JAPAN INTERNATIONAL COOPERATION AGENCY

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE REPUBLIC OF THE PHILIPPINES

# THE FEASIBILITY STUDY OF THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN THE REPUBLIC OF THE PHILIPPINES

# FINAL REPORT

# VOLUME II

# MAIN REPORT

FEBRUARY 2002

NIPPON KOEI CO., LTD.
NIKKEN Consultants, Inc.

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# List of Volumes



The cost estimate is based on the price level and exchange rate of June 2001.

The exchange rate is:

US$1.00 = PHP50.0 = ¥120.0

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Hideki SATO of NIPPON KOEI Co.,LTD. (consist of NIPPON KOEI Co.,LTD. and NIKKEN Consultants, Inc.) to the Philippines, six times between March 2000 and December 2001.

In addition, JICA set up an advisory committee headed by Mr. Hidetomi Oi, Senior Advisor of JICA between March 2000 and February 2002, which examined the study from technical points of view.

The team held discussions with the officials concerned of the Government of the Philippines and conducted field surveys at 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 to the enhancement of friendly relationship 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 Team.

February 2002

川上隆朗

Takao Kawakami
President
Japan International Cooperation Agency

February 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

Letter of Transmittal

It is with great pleasure that we submit to you the Final Report of the "Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines".

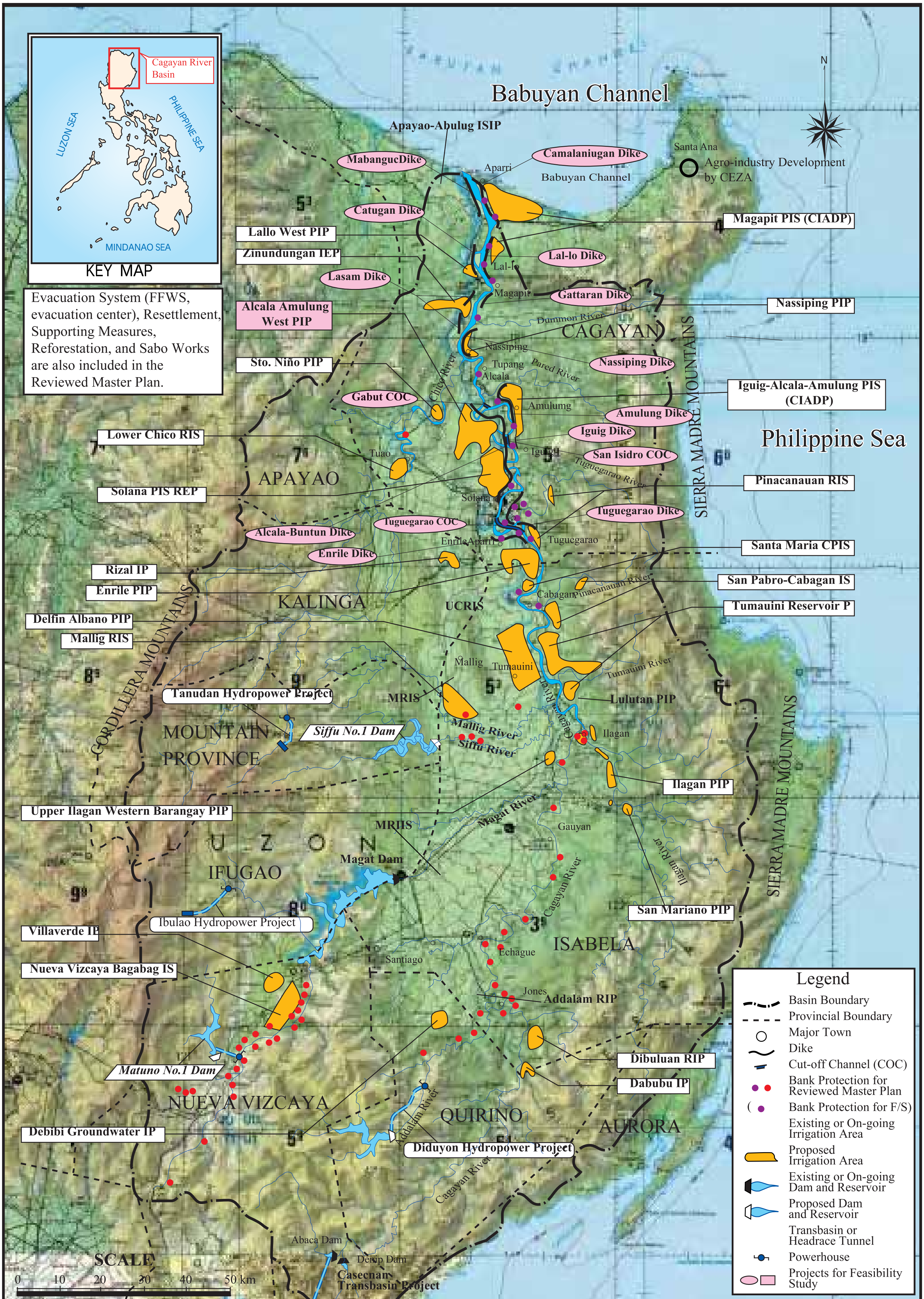
The Study has prepared the Reviewed Master Plan for the Cagayan River basin water resources development through examination and review of the Master Plan formulated in 1987, and conducted the Feasibility Study for the priority flood control projects and priority irrigation project in the Lower Cagayan River to protect life and properties from floods and to enhance efficient land use. The Report presents the said Reviewed Master Plan and feasibility study results.

We hope that this Report will be helpful for realization of the projects and programs proposed in this Study to mitigate the flood damage and enhance the land use in the Lower Cagayan River area, and will contribute to the socio-economic development of the Cagayan River basin.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, JICA Philippines Office, the Embassy of Japan in the Philippines, the Department of Public Works and Highways and the authorities concerned of the Government of the Republic of the Philippines for the courtesies and cooperation extended to us during our Study.

Very truly yours,

Hideki Sato
Team Leader
for the Feasibility Study
of the Flood Control Project
for the Lower Cagayan River
in the Republic of the Philippines




Proposed Schemes in the Reviewed Master Plan and Feasibility Study

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

# OUTLINE OF THE STUDY

## *1. River Basin Condition*

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| **Cagayan River** | **Location:** | **Northeastern Luzon Island** |
| | **Basin area:** | **27,281 km$^2$** |
| | **River length:** | **520 km** |
| | **River width:** | **300 - 2,000 m in the lower reach** |
| | **River slope:** | **1/7,000 – 1/21,000** |
| **Socio-economy** | **Population:** | **2.55 million in 1995 (3.3% of the National)<br>Region-2 84%** |
| | **GRDP in R-2:** | **54.5 billion Pesos (1998)** |
| | **Per-capita GRDP:** | **20,200 Peso (500 US$ in 1998)** |
| | **Poverty incidence:** | **About 40%** |
| **Hydrology** | **Annual rainfall:** | **2,600 mm** |
| | **Annual runoff:** | **1,372 m$^3$/s** |
| **Flood damage** | **Inundation area:** | **1,860 km$^2$ in 1973 Typhoon Openg<br>1,740 km$^2$ in 1980 Typhoon Aling** |
| | **Annual flood damage:** | **3.55 billion Peso in the lower reach** |
| | **River bank erosion:** | **6 m - 28 m / year** |
| **Watershed** | **Land area by slope:** | **less than 8% 6,600 km$^2$ (24.2%)<br>8% - 18% 3,400 km$^2$ (12.4%)<br>Over 18% 17,300 km$^2$ (63.4%)** |
| | **Forest area:** | **41.7%** |
| | **Heavy land erosion:** | **Deposit in Magat Reservoir<br>Denudation of watershed** |
| **Land use** | **Agricultural land:** | **25%<br>Paddy: 472,500 ha<br>Corn: 137,300 ha<br>Other: 66,600 ha** |
| | **Grass land:** | **31%** |
| | **Forest area:** | **42%** |
| | **Others:** | **2%** |
| **Production** | **Paddy:** | **13% of national total** |
| | **Corn:** | **16% of national total** |

## *2. 1987 Master Plan*

**Water Resources Development Master Plan by JICA in 1985 -1987**

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| **Multi-purpose dams:** | **Existing Magat Dam (Irrigation, Flood Control, Hydropower)**<br>**Siffu No.1 (-Do-)**<br>**Mallig No.2 (Irrigation, Flood Control)**<br>**Matuno No.1 (Irrigation, Hydropower)**<br>**Alimit No.1 (-Do-)** |
| **Flood control projects:** | **Tuguegarao dike**<br>**Widening of Magapit Narrow**<br>**Cabagan dike**<br>**River bank protection** |
| **Agricultural development:** | **14 irrigation projects**<br>**Permanent crop development**<br>**Pasture land development** |
| **Hydropower development:** | **Ibulao**<br>**Tanudan**<br>**Diduyon** |

## *3. Basic Concept of the Cagayan River Basin Development*

**(1) Study Period: March 2000-January 2002**

**(2) Scope of Work:**

1) **Review of Master Plan**
2) **Feasibility Study of The Lower Cagayan Flood Control Project**
3) **Transfer of Technology**

**(3) Basic Concept:**

1) **Present condition: Depressed area / Low economic development/Less income**
2) **Causes: Natural calamity / less investment / little understanding of development needs**
3) **Needs of socio-economic development : Food security / balanced development / upgrading living standard**
4) **Development potential: Land resources / Water resources / others**
5) **Basic development concept:**
   - **Target year 2020**
   - **Per-capita GRDP to reach National Average Level**
   - **Reduction of Poverty Incidence**

- **Additional Investment for water resources development: 30 billion Pesos up to 2020**

6) **Project formulation**
- **Flood control**
- **Irrigation**
- **Watershed management**
- **Water supply / power generation**
- **Water quality management**
- **River environment management**
- **Project cost**

**New / Additional Investment**

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| **Multipurpose dam project** | **3,172** | **million Pesos** |
| **Flood control project** | **19,239** | |
| **Irrigation project** | **9,070** | |
| **Sub-total** | **31,481** | |

**Investment by regular fund / private sector**

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|---|---|
| **Irrigation projects** | **9,500** |
| **Watershed management** | **10,472** |
| **Hydropower projects** | **47,901** |
| **Sub-total** | **67,873** |
| **Total** | **99,354** |

