2	1,039.2	311.8
	Sugarcane	6,710.7	575.1	57.5
	Fishponds	2,035.7	61.1	55.0
	Infrastructure			127.3
II.	Indirect Damage			25.5
III.	Total			577.1

2) Annual Average Benefit

Based on the method described in Chapter 5.1, the annual average benefit under present condition is computed at 207.8 million pesos. The future benefit is shown in Tab.5-1.

5.2.5 Non-Structural Measures

(1) General

Non-structural measures are examined on the basis of filed survey and preliminary studies on flood warning system and soil loss related to reforestation. The methodology and detailed results of the study are described in Supporting Report H. It should be reminded that the Study is preliminary level because of limited time frame and resources. The Study concentrated to discuss general direction of flood mitigation using currently available information. Further detailed study toward implementation of flood mitigation measures is recommended at the next stage such as feasibility study. The recommended non-structural measures at this stage are summarized below.

(2) Recommendation on Non-Structural Measures

1) Recommended Flood Warning System

Community Based Flood Early Warning System (CBFEWS), which PAGASA is now introducing, is recommended. However, it is expected that there is a difficulty of inter-Regional communication between Region 6 and 7. Slight modification is necessary. For example, as a first step, for the warning system for Kabankalan and Ilog area, the system without using the information in Region 7 could be tentatively set. Instead of measurement of precipitation in region 7, direct measurement of river discharge at boundary of region 6 and 7 can be utilized, although warning time may be reduced.

After initial introduction of the warning system, it is recommended to refine the system every 3 years using the accumulated data and knowledge. Equipment introduced should also be checked at the same time.

Considering that the Ilog-Hilabangan River Basin is one of major river basins, more sophisticated system might be introduced in future. However, it is recommended to start simpler and less costly system with establishing good communication in the basin.

2) Recommendation on Baseline Activities on Watershed Management

Watershed management includes many aspects than flood mitigation. In the present Study, it is recommended that at least minimum necessary activities related to flood mitigation be implemented as baseline activities on watershed management. The following activities are recommended.

- To prepare watershed characterization and watershed management plan
  - There is on-going activity to prepare watershed characterization and management plan only at a part of the Hilabangan River Basin which is a major tributary of Ilog River. As a first step of watershed management, watershed characterization and watershed management plan should be prepared for the entire river basin.
  - The watershed characterization and watershed management plan should be reviewed and revised every 5 years to reflect the watershed situation properly.
- Reforestation with at least same rate as current national average
  - In order to keep at least current condition of watershed so that sediment load from catchment will not increase drastically in future, reforestation should be continued with at least same rate as current national average, e.g., reforestation of grass land (Total area in 26 years = 5.7% of land without forest in the basin).
- Supporting of River Basin Council
  - In Hilabangan area, there is a river basin council established. To enhance more communication within a basin, it is recommended to prepare budget to support activities of river basin council.

3) Recommendation on Other Measures

Issues and recommendations for further improvement for disaster management activity for the Ilog-Hilabangan River Basin based on the result of field survey are summarized.

General recommendations are, as follows:

- Enhancement of disaster management activities at community level;
- Necessity of periodical refinement of disaster management plan; and
- Necessity of preparation and dissemination of hazard map for excess flood after completion of structural measures.

Recommended other measures for the Ilog-Hilabangan River Basin are, as follows:

- Preparation of flood hazard map
  - Preparation of flood hazard map is generally not enough. It is recommended to prepare the flood hazard map to show flooding patterns for whole downstream reach of Ilog and Hilabangan Rivers during the next stage of the study such as feasibility study, together with structural measures. Technical assistance including how to express flooding process in the flood prone area and evacuation place should be provided to CDCC and MDCC.
- Enhancement of communication between neighboring LGUs
  - MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended. Exchange of know-how of disaster management each other is also recommended.

(3) Rough Estimation of Cost and Benefit for Reference

As a reference, rough cost estimation is made for the flood warning system and the baseline activity on watershed management.