## *4. Priority Projects (Feasibility Projects)*

- **Lower Cagayan Flood Control Project(1st Phase)**

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| **#Urgent bank protection** | **21 sites** |
| **#River bank tree zone** | **70 km** |
| **#Left dike system (Rivermouth - Magapit)** | **17.3 km** |
| **#Right dike system (Rivermouth - Magapit)** | **26.0 km** |
| **#Non-structural/supporting measures** | **LS** |
| **Total Project Cost** | **2,786 million Pesos** |

- **Alcala Amulung West Irrigation Project(1st Phase)**

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|---|---|
| **#Irrigation system (1st Stage only)** | **4,090 ha** |
| **#Supporting measures** | **LS** |
| **Total Project Cost** | **1,626 million Pesos** |

- **Project cost (G.Total) 4,412 million Pesos**

## *5. Project Implementation (1st Phase)*

**Leading agency: DPWH**

**Cooperation: Coordination Committee in the members of DA, NIA, PAGASA, LGUs, etc.**

**Construction period: 2002-2007**

**Funding source: GOP and Foreign assistance**

# Part-I GENERAL

## I. INTRODUCTION

### Background and Authority of the Study

1.1 The Master Plan on the Cagayan River Basin Water Resources Development was firstly formulated in 1987 (1987 Master Plan) by Japan International Cooperation Agency (JICA) based on the mutual agreement between the Government of the Philippines (GOP) and the Government of Japan (GOJ). The GOP has endeavored to implement the projects proposed in the said Master Plan, however, no project has been realized for reasons beyond the government's control, such as political disturbance, insecure peace-and-order situation in the objective area, financial constraints, etc. This situation has improved remarkably in recent years. Accordingly, the GOP now wishes to implement the projects proposed in the 1987 Master Plan.

1.2 Frequent flood inundation has been a main constraint in the promotion of sustainable socio-economic development and improvement of the living condition of the people in the Cagayan River basin. In view of this and realizing the priority of the flood control project proposed in the 1987 Master Plan, GOP made a request to GOJ in May 1999 for technical assistance to conduct the feasibility study of the flood control project for the Lower Cagayan River. In response to the request, the GOJ decided to conduct the feasibility study (the Study). The Implementing Arrangement on the technical cooperation for the Study was agreed upon between the Department of Public Works and Highways (DPWH) and JICA on December 17, 1999. The Study was performed in conformity with the Implementing Arrangement.

1.3 JICA organized the Study Team with the selected consultants in order to carry out the Study. The Team conducted the Study in close cooperation with the GOP through the Counterpart Officials. JICA also established an Advisory Committee formed by staff of the Ministry of Land, Infrastructure and Transport, Ministry of Foreign Affairs and Japan Bank for International Cooperation (JBIC) in order to guide the Study Team and review the findings thereby. The GOP established a Steering Committee chaired by the Undersecretary of the DPWH with members from various related agencies and established the Technical Working Groups, one each by DPWH and National Irrigation Administration (NIA) to support the Study Team. Furthermore, the GOP provided counterpart personnel to support the Study Team working together.

## Objectives of the Study

2. The objectives of the Study are:

1) to carry out the feasibility study for the flood control project including land use planning in the Lower Cagayan River, and
2) to conduct technology transfer to the Philippine counterpart personnel in the course of the Study.

The Study also covers a review of the 1987 Master Plan focusing on flood control, watershed management and land use within the objective areas aiming at enhancing socio-economic development in the basin..

## Study Area

3. The area for the feasibility study is the Lower Cagayan River area. The area for the review of the 1987 Master Plan is the whole Cagayan River basin.

## Study Schedule and Activities

4.1 The Study commenced in March 2000 and completed in January 2002. Through six (6) field and five (5) home works including data collection and analyses and field investigations covering topographic survey, geological and soil investigation, hydrological survey and analysis, environmental investigations, etc., the 1987 Master Plan was reviewed and the feasibility study for the priority projects was conducted. The Reviewed Master Plan has been formulated on the basis of the reviewed long-term plans on flood control, watershed management and land use. The feasibility study covers flood control projects in the Lower Cagayan River and a selected priority irrigation project.

4.2 Transfer of technology was made through on-the-job training in the course of the day-to-day Study works, eight (8) joint meetings with the counterparts, four (4) workshops and two (2) technology transfer seminars. Two (2) public consultation meetings were also held with the Local Government Units (LGUs) for exchanging opinions on the LGUs' participation in the project implementation.

## Final Report

5.1 This Final Report contains all the findings of the field investigations and the results of the Study including the Reviewed Master Plan and the Feasibility Study. This Final Report was prepared incorporating the conclusions of the last Steering Committee Meeting held on 13 December 2001 and all the comments of the respective Philippine Government agencies on the Draft Final Report which the Study Team submitted on 4 December 2001.

5.2 This Final Report consists of six (6) Volumes; Volume I Executive Summary, Volume II Main Report, Volume III Supporting Report which consists of three (3) separate volumes, Volumes III-1, III-2 and III-3, and Volume IV Data Book.

# II. CAGAYAN RIVER BASIN

## Geographical Location

6. The Cagayan River basin, the largest river in the Philippines having a catchment area of 27,281 km$^2$ and river length of 520 km, is located in the northeastern part of Luzon Island. It is bounded by mountain ranges, the Sierra Madre in the east, Cordillera Central in the west and Caraballo-Maparang in the south. And it faces to the Babuyan Channel in the north (Refer to the Location Map for the Project).

## Socio-economy

7.1 The Cagayan River basin extends over Region 2, Cordillera Administrative Region (CAR) and some part of Region 4, administratively. The basin consists of 110 cities/municipalities in nine (9) provinces, including two (2) cities of Tuguegarao and Santiago. The former is located in Cagayan Province and is the central city in the Region 2, and the latter is located in Isabela Province.

7.2 The Cagayan River basin population was 2.55 million in 1995 corresponding to 3.3% of the national population of the Philippines. The average growth rate in the 1980's was 2.25% per annum, however it decreased to 1.73% in the 1990's. Eighty-four percent (84%) of the basin population (2.14 million) belongs to Region 2, 16% (410 thousand) to CAR and just under 0.5% (9 thousand) to Region 4. Thus, it may be said that the socio-economy of Region 2 represents that of the Cagayan River basin.

7.3 Gross Regional Domestic Product (GRDP) of Region 2 was 54.5 billion Pesos (about 1.35 billion US$ equivalent) in 1998, which ranked as fourteenth (14$^{th}$) among all 15 regions in the Philippines (excluding Region 13 having no data in 1998). Per capita GRDP of Region 2 was 20,200 Pesos (about 500US$ equivalent) in the same year, which ranked as twelfth (12$^{th}$) among the 15 regions, corresponding to about 55% of the national average. Thus, the Cagayan River basin is recognized to be economically underdeveloped area in the Philippines. The poverty incidence of Region 2 is currently about 40%, which is lower than the national average. However, it is still high in absolute term.

## Topography and Geology

8.1 The Cagayan River basin has much sloped area, with 6,600 km$^2$ having slope less than 8%, 3,400 km$^2$ between 8% to 18%, and 17,300 km$^2$ over 18%. Major tributaries of the Cagayan River are the Magat, Ilagan, Siffu-Mallig, Tuguegarao, and Chico Rivers. These tributaries flow down the eastern, western and southern slopes of the Cagayan River basin and join the main course of the Cagayan River.

The main Cagayan River runs from the south to the north in the flat alluvial plain and finally empties into the Babuyan Channel.

8.2 Rocks of the Cagayan River basin consist of the metamorphic and plutonic rocks of pre-Tertiary age, which have been uplifted by igneous intrusions during the Late Tertiary and Quaternary. The Oligocene section consists of basic lava flows, metamorphosed conglomerate, tuff breccia, and tuffaceous sandstone and siltstone. There occurred many earthquakes to the west in northern Luzon, but relatively few in the Cagayan River basin located in the east of northern Luzon. The Baguio earthquake occurred in July 1990 was of the biggest among those recorded in the past and the magnitude was 7.8 on the Richter scale. The earthquake caused the collapse of slopes in the southwestern area of the Cagayan River basin leading to large increases in sediment yield/load in the Magat River basin.

**Meteorology and Hydrology**

9. The Cagayan River basin has ample water resources having a mean annual rainfall of 2,600 mm and mean annual runoff of 1,372 $m^3/s$ at the river mouth of the Cagayan River. There is no distinct separation of the dry and the rainy seasons climatically in the basin but the former is roughly from December to April and the latter from May to November. There is a rather wide range in the annual rainfall, from more than 4,000 mm in the mountainous area to less than 2,000 mm on the plain in the north. The 100-year probable flood is estimated at 21,400 $m^3/s$ at the river mouth of the Cagayan River, which is equivalent to 0.784 $m^3/s/km^2$ of specific flood runoff.

**Present River Condition**

10.1 In the downstream of the Cagayan River from Tuguegarao to Alcala, the discharge capacity of the river is about 2,000 $m^3/s$, which is less than two (2)-year probable flood. The longitudinal riverbed slope varies from 1/7,000 to 1/21,000 and the river width from 300 m to 2,000 m. There is a narrow stretch, so called the Magapit Narrows with the river width of about 300m in a reach between 30 km and 70 km upstream from the river mouth.

10.2 The Lower Cagayan has a narrow river width section from 30 km to 70 km from the river mouth so called Magapit Narrows. Since the upstream reach of the Magapit Narrows has a gentle water surface slope due to a backwater by the Narrows, river meandering is significant causing the movement of the river course, such that the river course near Iguig has moved about 5 km for the past 50 years. On the other hand, it may be said that the riverbed elevation is rather stable without much change in the Lower Cagayan River, although slight rising of riverbed has been observed in the reach between the Magapit Bridge and the confluence of the Tuguegarao River with the Cagayan River.

**Flood Damages and Flood Control Projects**

11.1 Since the discharge capacity of the Cagayan River is very small, floodings have occurred frequently and the basin people residing along the river have suffered from flood damage. In particular, the major flood disasters occurred in 1973, 1980 and 1998 (refer to Figure 1). Typhoons Openg, Aling and Iliang brought these flood disasters, with the flooded areas covering about 1,860 $km^2$, 1,740 $km^2$ and 620 $km^2$, respectively. The 1973 flood, the recorded biggest flood, is estimated to be equivalent to about 25-year probable flood. The average annual flood damages in the area between Tuguegarao and the river mouth of the Cagayan River is estimated at about 3.6 billion Pesos, which is equivalent to about 6.6% of GRDP of Region 2.