Cost for the flood warning system is roughly estimated as follows. O&M cost includes 1) cost for refinement of the system every 3 years, and 2) cost for observer.

Table 5.23 Rough Cost Estimation for Flood Warning System for 26 years in the Ilog-Hilabangan River Basin (2009 to 2034)

Cost for Initial Setting (mil. Pesos)	Total Cost for O&M for 26 years (mil.Pesos)	Total Cost for 26 years (mil.Pesos)
6.0	12.1	18.1

Cost for recommended baseline activities on watershed management for 26 years (2009 to 2034) is roughly estimated as shown in the following table.

Table 5.24 Rough Cost Estimation for Recommended Baseline Activities on Watershed Management for 26 years in the Ilog-Hilabangan River Basin (2009 to 2034)

Cost			
Preparation of Watershed Characterization & Watershed Management Plan (mil.Pesos)	Reforestation (mil.Pesos)	Supporting of River Basin Council (mil.Pesos)	Total Cost (mil.Pesos)
12.00	220.53	10.4	242.93

The breakdown of the estimated costs is shown in Supporting Report H.

Possible benefit by flood forecasting and warning system is preliminary estimated to examine appropriate flood forecasting and warning system in this river basin. Based on it, the above-mentioned flood warning system is recommended. The detail discussion is presented in Supporting Report H.

5.2.6 Initial Environmental Examination

(1) Result of the IEE

The IEE for the structural measures was carried out based on the information and data collected during this Study and consultation with concerned government and stakeholders.
In the Matrix (refer to Tab.5-2), the major environmental resources are shown in the horizontal line, and the activities for implementation of the proposed plan are shown in the vertical line. The assessment of impacts was made in terms of magnitude (e.g., significant, moderate, and negligible) of the negative or positive affecting the environmental elements.
Positive impacts are not considered in the cumulative quantification of the environmental impact score for each alternative since they would not lead to any hindrance in decisions of whether or not to proceed with the project. On the other hand, negative environmental impacts remain critical in so far as decisions in the proper selection of project alternatives.

Table 5.25 Activities for Each Project Phase in the Ilog-Hilabangan River Basin

Phase	Project Activity
Pre-construction Phase	Resettlement of Project affected Persons/Families
	Land Acquisition
	Project Mobilization
Construction Phase	Construction of Earth Dike
	Installation / Construction of Sluice Gates
	Bank Erosion Protection Work
	Channel Widening Along Ilog River
	Widening Along Cut-off Channel
	Dredging and Excavation
O & M Phase	Dredging and Excavation
	Watershed Management
	Installation of Flood Warning System

As the result of the assessment, it is evaluated that the channel widening and demolition and reconstruction of existing bridges are considered to cause the potential adverse impact for this area. The particular evaluations for these impacts are described below (for details, refer to Supporting Report I).

1) Social Environment

a) Resettlement

The resettlement should be one of the most critical social impacts in project identification. The number of PAFs was estimated as more than 30. Adverse impacts caused by the project should be mitigated so that it enables the project affected persons to improve their living standards, income opportunities or at least to restore their living including their income to the pre-project level. The resettlement framework introduced in Supporting Report I may be used as a guideline in establishing compensation of displaced entities.

b) Loss of agricultural land

In addition to it, the widening of Ilog River and the cut-off channel will result in the loss of agricultural land that currently functions as sugarcane plantation. Hence, the Right-of-way or land acquisition concerns will also be the significant issues. In such instances, the process of public/stakeholders consultation shall be satisfied since this is a mandatory component of achieving social acceptability under the Philippine EIS System.

c) Disruption of local transport

Other significant impact of channel widening that is inevitable is the disruption of local transport and the substantial financial requirement in the reconstruction of bridges associated to all the alternatives. The potential expansion in length and width in order to attain structural stability of the bridges will require the preparation of a separate IEE document. The IEE document should be substantiated to include traffic impact assessment that will ascertain the extent of impact and develop a traffic management plan for use by the LGU during the project construction phase. It is specified in DAO 2003-30 that bridges whose length is over or equal to 80m, or whose capacity (length/width) is increased by 50% or more falls under Category B (Philippine EIS System) which requires an IEE report for the application and issuance of an ECC.