11.2 Bank erosion is observed at various places in all reaches of the Cagayan River. In particular, heavy erosion and large damages have occurred in 73 places where the average annual bank erosion rates have reached 6 m to 28 m.

11.3 The flood control structural measures which have been implemented so far by the DPWH and the LGUs are limited to small-scale bank protection works and small-scale spur dike works because of the limited budget. There are flood forecasting and warning systems in the basin as one of the non-structural measures for flood control. However, it may be pointed out that parts of the forecasting system have not been properly operational because of faulty equipment and insufficient management. Hence, flood forecasting has not been performed properly. Furthermore, the existing shelter facilities for emergency use are not sufficiently provided.

**Present Watershed Condition**

12.1 The forest area in the Cagayan River basin is 41.7% of the whole basin area, which has been slightly decreased from 42.3% reported in the 1987 Master Plan Study, hence the conservation of the forest area is required. Slope collapses have occurred since the earthquake in 1990 in the upstream area of the Magat River and sediment yields have greatly increased. Sediment deposition in the Magat Dam reservoir was increased abruptly since the 1990 earthquake. Its accumulated deposition reached about 188 million $m^3$ in 1999 for 17 years since the dam completion in 1982, which corresponds to 62.7% of the designed dead storage capacity (268 million $m^3$) for life time of 100 years. Furthermore, about 30 million $m^3$, which have been retained in the upstream river course of the reservoir, would be a potential sediment deposition in the Magat Dam reservoir.

In order to extend the lifetime of the existing Magat Dam reservoir, countermeasures against sedimentation flowing into the reservoir are urgently required.

12.2 The Department of Environment and Natural Resources (DENR) and other government offices have implemented watershed conservation measures such as reforestation, check dam constructions and so on under the technical and financial assistance of the foreign governments, non-government organizations and so on. However, owing to lack of fund and incompleteness of overall watershed conservation plan, these initiatives are insufficient to stabilize the watershed and reduce sediment yields.

**Present Land Use**

13.1 Of the Cagayan River basin, about half of the area is higher than 400 m in elevation and more than 60% of the area is steeper than 18% in slope. Agricultural land occupies 25%, grassland 31% and forests 42% and other land uses 2%. The agricultural land consists of paddy field (472,500 ha), cornfield (137,300 ha) and other diversified crop fields (66,600 ha). The existing irrigation area is 218,000 ha corresponding to 46% of the potential irrigable area.

13.2 The Cagayan River basin is an isolated area surrounded by steep mountain ranges on three sides and the sea on the other. The Dalton Pass route, being the trunk route to and from Metro Manila, has been closed sometimes by land collapse making it an insufficient transportation system, which is one of the most critical problems in the basin. Other problems in the basin are heavy land erosion, large-scale land possession in the hilly area and low agricultural productivity in the plains. The heavy land erosion is due to past tree felling, and causes heavy sedimentation in the downstream. The large-scale land possession in the hilly area impedes its active land use, although the area has high potential of livestock development. Low agricultural productivity in the plains is due to flood and drought.

13.3 The Cagayan River basin is a granary in the Philippines, and production of paddy and corn during 1995 to 1999 in Region 2 shared 13% and 16% of the total production of the Philippines, respectively. Problems in agricultural farming are frequent flood and drought, high rate of post-harvest loss, insufficient processing, marketing and credit systems, and so on. They are some of the key reasons why poverty and regional inequity have not been improved in the basin.

**Existing Flood Control Facilities and Related River Structures**

14. The existing major flood control structures are a jetty and concrete parapet walls

near the estuary of the Cagayan River, cut-off channel and revetment works on the banks in the lower reach in the Tuguegarao River, and bank protection works with groins in various places. Further, in the Cagayan River basin, there are the Magat Dam, the flood forecasting and warning systems, and designated shelters for emergency evacuation from flood. The other related structures are the MARIS intake weir, Baligatan intake weir, Chico intake weir, Casecnan dam, Magapit pump station, Amulung pump station, Iguig pump station, Solana pump station, some bridges and so on.

**Present Water Uses**

15. Annual diversion water for irrigation from the Cagayan River is estimated at 3.44 billion $m^3$ in the year 2000. The municipal water requirement in the year 2000 is estimated at 282,000 $m^3$/day (103 million $m^3$/year). Water resources of the Cagayan River basin are ample (annual average runoff of 1,372 $m^3$/s or 43.3 billion $m^3$/year). Therefore, there is no serious problem regarding the balance between the water resources potential and the water demand, although the water deficit due to the seasonal variation of available water are observed.

**Environment**

16.1 There are 298 species of terrestrial flora and 182 species of terrestrial fauna recorded in the whole Cagayan River basin. These include species registered in the red list of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES so-called as the Washington Treaty) or the International Union for the Conservation of the Nature and Natural Resources (IUCN). Also, there are a few-known extinct or rare species. Further, around forty (40) nekton species are found out in the Cagayan River system, and of these, the most remarkable species is Ludong. However, the number of Ludong has been decreased because of recent excessive fishing and decrease of habitat area due to the Magat Dam construction. There are 18 protected areas, such as National Parks, the protection area of fauna and flora, and forest protection areas in the Cagayan River basin. Most of them are located far from the main river course of the Cagayan River.

16.2 The water quality of the Cagayan River is generally good with low concentration of BOD at less than 2 ppm and high DO at more than 7 ppm. However, there are some areas where the river water is contaminated by biological bacteria such as colon bacillus. The water quality of wells is also generally good in the same manner as the Cagayan River, but contamination by colon bacillus has been confirmed in some wells. Regarding the ambient air and noise, there are no serious issues as they satisfy the corresponding terms in the environmental guidelines.

16.3 The Cagayan River provides good fishing areas to the local people. Most people are mainly engaged in the agricultural production activities and full-time fishermen are few. There are 18 ferryboat navigation routes in the lower reach of the Cagayan River. Most of them are small passenger ferries, but there are also some small car ferries. There are many items of historical and cultural heritage in the Cagayan River basin, most of which are churches constructed during the Spanish colonial era. Further, there are rice terraces distributed in Ifugao Province registered in the World Heritage Treaty.

16.4 Recently, public sanitation has been improved greatly, however there is still a necessity for improvement because of the access rate to safe water is only about 73% and the diffusion rate of the sanitary toilet is about 80%. Regarding education, both the school attendance and graduation rates have been improved greatly, and in particular, the elementary school attendance rate is more than 95% at present. The present problem on education is the lack of educational equipment and materials, and furthermore other problem is that the school cannot be opened at the emergency of flood occurrence because they are used as the evacuation centers (shelters).

16.5 Lots of minority tribes or indigenous people have existed in the Cagayan River basin. However, most of them have been assimilated into the majority culture and their life style and culture are not distinguished currently.

## Institutional Study

17.1 Water management, including water resources development, water use, etc. has been undertaken by more than 20 government agencies in the Philippines. There is no unified authority to implement and control overall river management and water resources development. The National Water Resources Board (NWRB) is a regulatory board for water resources management, however it may be insufficient in its capacity and capability. The Philippine Government is now examining several conceivable measures such as strengthening of NWRB, establishment of a Department of Water Resources, establishment of a River Bureau in DPWH, etc. An overall management system for water and rivers is required. Figure 2 shows the current institutions of water-related agencies in view of those functions and organizations.

17.2 The Water Code is the basic law on water and rivers. It contains the provisions on water allocation, water use, river maintenance and management, designation of river areas and flood control areas, etc. One of the basic law on land use is NIPAS Act. The Philippine Government prohibits the diversification of land use from agricultural land to others, since the Philippines is not self-sufficient in rice and corn production and needs to sustain and increase agricultural production.

17.3 The Philippine Government is gearing towards decentralization from a position of centralized administrative power. For realization of this strategy, the Local Government Code has been enforced. However, local governments are obliged to rely on the support of the national government since they have insufficient financial and engineering capacity/capability.

17.4 Although the law and regulations have been well provided, the review and strengthening of implementing rules and regulations are essential, since there are many cases of the laws not being adequately enforced.

# Part-II REVIEW OF 1987 MASTER PLAN

## III. 1987 MASTER PLAN

### Outline of 1987 Master Plan

18.1 The 1987 Master Plan Study for the Cagayan River basin was conducted by JICA from 1985 to 1987. The objective of the Study was to formulate a Master Plan for water resources development in the entire Cagayan River basin covering an area of 27,281 $km^2$. The target of regional economic development was set to raise the per capita GRDP of Region 2 by the year 2005 up to that of the national average excluding the highly industrialized National Capital Region (NCR) and Region 4.

18.2 Framework Plans and Long-term Plans were formulated for each sector of the water resources development as presented below. The Framework Plan was defined as a potential development plan prospecting indefinitely future ideal development. The Long-term Plan was defined as a plan being more economically effective within the target period.

1) <u>Flood Control Plan:</u>

<u>Framework Plan:</u>

a) The framework plan of the flood control contemplated alleviating flooding along the Cagayan River for the design flood of 100-year probable flood.
b) Flood control dams were planned in the upstream reaches to reduce flood magnitude.
c) The Magapit Narrow improvement (widening) in the Lower Cagayan River was contemplated increasing discharge capacity thereat.
d) The areas along the middle and lower reaches were planned with dike systems to prevent flooding in the low-lying areas.
e) Tributary area was planned to retain natural flood retarding effect as much as possible.

<u>Long-term Plan:</u>

a) The long-term plan was formulated on the basis of the framework plan by reducing the design discharge to a 25-year probable flood as a more economically effective scale.
b) The long-term plan consisted of ;
   i) dike embankment including revetment and sluice along the main Cagayan River and major tributaries (the Siffu, Ilagan and Magat),
   ii) narrow excavation at Nassiping (a portion of the Magapit Narrows),

iii) cut-off channel works (Gabut and San Isidro),
iv) bank protection,
v) flood control dams (Cagayan No.1 and Ilagan No.1),
vi) Flood control function in the multipurpose dam projects (Siffu No.1, Mallig No.2, and Magat) in addition to the above.

2) Agricultural Development Plan: The agricultural development plan presented was based on the following concept:

Framework Plan:

a) Full development of agricultural land of 1,080,000 ha, consisting of low land 476,000 ha (of this, the existing irrigation area is 224,000 ha) and upland 604,000 ha,
b) Full development of low land area 476,000 ha, dividing into 306,000 ha for paddy with full irrigation system and remaining 170,000 ha for diversified crop,
c) Full development of upland area 604,000 ha dividing into 200,000 ha for permanent crop, 300,000 ha for pasture land for cattle grazing and 104,000 ha for grass land, and,
d) Fresh-water aquaculture development for the main source of fishery products.

Long-term Plan:

The long-term plan consisted of the following:

a) Nine (9) new irrigation and extension schemes for 65,330 ha (including command area belonging to the multipurpose dam schemes of Chico, Mallig and Matuno),
b) Five (5) irrigation rehabilitation and improvement schemes for 12,212 ha,
c) Full development of diversified crop for 170,000 ha,
d) Full development of permanent crop land for 200,000 ha,
e) Full development of pasture land for 300,000 ha, and,
f) Fresh water aquaculture development for the main source of fishery products.

3) Hydropower Schemes:

Framework Plan: Hydropower development potential of the Cagayan River was estimated at about 4 million KW. About 50% of this potential could be developed economically. The Framework Plan contemplated full development of this potential.

Long-term Plan: Proposed hydropower schemes envisaged within the Cagayan River basin were as follows:

a) Single purpose projects consisting of Ibulao (17 MW: Run-of-river type), Tanudan (25 MW: Run-of-river type) and Diduyon (352 MW: Dam scheme),

b) Multipurpose dam schemes consisted of Siffu No.1 (5.4 MW), Matuno No.1 (180 MW), Alimit No.1 (12.2 MW) and Magat Dams (360 MW),

c) Besides the above, the Casecnan multipurpose dam project including hydropower development (268 MW), which was recognized as an on-going project at the 1987 Master Plan stage.

4) Municipal Water Supply: Total source requirement of municipal water in 2005 was estimated to reach 860,000 $m^3$/day. Most of municipal water has been taken from ground water and / or springs. Regarding municipal water, water demand and source requirement only was estimated in the 1987 Master Plan without physical planning for water supply.

5) Multipurpose Dams Schemes: Proposed multipurpose dam schemes were as follows:

a) Siffu No.1 Dam (Flood control, irrigation and hydropower)

b) Mallig No.2 Dam (Flood control and irrigation)

c) Matuno No.1 Dam (Irrigation and hydropower)

d) Alimit No.1 Dam (Irrigation and hydropower)

e) Magat Dam (Existing dam for flood control, irrigation, hydropower)

Of these dams, the Magat Dam is the existing one and others were the proposed. The 1987 Master Plan revealed that the Magat Dam Reservoir capacity was insufficient to supply irrigation water to its command area and also was to be allocated more to flood control function since it is located at a strategic location for the purpose. Combined operation of the Alimit No.1 Dam, Siffu No.1 Dam, Matuno No.1 Dam and Magat Dam was proposed as the optimum scheme to meet the deficit of the Magat project (94 MCM) for irrigation water supply and to allocate a part of the Magat reservoir space to flood control (139 MCM).

18.3 The following projects and schemes were selected for inclusion in the proposed Master Plan (Refer to Figure 3):

1) Multipurpose Projects: Siffu No.1 Dam Project, Mallig No.2 Dam Project, Matuno No.1 Dam Project, Alimit No.1 Dam Project and Magat Dam (allocation of flood control space),

2) Flood Control Schemes: Tuguegarao Dike, Cabagan Dike, Narrows Improvement (Nassiping Lower-Left Bank, NLL), Narrows Improvement (Nassiping Lower-Right Bank, NLR), Bank Protection Works,

3) Agricultural Development Schemes: 14 Irrigation Development/ Rehabilitation Schemes, Diversified Crops Development, Permanent Crops Development, and Pasture Land Development,
4) Hydropower Development Schemes: Ibulao, Tanudan, and Diduyon Hydropower Development Schemes.

Total cost for the proposed Master Plan was estimated to be Pesos 33.0 billion (US$ 1,736 million equivalent) at 1987 price level.

18.4 The 1987 Master Plan also proposed a Short-term Plan to be implemented within 10 years. Schemes proposed for the Short-term Plan were selected among the projects in the Master Plan as follows:

1) Multipurpose Dam Projects: Siffu No.1 Dam, Mallig No.2 Dam, and Matuno No.1 Dam projects,
2) Flood Control Schemes: Tuguegarao dike, Narrows improvement (Nassiping Lower-Left bank, NLL), bank protection works and modification of the Magat Dam operation including flood control,
3) Agricultural Development Schemes: Pinacanauan irrigation scheme, Dabubu irrigation scheme, and model developments in the uplands.

**Change in the Cagayan River Basin after 1987 Master Plan**

19.1 A population in the Cagayan River basin was 1.88 million in 1980 and increased to 2.55 million in 1995 according to the national census. Its annual growth rate was 2.07% on average. GRDP of Region 2 was 15.3 billion Pesos in 1985 as presented in the 1987 Master Plan and was 17.5 billion Pesos in 1999 at 1985 constant prices. The 1985 GRDP value had increased by 2.2 billion Pesos or 14% over 13 years. Hence, the regional growth rate was calculated at 1.0% on average, which was considerably lower than the national average growth rate of 3.4%. The agriculture and services sectors increased 1.3 billion Pesos and 1.1 billion Pesos over 13 years, respectively. The industry sector, however, decreased 0.3 billion Pesos over 13 years. Per capita GRDP was 7,225 Pesos in 1985 and 6,441 Pesos in 1998 at 1985 constant prices. It decreased 784 Pesos for 13 years at 1985 constant prices. Its annual growth rate was negative 0.88% on average. This implies that the imbalance in economic development among the regions in the country has been magnified. On the other hand, socio-economic and political disturbances that were observed in the 1987 Master Plan stage seemed to have ceased. Under these circumstances it is appropriate for suits for the implementation of the development projects to proceed.

19.2 There is no remarkable changes or improvement in the river conditions in the recent 10 years. Riverbank erosion due to heavy meandering has been serious problems for the people as before. Serious riverbank erosion sites were identified at 75 sites in the 1987 Master Plan and even now, 73 such sites still exist. Low-lying areas along the Cagayan River have suffered from frequent inundation as serious as ever, especially in the upstream reaches of Alcala. The JICA study in 1987 recommended the implementation of the urgent flood control works as priority projects selected from the said Master Plan to mitigate flood damage in the basin. However, probably owing to budget limitations, less understanding on the real problematic situation and / or less understanding on the necessity of the development, they have not yet been realized.

19.3 In the 1987 Master Plan stage, the forest cover of the Cagayan River basin was 11,528 km$^2$ equivalent to 42.3% of the basin area. The present forest cover is 11,384 km$^2$ equivalent to 41.7% of the basin area. This change in the forest cover implies that the forest area in the basin has gradually decreased. The land collapses as well as severe land erosion caused by the 1990 earthquake resulting in increase of sediment runoff have affected the reservoir capacity of the existing Magat Dam. The accumulated sediment deposition in the reservoir was 188 MCM in 1999, which was substantially more than expected in the design.

19.4 In the Cagayan River basin, paddy and corn productions have increased in comparison with averages in 1982-1984 and in 1998-1999. Recent share to national production is 13.8% for paddy and 14.0% for corn. After completion of several National Irrigation Projects (NIPs) which were under implementation at the time of 1987 Master Plan, any NIP was not completed until now although there are two on-going NIPs. The irrigation area increased slightly from about 210,000 ha in 1987 to about 218,000 ha at present.

**Need of Review of 1987 Master Plan**

20. Around 14 years have passed since the 1987 Master Plan was formulated for the Cagayan River basin. Differences between the projected socio-economic bases of the 1987 Master Plan such as population, GVAs or GRDP and current values have developed during these 14 years. No major flood control projects proposed in the 1987 Master Plan have been implemented. Only 8,000 ha of irrigation area have expanded since the year 1987 in the national irrigation system and communal irrigation system in the basin. Watershed conservation has been recognized as one of the important sectors in the basin development plan. The above mentioned facts meant there was a necessity to review the 1987 Master Plan.

## IV. SOCIO-ECONOMIC FRAMEWORK PLAN

### Projection of Population

21. The future basin populations projected in the years 2000, 2010 and 2020 are 2.84 million, 3.38 million, and 3.79 million, respectively. The respective annual growth rates are 2.22%, 1.75% and 1.13% on average.

### Economic Growth Target and Investment

22. The goal of the Reviewed Master Plan was set as that GRDP per capita in Region 2 attains to the national average, excluding National Capital Region (NCR), by the target year 2020. The economic growth scenario was drawn up on condition that the following economic events are implemented during the planning period. The total investment in the region during the planning period is summarized in the table below.

(Unit: Billion Pesos)

| Item | Investment | | Accumulated Investment | | |
|---|---|---|---|---|---|
| | 2010 | 2020 | 2000-'10 | 2011-'20 | Total |
| 1. Current Projects | 15.2 | 32.4 | 258.8 | 250.1 | 508.9 |
| 2. Special Projects | 20.0 | 33.3 | 141.7 | 267.6 | 409.3 |
| • AFMA | 0.7 | 1.2 | 6.4 | 9.9 | 16.3 |
| • CEZA | 1.6 | 2.7 | 13.3 | 21.9 | 35.2 |
| • Water Resources | 1.6 | 2.7 | 8.6 | 21.7 | 30.3 |
| • Other Capital Formation | 16.0 | 26.6 | 113.4 | 214.1 | 327.4 |
| 3. Total | 35.2 | 65.7 | 400.6 | 517.7 | 918.2 |

Thus, the government should invest approximately 30 billion pesos for water resources development including flood control projects by the target year 2020, in order for the economic level to reach the target per capita GRDP in 2020. Refer to Chapter 4 of the Main Report for details. Notes on the above table are given below.

The Current Projects mean that current investment in the various fields of the public investment is to be continued in the same level as ever. In addition to the current projects, the investment to the special projects such as AFMA, CEZA and water resources development to be proposed in the Reviewed Master Plan should be considered. Other Capital Formation means the private sector investment and other sources which may be expected to be induced following the public investment including those for Special Projects. According to the recent information given by CEZA, the investment thereto might be slowed down to only 50% of the above although it will make possible effort to attain the original scheme. The above required investment amount by category is to be applied flexibly such that if one decreases and the another should be increased.