2) Natural Environment

a) Removal of plants

During the construction period, the civil works and earthmoving activities will entail the removal of ornamental plants, other locally available invasive (grows anywhere) trees, including natural vegetation (patches of grasses and weeds, patches of bamboo, plantation of sugarcane, root crops) which are present along the river banks. Negative ecological impacts may also arise in the removal of mangrove strips near the river mouth as well as in other sites along Ilog River.

b) Removal of mangrove

Although the extent of mangrove removal is not towards clear cutting operations, the implementing agency should consider re-vegetation of mangroves along coastlines as prescribed under Section 43 of the revised forestry code of the Philippines (RA 7161) and Section 12 of DENR AO 1990-15.

3) Public Hazard

a) Disposal of dredge material

The effect of widening Ilog River and the existing cut-off channel will generate voluminous amount of soil materials. These can pose significant aesthetic threat to the surroundings and if left unmanaged may increase the turbidity of the river. Another physical and chemical effect that will likely occur is the increase in total suspended particulates from the unmanaged stockpile of spoils released or re-suspended in the atmosphere. Such scenario may lead to the indiscriminate disposal of spoils and dredged materials to vacant lots and agricultural land. The indiscriminate disposal of dredge material could spur competition in the available land for cropping/planting and other agricultural activities.

The foregoing scenario can be addressed at the onset by looking for an acceptable and appropriate disposal site. The eventual disposal of spoils is not critical in terms of health and sanitation since heavy metal content is substantially below the permissible level for toxicity set by USEPA. However, it is important to have the site identified collaboratively with the LGU and the DENR so that the physico-chemical impacts mentioned above are addressed including the social concerns and regulatory compliance is achieved.

(2) Management/Mitigation Plan

Overall, environmental management and mitigation plan shall be closely exercised during the development phase of these major project components in order to minimize if not totally eradicated the negative environmental impacts. Several potential adverse impacts identified in the evaluation were concluded that the Environmental Impact Assessment (EIA) is required in the succeeding study period.

5.2.7 Project Evaluation

(1) Technical Feasibility

The Philippines has experienced the construction of river channel improvement many times. Thus, no difficulty would be encountered in the actual construction of the river channel improvement. The recommended non-structural measures have also been experienced in the country. This project is, therefore, evaluated to have a technical feasibility.

(2) Economical Viability

The economic viability is assessed based on the economic cost and benefit stream of the proposed structural measures. As for the assessment of the non-structural measures, this is not carried out based on the situation as discussed before.

Tab. 5-1 shows the economic cost and benefit stream. As the results, the economic viability is figured out as follows:

Table 5.26 Economic Viability of the Optimum Plan in the Ilog-Hilabangan River Basin

Viability Index	
EIRR (%)	18.9
NPV (mil. Pesos)	268.6
B/C	1.31

Based on the above results, EIRR becomes higher than the opportunity cost of capital of 15%. Therefore, the project is evaluated to have an adequate economic viability.

(3) Environmental and Social Acceptance

As the social environmental impacts, the resettlement and the loss of agricultural land by the channel widening and the construction of the bridge are expected. The resettlement framework, public/stakeholder consultation, and separate IEE for the bridge will be needed to satisfy the achievement of the social acceptability. As the natural environmental impacts, the removal of plants along the river bank and the mangrove in the river mouth are expected. The plan for re-vegetation will be needed to satisfy the achievement of the natural acceptability. As the public hazard, the disposal of dredge materials and spoils are expected. Preparation of the appropriate disposal site will be needed prior to construction work.

Overall, environmental management and mitigation plan shall be closely exercised during the development phase of these major project components in order to minimize if not totally eradicated the negative environmental impacts.

The project plan was explained and discussed with the stakeholders through the stakeholder meetings at each end of the field survey and workshop in the site. Through these experiences and activities, it is concluded that, at this stage, implementation of this project is socially and environmentally accepted by the stakeholders.