# V. METEOROLOGY AND HYDROLOGY

## Flood

23. The available rainfall data recorded since the 1987 Master Plan study is very limited, so that it cannot be judged whether the probable flood peak discharges obtained in this Study with the limited additional rainfall data have a higher accuracy than those obtained in the 1987 Master Plan study. Therefore, no change was made to the probable flood runoff obtained in the 1987 Master Plan and all the calculated floods in the 1987 Master Plan are adopted in this JICA Study as well.

The 100-year probable flood peak discharges for a number of base points are as given below.

| Base Point | | 100-year Probable Flood Peak ($m^3/s$) |
|---|---|---|
| BP-1 | River Mouth of Cagayan Main Stream | 21,400 |
| BP-2 | Confluence of Cagayan and Chico (Nassiping) | 21,000 |
| BP-3 | Confluence of Cagayan and Siffu | 25,300 |
| BP-4 | Confluence of Cagayan and Ilagan | 23,500 |
| BP-5 | Confluence of Cagayan and Magat | 14,700 |
| BP-6 | Chico River Mouth | 8,700 |
| BP-7 | Siffu River Mouth | 3,300 |
| BP-8 | Ilagan River Mouth | 9,400 |
| BP-9 | Magat River Mouth | 10,600 |

## Stream Flow

24. Applying the sub-basin divisions as well as the tank model constructed for the 1987 Master Plan, the additional long term naturalized 10-day mean runoff was generated for the period from 1985 to 1998. The generated runoff is combined with the runoff from 1963 to 1984 estimated in the 1987 Master Plan. The following summarizes the annual average runoff for each basin of the major tributaries for 36 years from 1963 to 1998:

| Tributary | Catchment Area ($km^2$) | Annual Average Runoff ($m^3/s$) |
|---|---|---|
| Upper Cagayan River | 6,633 | 289.3 |
| Magat River | 5,113 | 269.8 |
| Ilagan River | 3,132 | 147.1 |
| Siffu Mallig River | 2,015 | 88.2 |
| Chico River | 4,551 | 256.1 |
| Whole Basin | 27,281 | 1,371.6 |

**Water Balance**

25.1 The water balance analysis was conducted with the representative runoff of 5-year probable drought and future water demand. Conditions of the analysis adopted are that 1) river maintenance flow is 0.0046 $m^3/s/km^2$, and 2) percentages of return flow are 30% for irrigation water supply, 100% for hydropower, and 40% for municipal water supply.

The total municipal water source requirement for the year 2020 was projected at 979,000 $m^3$/day (11.3 $m^3$/s) for the study area based on the projected population up to the year 2020. The irrigation water requirement for the year 2020 was estimated to be in a range from 65 $m^3$/s to 377 $m^3$/s.

25.2 The water deficit estimated was the balance of the representative runoff of 5-year probable drought and future water demand, which was computed as the sum of the irrigation water requirement, municipal water requirement and the river maintenance flow. In order to make up the deficit for irrigation water, small-scale dams are required.

**Sediment**

26. The sediment runoff equivalent to soil erosion of 1.5 mm/year was estimated for the whole Cagayan River basin in the 1987 Master Plan. This was retained for the current Study, since no significant difference in the annual sediment runoff is observed between 1987 Master Plan and this Study except the Magat River basin which is discussed in the Watershed Management.

**Riverbed Fluctuation**

27. Simulation analysis of the riverbed fluctuation shows that widening of the Magapit Narrows will not cause any drastic riverbed change in the upstream and downstream of the Narrows.

**Saline Water Intrusion**

28. Hydraulic analysis for saline water intrusion indicates that the tip of salt water wedge for 5-year probable drought runoff cannot reach the Magapit Bridge because of the topographical barrier existing about 22 km upstream from the river mouth. As long as the deepest riverbed elevation is not altered, salinity intrusion length will not be elongated, even if the Magapit Narrows are widened.

**Flood Inundation**

29. A flood inundation analysis was conducted along the Lower Cagayan River from the river mouth to Cabagan. The inundation area was divided into meshes of 1 km × 1 km grid cells. The maximum inundation area, inundation depth and duration

were calculated for each cell for different probable floods. The following shows the maximum inundation area in the reach between the river mouth and Cabagan for each probable flood:

| Probable Flood | 2-Year Flood | 5-Year Flood | 10-Year Flood | 25-Year Flood | 50-Year Flood | 100-Year Flood |
|---|---|---|---|---|---|---|
| Inundation Area ($km^2$) | 350 | 650 | 740 | 810 | 840 | 870 |

# VI. MULTIPURPOSE DAM PROJECTS

## Review of Multipurpose Dam Projects Proposed in 1987 Master Plan

30. All five (5) multipurpose dams proposed in the 1987 Master Plan were formulated to utilize the maximum potential at the respective dam sites. Hence, the physical project features for all dams were retained unchanged from the 1987 Master Plan.

## Reviewed Multipurpose Dam Projects

31. The following is an outline of the five (5) multipurpose dams:

| | Multipurpose Dam | Features |
|---|---|---|
| 1) | Magat Dam | - Rockfill type,<br>- 114 m high, 18 million $m^3$ in embankment volume, 4,160 m in crest length,<br>- 795 million $m^3$ in effective storage volume, 164 million $m^3$ in flood control space,<br>- proposed additional flood control space of 139 million $m^3$,<br>- installed capacity of 360 MW, irrigation area of 95,000 ha, |
| 2) | Siffu No.1 Dam | - Earthfill type,<br>- 58 m high, 1.7 million $m^3$ in embankment volume, 240 m in crest length,<br>- 93 million $m^3$ in effective storage volume including 41 million $m^3$ for supplemental irrigation water supply to Magat Irrigation project, 115 million $m^3$ in flood control space,<br>- installed capacity of 5.4 MW, |
| 3) | Mallig No.2 Dam | - Rockfill type,<br>- 84 m high, 2.4 million $m^3$ in embankment volume, 300 m in crest length,<br>- 545 million $m^3$ in effective storage volume, 112 million $m^3$ in flood control space,<br>- irrigation area of 31,200 ha, |
| 4) | Matuno No.1 Dam | - Rockfill type,<br>- 147 m high, 10 million $m^3$ in embankment volume, 580 m in crest length,<br>- 97 million $m^3$ in effective storage volume,<br>- installed capacity of 180 MW, irrigation area of 12,860 ha, |
| 5) | Alimit No.1 Dam | - Concrete dam,<br>- 89 m high, 0.65 million $m^3$ in concrete volume, 430 m in crest length,<br>- 156 million $m^3$ in effective storage volume,<br>- installed capacity of 12.2 MW, |

## VII. FLOOD CONTROL

### Basic Concept of Flood Control

32. Flood damage mitigation measures consist of structural measures, non-structural measures and supporting measures. Stage-wise development of the flood control projects is contemplated from technical and financial viewpoints aiming at the target year of 2020.

### Framework Plan

33. The framework plan of flood control proposed in the 1987 Master Plan was also applied for the Reviewed Master Plan without modification, because the fundamental relevant characteristics of the Cagayan River and its basin have not changed since the 1987 Master Plan was formulated.

### Reviewed Long-Term Plan

34.1 To cope with flood control problems involved in the basin, the long-term flood control plan proposed in the 1987 Master Plan was reviewed through a comparative study. The target area was the whole Cagayan River basin and its major tributaries. The review was made for a 25-year probable flood as a more economically effective scale for development.

34.2 The identified structural measures in the reviewed plan are shown in Figure 4 and summarized below.

1) Dike embankment
    - In the main Cagayan River
    - In the major tributaries, the Siffu, Ilagan, and Magat Rivers
2) Cut-off channel works
    - In the main Cagayan River at Gabut, San Isidro and Tuguegarao
    - In the Magat, Siffu and Mallig Rivers
3) Bank protection at 73 sites
4) Flood control dams
    - Cagayan No.1 dam
    - Ilagan No.1 dam

The major modification of the long-term plan between the 1987 Master Plan and this Study are as enumerated below.

1) Magapit Narrow Improvement Scheme which had been proposed in the 1987 Master Plan was reviewed in detail by using river cross sections and topographic maps surveyed in this Study. It was concluded that this scheme

showed lower economic efficiency, hence was discarded in the reviewed long-term plan.

2) The Gabut Cut-off Channel and San Isidro Cut-off Channel had been included in the 1987 Master Plan. The Tuguegarao Cut-off Channel was newly proposed in the reviewed long-term plan.
3) Bank protection works were counted for 75 sites in the 1987 Master Plan. In this Study, 73 sites needing bank protection works were identified and included in the long-term plan.

34.3 The non-structural measures to be incorporated in the long-term plan are as follows:

1) Evacuation system including flood forecasting and warning system and evacuation centers, and
2) Resettlement including resettlement area development.

A hazard map was also prepared in terms of flood inundation, riverbank erosion and soil surface erosion for the whole Cagayan River basin.

34.4 The supporting measures to be incorporated in the long-term plan are as follows:

1) Strengthening of funding for flood control works,
2) Strengthening of river administration including organizational improvement and capacity building, and
3) Peoples awareness building.

All these supporting measures are essential for the implementation of flood control projects. However, these supporting measures should be contemplated as a nationwide program separately from this Study since those are related to the nationwide institutional aspects.

## VIII. WATERSHED MANAGEMENT

### Basic Concept of Watershed Conservation Plan

35. The existing problems are decrease of forest area and increase of sediment yield in the upper Magat River basin. The main objectives of the long-term watershed conservation plan are to mitigate flood magnitude and to reduce the sediment yield of the Cagayan River basin, thus to function as a measure of the flood control of the Cagayan River. Components to be incorporated in the plan are reforestation and sabo works, which are common and effective measures for the watershed conservation.

### Long-Term Plan

36.1 The area of required reforestation in the Cagayan River basin was estimated on the assumption that all land over 18% slope, except for present agricultural land, should be covered by forest. The area of the required reforestation for the entire Cagayan River basin was estimated to be 3,188 $km^2$ as illustrated in Figure 5 and summarized below.

| Sub-basins | Land Area over 18% Slope excluding Agricultural Land ($km^2$) | Present Forest Area in Land over 18% Slope ($km^2$) | Proposed Reforestation Area ($km^2$) |
|---|---|---|---|
| Upper Cagayan River basin | 3,657 | 3,266 | 391 |
| Magat River basin | 3,670 | 2,443 | 1,227 |
| Ilagan River basin | 2,389 | 2,371 | 18 |
| Siffu-Mallig River basin | 1,032 | 694 | 338 |
| Chico River basin | 3,832 | 3,249 | 583 |
| Lower Cagayan River basin | 2,380 | 1,749 | 631 |
| Whole Cagayan River basin | 16,960 | 13,772 | 3,188 |

Agro-forestry and rehabilitation of infrastructure are included to ensure peoples' livelihood and attain sustainable reforestation activities. Participation of volunteers is expected in the plantation establishment, maintenance and protection. The reforestation is to be implemented through Community Based Forest Management (CBFM) strategy established by the GOP. The estimated cost for reforestation is Pesos 5 billion.

36.2 The existing Magat Dam faces reservoir sedimentation problem, which has been accelerated by land collapses in the Magat River basin that were caused by the earthquake occurred in July 1990. Urgent sabo works are required in the upstream of the Magat reservoir to extend the lifetime of the Magat Dam reservoir. Sabo dams are considered efficient and the total number of required sabo dams is estimated to be 26. The estimated construction cost is Pesos 5.47 billion.

36.3 Illegal tree cutting and slash-and-burn activities are major problems in terms of forest conservation. An intensive survey on these activities and study of efficient countermeasures should be conducted in order to preserve the existing and future watershed in due consideration of residents' livelihood.

# IX. LAND USE

## Reviewed Land Use Plan

37. Since the 1987 Master Plan was formulated, there have been some changes in such land use as increased agricultural land and decreased grassland. These changes quite conformed to the basic strategy of the GOP that the country has still needs to increase agricultural production by means of retaining or increasing the agricultural areas. Basic concepts for the reviewed land use plan are as follows:

1) Present total agricultural area is to be maintained, though paddy field area is to be increased and cornfield area is to be decreased.
2) Crop production is to be increased through increase of cropping intensity and unit yields.
3) Pastureland is to be increased, while grassland and brushes are to be decreased.
4) Agro-forestry, forest, and built-up areas and others are to be increased.

The reviewed land use plan is shown in Figure 6. In the land use plan, the most important sector for development of the Cagayan River basin is irrigation. The Study, therefore, focused on the irrigation development plan.

## Irrigation Framework Plan

38. Irrigation Framework Plan for the Cagayan River basin is composed of the following.

1) The irrigable area of 475,000 ha is to be fully irrigated, out of which currently non-irrigated area of 257,000 ha is to be newly irrigated.
2) The existing irrigation system is to be rehabilitated and maintained for 100 % or full operation.

## Reviewed Irrigation Long-Term Plan

39.1 There are 38 irrigation projects selected for the irrigation long-term plan with consideration of economic viability of each project as listed below. The proposed irrigation projects are categorized into two groups; one is a group of projects needing flood control project to be implemented simultaneously and another group of projects not needing flood control measures. The locations of the schemes are shown in Figure 7.

| | | |
|---|---|---|
| Irrigation Project affected by Flood | Alcala Amulung West PIP | Pinacanauan RIS |
| | Solana PIS-REP | San Pablo-Cabagan IS |
| | Mamil PIP | Santa Maria PIS |
| | Santa Isabel PIP | Delfin Albano PIP |
| | Damao PIP | Tumauini Reservoir P |
| | Lapogan PIP | Upper Chico RIS |
| | Lulutan PIP | Mallig RIS |
| | Gamu PIP | Nueva Vizcaya Bagabag IS |
| | Enrile PIP | Ilagan PIP |
| | Zinundungan IEP | Napaccu PIP |
| | Lallo West PIP | Tagaran PIP |
| | Nassiping PIP | Reina Mercedes PIP |
| | Magapit PIS (CIADP) | Santo Nino PIP |
| | Iguig-Alcala-Amulung PIS (CIADP) | |
| Irrigation Project not affected by Flood | Upper Ilagan Western Barangay PIP | Bantug PIS |
| | San Agustin PIP | San Mariano PIP |
| | Dibuluan RIP | East Tabacal PIP |
| | Dabubu IP | Debibi Groundwater IP |
| | Rizal IP | Villaverde IP |
| | Lower Chico RIS | |

39.2 Supporting measures recommended for irrigation development are as follows:

1) Continuation and enhancement of on-going agriculture support services including promotion of agrarian reform through CARP by DAR, financial support by Land Bank, promotion of farmers' organization by DA, improvement of infrastructure by DPWH and DA, etc.,
2) Strengthening of supporting system for irrigation system, including strengthening of post-harvest facilities such as drying facilities, farm to market road, rice mill, etc., improvement of micro credit system, enhancement of Irrigator's Association, and so on, mainly by DA, NIA and LGU. As one of the measures for the above, establishment of rural development center is considered as a core of the supporting system, and
3) Enhancement of marketing and transportation system between the National Capital Region (NCR) and the Cagayan River basin. This includes conceivable improvement of the Dalton Pass route by a tunnel and sea route via the Irene Port. The Irene Port is to be developed with the northern coastal area development by CEZA together with DPWH, LGU, DA, and NIA.

# X. REVIEWED MASTER PLAN

## Basic Concept of Cagayan River Basin Development

40.1 Present Socio-economic Situation: Per Capita GRDP in Region 2 was Pesos 20,200 which was equivalent to 55.3% of the National Average of Pesos 36,500 and was in 12th position or 4th lowest among the 15 Regions. This implies that Region 2 is an under-developed or depressed region in the Country. The regional annual average family income in Region 2 was Pesos 86,822 in 1997, which was far less than the national average of Pesos 123,168. When the Water Resources Development Master Plan was formulated in 1987, there were some political disturbances in the Region. Therefore, few of the development projects proposed in the 1987 Master Plan were implemented. At present, there is no political disturbance in the objective area and the mutual agreement on the project implementation has been confirmed through consultation meetings among the National Government and LGUs concerned. This implies that it is now good timing to implement the Master Plan Projects.

40.2 Background/Causes of Under-development: Frequent flooding has occurred in the Cagayan River basin, especially in the lower Cagayan. The recorded maximum flood in the Cagayan basin occurred in 1973, and had an inundation area of 1,860 $km^2$, equivalent to 39.2% of the total irrigable area in the basin. Flood inundation is one of the major causes of the low regional economic development. Other natural calamities, which have affected the area, are earthquake, deforestation, erosion and sedimentation especially in the upstream area. The Workshops conducted identified that the most serious problem encountered in the regional development is low investment and financial constraints. The conclusion of the Workshops was "Insufficient fund ⇒ No comprehensive development Master Plan ⇒ No chance to look for the finance ⇒ No Feasibility Study ⇒ No Project Implementation”. The Workshops also pointed out that the both National Governments and LGUs did not understand and/or ignored the needs of the Development in the Cagayan Valley.

40.3 Need to Socio-economic Development (National Level): The Philippines is not self-sufficient in rice production at present. The DA has forecast for the rice production shortage even in 2010 by 5% of the total demand. More intensive irrigation for rice production is needed to reach self-sufficiency in the country. The Government has a basic policy to realize balanced/equitable development in the country in order to abolish a disparity in economic development among the regions. The under-developed areas, like Region 2, should be given higher priority for development with necessary investment. The Medium-Term Development

Program (MTDP) of the Cagayan Province stated that the target of development for the Cagayan Province is to realize international competitiveness for the agricultural-industry sector.

40.4 Development Potentials: The Cagayan River is the largest river in the Philippines having a land area of 27,281km$^2$. The irrigable area in Region 2 covers 475,000 ha, which contains 218,000 ha of the existing irrigation system (about 45.9% of the total). Remaining areas for irrigation development in Region 2 are 257,000 ha, which is the largest in the country with remaining potential for further development. Those areas are fertile and good for agricultural cultivation. The Cagayan River has plenty of surface water resources. Average runoff at the river mouth is 1,372 m$^3$/s or 43.2 billion m$^3$/year. Water resources developments implemented so far are limited to the Magat Dam and Irrigation Project, Casecnan Diversion Project and other minor small-scale projects. There is still a room to develop the area with such untapped development potential.

40.5 Basic Development Concept: The target year for Master Plan was set at the year 2020. The target Per Capita GRDP in Region 2 in the year 2020 was set to reach the national average excluding National Capital Region with the mutual consent of the Steering Committee for this Study. The poverty incidence should be reduced to 20% at least in the target year 2020. In order to realize this target of Per Capita GRDP, the required investment up to the year 2020 is estimated as shown below (Refer to Item 22, Chapter IV).

| | |
|---|---|
| Current Projects | 508.9 billion Pesos |
| Special Projects | |
| AFMA | 16.3 |
| CEZA | 35.2 |
| Water Resources Projects | 30.3 |
| Other Capital Formation | 327.4 |
| Total | 918.2 |

The Study assumed that allocation of the water resources development fund of Pesos 30.3 billion would be about Pesos 20 billion for flood control, and about Pesos 10 billion for irrigation. Hydropower, watershed management and others are expected to be funded from other sources for current projects, private sector investment, etc. Of the above investment, about 30-40% will be in foreign currency and 60-70% in local currency.

## Review of 1987 Master Plan

41.1 In the review of the 1987 Master Plan, the sectors of flood control, irrigation, watershed management, water supply and power generation, water quality management and river environment management were contemplated.

41.2 In order to select the projects for the Reviewed Master Plan among the candidate projects of the flood control plan and land use plan, seven (7) project packages were constructed combining a multipurpose dam with flood control and irrigation projects relating to the multipurpose dam. The packages were then compared with respect to economy, urgency, equitable development and environment to select the most suitable package.

41.3 Among the five dams proposed in the 1987 Master Plan (Siffu No.1, Mallig No.2, Alimit No.1 combined with Magat Dam and Matuno No.1 Dams), the Siffu No.1 Dam and Alimit No.1 Dam/Magat Dam were selected for packaging because of their high economic viability of 28.3% and 20.7%, respectively. The Matuno No.1 Dam has the highest EIRR of 36.8% among five dams owing to high hydropower generation benefit. However, the Matuno No.1 Dam was not selected for the packaging considering that the country's privatization policy for the power generation sector does not permit the implementation of power-oriented project by public investment. In addition, the present installed capacity in the whole country meets the demand and does not present an urgent need for implementation of the project. The Mallig No.2 Dam was discarded because of its low EIRR of 16.6%.

41.4 The seven packages consist of the Siffu No.1 Dam or Alimit No.1 Dam with flood control and irrigation projects located downstream of the dam. The projects of flood control and irrigation are those identified in the reviewed long-term plan.

41.5 Among the seven packages, the package consisting of the Siffu No.1 Dam and related flood control and irrigation projects has the highest EIRR of 19.7%. The Siffu No.1 Multipurpose Dam is expected to supply water to the part of the irrigation command area of the existing Magat Dam, that presently cannot be supplied because of insufficient supply capacity. The supply of irrigation water from the Siffu No.1 Dam will lead to an increase in agricultural production to the level of the Magat command area. There are no serious environmental issues among seven packages.

41.6 From the result of the study on project packages above and some adjustment of the project to meet the target budget being more or less 30 billion Pesos, the reviewed Master Plan was formulated consisting of the following projects:

1) Multipurpose dam project: Siffu No.1 Dam,
2) Flood control schemes
   a) Dike embankment including revetment, sluice and riverbank tree zone
      - in the main Cagayan river from river mouth to Tuguegarao
   b) Cut-off channel works
      - Gabut, San Isidro and Tuguegarao

c) Bank protection works
   - 21 sites from river mouth to Cabagan in the main Cagayan
   - 52 sites upstream from Tumauini in the main Cagayan, Siffu, Mallig, Ilagan, and Magat Rivers

d) Evacuation system including FFWS and evacuation center

e) Resettlement

f) Strengthening of institution and organization

3) Watershed management schemes

a) Reforestation plan (Reforestation area 3,188 $km^2$)

b) Sabo works plan (26 Sabo dams)

4) Agricultural development schemes

<u>Structural measures:</u>

a) New irrigation / extension schemes (17 schemes with total 54,985 ha)

b) Irrigation rehabilitation / improvement schemes (7 schemes with total 22,506 ha)

c) Diversified crops development (148,400 ha)

d) Permanent crops development (105,100 ha)

e) Pasture land development (152,700 ha)

f) Magat O&M improvement

<u>Supporting measures:</u>

a) Continuation and enhancement of on-going agricultural support services

b) Strengthening of support system for irrigation system

c) Enhancement of marketing and transportation system

d) Establishment of upland development experimental center

5) Hydropower development schemes

a) Ibulao scheme (run-of-river type)

b) Tanudan scheme (run-of-river type)

c) Diduyon scheme with Diduyon dam

d) Matuno No.1 Dam

Total project cost is estimated to be Pesos 31.5 billion for the projects of above item 1), 2) and part of 4). Location of the selected projects in the Reviewed Master Plan is shown in Figure 8.

41.7 Outside the investment amount of Pesos 31.5 billion, it is recommended to implement the following projects:

1) Irrigation projects proposed in the long-term plan other than those included in the Reviewed Master Plan, which are to be implemented by the NIA regular funds,

2) The watershed management projects are to be implemented by the DENR with its regular fund and / or private sector investment,
3) The Alimit No.1 dam and the modification of the Magat Dam operation are to be implemented in order to provide additional flood control space to the Magat dam,
4) Hydropower projects of Ibulao, Tanudan and Diduyon schemes are to be implemented by looking for private sector investment, and
5) The Matuno multipurpose dam project, which is the most prospective dam scheme in terms of EIRR, is to be implemented by private investment.

**Evaluation of Reviewed Master Plan**

42.1 Natural and Physical Environmental Impact Evaluation: In the 1987 Master Plan, environmental evaluation was conducted on 1) Dam Projects, 2) Flood Control Projects and 3) Agricultural Development Projects. In this Study, the watershed management and resettlement area development schemes were added. The environmental evaluation was conducted on those additional schemes as well as the three projects above mentioned.

Dam construction will cause the area of the reservoir to be submerged resulting in the loss of all vegetation and disturbance on migration of some aquatic organisms owing to the disconnection of the special connectivity of the river system. The proposed dam schemes encompass some protection areas. Hence, an EIA study is necessary for dam projects at the feasibility study (FS) stage thereof.

Flood control and agricultural development projects may not bring about source of environmental pollution in principle, however may cause turbid water flow, air pollution and noise in and around the construction sites and transportation routes. These effects, however, will not last but will be confined within the construction phase.

42.2 Social Environmental Impact Evaluation: The flood control projects are planned to contribute or improve social environment such as flood damage mitigation, protection of life and property as a project nature. Therefore, no social environmental adverse impact may be considered in principle. However, there are some issues to be considered. The navigation existing in the lower Cagayan River is so important for the people that river planning should be done in order to prevent or minimize the lowering of the water level of the river to secure existing navigation system. Regarding the existing items of cultural and historical heritage, there will be no impacts on them because of adequate distance between them and the planned projects. There would be no significant impacts on minority tribes along the Cagayan River because they have already been assimilated with the majority people in the Region. However, at the F/S stage of dam construction, a study on minority tribes should be done for social considerations. Dam construction will create a water body, which might act as a source of water-related diseases such as malaria and dengue fever. Thorough vector control and education on environmental health to local people, therefore, should be carried out.

42.3 Economic Evaluation: The projects were evaluated under present socio-economic conditions in general. However, socio-economic conditions will be enhanced in accordance with the economic development scenario by the various target years. In this Study, the projects are evaluated under the enhanced socio-economic conditions, referred to as "under future conditions". The project features of the Reviewed Master Plan and its economic effect in terms of EIRR are summarized below.

| Project | Major work component | Project cost $10^6$ Pesos | EIRR (%) |
|---|---|---|---|
| **A. Multipurpose Dam** | | | |
| 1) Siffu No.1 Dam Project | Purpose: Flood control, irrigation & hydropower<br>Earthfill dam: H=58m, Em.V=1.7 million $m^3$<br>Storage capacity: 93 million $m^3$ irrigation<br>115 million $m^3$ flood control<br>Power: 5.4 MW / 41.1 GWH | 3,172 | 28.3% |
| **B. Flood Control** | | | |
| ***Structural Measures*** | | | |
| 1) Dike embankment | Embankment including revetment, sluice and riverbank tree zone in the Main Cagayan from river mouth to Tuguegarao | | |
| - River mouth ~ Nassiping | L=82.7 km, Em.V=9.3 million $m^3$ | 2,844 | 28.1 |
| - Alcala ~ Tuguegarao | L=57.5 km, Em.V=8.5 million $m^3$ | 2,891 | 27.0 |
| 2) Cut-off channel | | | |
| - Gabut COC | L=0.9km, Ex.V=4.0 million $m^3$ | 1,008 | 16.6 |
| - San Isidro COC | L=2.1 km, Ex.V=7.4 million $m^3$ | 1,722 | 18.8 |
| - Tuguegarao COC | L=6.7 km, Ex.V=17.5 million $m^3$ | 4,662 | 15.0 |
| 3) Bank protection | 73 sites in total | 4,383 | 15.1 |
| - River mouth ~ Cabagan | 21 sites, L=18.8 km, A=514,900 $m^2$ | 726 | 19.2 |
| - Main Cagayan: upstream of Tumauini, Tributaries: Siffu, Mallig, Ilagan, Magat | 52 sites, L=51.9 km, A=931,000 $m^2$ | 3,657 | |
| ***Non-structural Measures*** | | | |
| 1) Evacuation system | | | |
| - FFWS | Improvement of facilities<br>Strengthening of Tuguegarao Sub-center | 242 | 18.0 |
| - Evacuation center | Strengthening evacuation center & DCC | 152 | |
| 2) Resettlement | Number of households 2,776, land acquisition 7,468 ha | 1,185 | - |
| ***Supporting Measures*** | | | |
| 1) Strengthening institution & organization | | 150 | - |
| **C. Watershed Management** | | | |
| 1) Reforestation | Reforestation area 3,188 $km^2$ | 5,000 | 16.3 |
| 2) Sabo works | 26 Sabo dams in Magat River basin | 5,472 | 16.8 |

| | | | |
|---|---|---|---|
| **D. Agricultural Development** | | | |
| ***Structural Measures*** | | | |
| 1) New irrigation/extension | 17 schemes for 54,985 ha | | |
| - By new fund<br>10 schemes / 35,085 ha | Alcala Amulung west PIP | 1,527 | 22.8 |
| | Other 9 schemes | 6,327 | 17.6~<br>25.0 |
| - By NIA regular fund | 7 schemes/19,900 ha | 4,214 | 16.1~<br>18.4 |
| 2) Irrigation rehabilitation & improvement | | | |
| - By new fund | 5 schemes/19,960 ha | 866 | 27.0~<br>37.1 |
| - By NIA regular fund | 2 schemes/2,546 ha | 192 | 27.3~<br>29.0 |
| 3) Diversified crop | 148,400 ha for increase of unit yield | - | - |
| 4) Permanent crop | 105,100 ha for enhancing fruits cultivation | - | - |
| 5) Pasture land | 152,700 ha for cattle grazing | - | - |
| 6) Magat O&M impr't | Improvement of irrigation efficiency | - | - |
| ***Supporting Measures*** | | 1,310 | - |
| **E. Hydropower Development** | | | |
| 1) Ibulao scheme | Run-of-river type, 17 MW, 85 GWH | 1,653 | 26.6 |
| 2) Tanudan scheme | Run-of-river type, 25 MW, 130 GWH | 1,938 | 31.5 |
| 3) Diduyon scheme | Diduyon concrete gravity dam H=111m<br>352 MW, 957 GWH | 26,745 | 26.5 |
| 4) Matuno No.1 Dam project | Rockfill dam, H=147m 180 MW,<br>528 GWH, Irrigation area 12,860 ha | 17,565 | 36.8 |

## Implementation Schedule and Implementing Structure

43.1 Implementation Schedule

The implementation schedule of the Reviewed Master Plan was prepared as presented in Figure 9. The assumed cost disbursement for the Reviewed Master Plan is shown in Table 1.

43.2 Implementing Structure

1) Nature of the Projects
The recommended projects herein are the basin-wide water resources development and management including watershed management, water utilization, flood control, water quality management and river environment conservation. These works extend over many agencies under current administrative arrangements.

2) Implementing Structure of Multi-purpose Projects in the Philippines
There is no unified agency to handle overall water resources development and management in the Philippines. In the case of implementing multi-purpose projects, the following three forms/systems have been adopted to meet to the requirement of the projects.

a) Coordination Committee System
This system may be applied to such projects that may have a

comparatively high level of independence among the individual components and extending over 2-3 agencies only. The Coordination Committee may be formed with mutual agreement among the agencies concerned.

b) Commission System

This system may be applied to such projects that would be rather hard to coordinate among the agencies concerned in the case that the projects are related to many agencies. The Commission under this system has its own staff and budget for project implementation, and may be established with a Presidential Order.

c) Authority System

This system may be applied to such projects that may encompass many factors/purposes with many agencies to be involved, including in the operation and maintenance of the project after its completion. This may be established by an act passed the congress.

3) Implementing Structure of the Reviewed Master Plan Projects

The implementation of the Master Plan is scheduled to start with flood control projects and irrigation projects. At this stage, it is assumed that a Coordination Committee System will be sufficient for implementation. This may be transformed to a Commission System in such time that the projects will be expanded to full-scale development with the other components such as watershed management, water quality management, and river environment management. Furthermore, the implementing system may be reformed to an Authority when the basin-wide economic development will be geared to full-scale economic development, including CEZA and AFMA, which will bring the entire implementation together. This strategy of step-wise transformation of implementing structures was agreed on by the Steering Committee of this JICA Study. Figure 10 shows the proposed organization of the final features of the implementing structure to be established in future.

# Part-III FEASIBILITY STUDY OF PRIORITY PROJECTS

## XI. PRIORITY PROJECTS FOR FEASIBILITY STUDY

### Basic Approach of Feasibility Study

44. The Reviewed Master Plan has proposed the projects in the sectors of a) Flood control, b) Irrigation, c) Watershed management, d) Water supply and power generation, e) Water quality management and f) River environment management. Among the proposed sector projects, flood control and irrigation projects have been given priority for implementation in view of the development policy of the Government, regional economic target and results of the workshops conducted during the Study period.

The Reviewed Master Plan reveals that the flood control projects are prerequisites for the development of the Cagayan River basin, and that the flood control projects of the Lower Cagayan River should be implemented first from the viewpoints of engineering and economical effectiveness.

The Reviewed Master Plan also states that irrigation projects should be given the priority for development of the basin following the flood control projects. Agricultural development is the key industry in the Cagayan River basin as the DA has identified the Cagayan basin as a part of the granary of the country, specifically for rice and corn production. Hence, agricultural development has a very high priority. The Alcala Amulung West Pump Irrigation Project is one of the most promising projects in view of the NIA's development strategy and for effective use of land resources after implementation of the flood control projects.

### Projects for Feasibility Study

45.1 The feasibility study was conducted for the following flood control projects in the Lower Cagayan River. Figure 11 shows the general locations of each flood control project including urgent bank protection works in the Lower Cagayan.

1) Left dike systems in the reach from the river mouth to Nassiping (Mabanguc dike, Catugan dike, Lasam dike)
2) Right dike systems in the reach from the river mouth to Nassiping (Camalaniugan dike, Lal-lo dike, Gattaran dike, Nassiping dike)
3) Left dike systems in the reach from Alcala to Tuguegarao (Alcala-Buntun dike, Enrile dike)
4) Right dike systems in the reach from Alcala to Tuguegarao (Tuguegarao dike, Amulung dike, Iguig dike along national highway)

5) Cut-off channels (COCs) in the reach from Alcala to Tuguegarao (Gabut COC, San Isidro COC, and Tuguegarao COC)
6) Urgent bank protection works at 21 sites in the Lower Cagayan

45.2 The non-structural measures subjected to the feasibility study consist of (1) an evacuation system including the flood forecasting and warning system and evacuation center, and (2) resettlement area development.

45.3 The Alcala Amulung West Pump Irrigation Project (AAWPIP) is the most prospective irrigation development scheme. This project is selected for the pre-feasibility study, as referred to in Figure 11. The pre-feasibility study was conducted based on the topographic map of scale 1/10,000, which was prepared in this Study. This is herein referred to as a pre-feasibility since detailed investigations were not conducted for topographic survey, geological and soil investigations, etc. However, NIA conducted already a feasibility study of a part of this proposed project, which revealed an economic viability of this project supported by detailed investigations even a part of the project area. Hence, it is recommended that this project be implemented as early as possible recognizing that this pre-feasibility study is in a level of a feasibility study.

# XII. PRELIMINARY DESIGN

## Flood Control Projects

46.1 The feasibility study is conducted for all the flood control projects in the Lower Cagayan River identified in the Reviewed Master Plan. The 25-year probable flood is applied for the design of facilities. The location of the 16 proposed river improvement works is shown in Figure 11.

46.2 The design river width is set to be 1.5 to 2.0 km for the design flood of 100-year probable flood in order to avoid difficulty in widening in future.

46.3 The respective components are outlined below.

<u>Left dike systems in the reach from the river mouth to Nassiping</u>

1) Mabanguc dike (10.9 km in long)
2) Catugan dike (7.4 km)
3) Lasam dike (7.0 km)

<u>Right dike systems in the reach from the river mouth to Nassiping</u>

4) Camalaniugan dike (13.1 km)
5) Lal-lo dike (12.9 km)
6) Gattaran dike (6.1 km)
7) Nassiping dike (9.7 km)

<u>Left dike systems in the reach from Alcala to Tuguegarao</u>

8) Alcala-Buntun dike (33.5 km)
9) Enrile dike (12.2 km)

<u>Right dike systems in the reach from Alcala to Tuguegarao</u>

10) Tuguegarao dike (21.3 km)
11) Amulung dike (12.6 km)
12) Iguig dike along national highway (3.2 km)

<u>Cut-off channels in the reach from Alcala to Tuguegarao</u>

13) Gabut COC (0.7 km)
14) San Isidro COC (1.6 km)
15) Tuguegarao COC (5.8 km)

<u>Urgent bank protection works in the Lower Cagayan</u>

16) Urgent bank protection works in the Lower Cagayan (21 sites)

The cut-off channel and the low water channel, from Alcala to Buntun Bridge, are aligned on the right bank side where sound geology exists. The alignment is designed in conformity with the river morphology in the Cagayan Valley.

Major work quantities are estimated as follows:

1) Total excavation volume: 33.3 million $m^3$ of the three cut-off channels
2) Total embankment volume: 18.2 million $m^3$ of the dike
3) Total bank protection area: 306,000 $m^2$
4) Total tree zone area: 1.8 million $m^2$

46.4 The following non-structural measures are studied:

1) Improvement of existing flood forecasting and warning system facilities, Tuguegarao sub-center and disaster management capacity in Tuguegarao in association with Consultancy and Engineering Services. Total cost of 242 million Pesos is estimated.
2) Improvement of evacuation center, strengthening of Disaster Coordinating Councils (DCCs) and people's awareness/capability building. Total cost of 152 million Pesos is estimated.
3) Resettlement area development at 6 sites with the area of 58.7 ha in total.

**Irrigation Project**

47.1 A study of Alcala Amulung West Pump Irrigation Project is conducted at pre-feasibility study level. Total net irrigation area is 7,060 ha consisting of Stage I area of 4,090 ha and Stage II area of 2,970 ha. The NIA performed a feasibility study of 2,120 ha within the Stage I area in 1997. The Stage I area is covered with rain-fed paddy field at present. This area is located rather far from the Cagayan River and has relatively high elevation, hence this area has not suffered from flood damage by a flood with magnitude of 5-year probable flood or so. Stage II area is mainly covered by cornfield at present. This area is located near the Cagayan River and has relatively low elevation, hence this area has suffered from flood damages by a flood with a magnitude of 5-year probable flood. Implementation of Stage II area is to be carried out in concurrence with that of related flood control measures.

47.2 Major facilities of the project include intake and booster pump stations, irrigation and drainage systems, roads, siphons, a tributary cut-off channel and flood dike, and so on.

## XIII. CONSTRUCTION PLAN AND COST ESTIMATE

### Construction Plan and Schedule

48.1 Major construction works required for the Lower Cagayan River Flood Control Project are 1) bank protection works, 2) dikes construction including maintenance roads and tree zones, 3) construction of cut-off channels and 4) related river structures such as culverts and sluices.

Urgent implementation is required for the urgent bank protection works at 21 sites. Planting the riverbank tree zones of 70 km is to be started at an early stage of implementation by LGUs.

48.2 Flood control structural measures are planned to be implemented in 4 phases aiming at the target year of 2020 commencing in the year 2002 in order from river mouth toward upstream, as presented in the table below.

| Phase | Year | Projects |
|---|---|---|
| 1st | 2002-2007 | Urgent bank protection works, Lower Cagayan |
| | | River bank tree zones, Lower Cagayan |
| | | Left and right dike systems, river mouth to Magapit |
| 2nd | 2004-2011 | Left and right dike systems, Magapit to Nassiping |
| | | Amulung dike system |
| | | Gabut cut-off channel |
| 3rd | 2007-2015 | Alcala-Buntun and Iguig dike systems |
| | | San Isidro cut-off channel |
| 4th | 2011-2020 | Tuguegarao and Enrile dike systems |
| | | Tuguegarao cut-off channel |

48.3 The improvement of the evacuation system including flood forecasting and warning system is planned to implement in the 1st Phase. The resettlement area development is planned to implement well in advance in concurrence with the implementation of related structural measures.

48.4 To ensure the construction time schedule and the quality of structures, mechanized construction system should be applied for the construction of the huge amounts of dike embankment of 18.2 million $m^3$ and excavation of 33.3 million $m^3$ for cut-off channels at 3 sites in Gabut, San Isidro and Tuguegarao. The excavated soils in the construction operation are to be used effectively for dike embankments and improvement of low-lying land in the basin.

48.5 The Alcala - Amulung West Pump Irrigation Project is implemented in two (2) stages. Construction of Stage 1 (4,090 ha) is to be executed during the 1st phase, while Stage 2 (2,970 ha) is to be implemented in the 3rd phase. The implementation schedule and annual disbursement of the 1st phase are shown in Figure 12 and Table 2.

## Mode of Construction Execution

49. 1st phase projects include 1) urgent bank protection works, 2) construction of left and right dike systems from the river mouth to Magapit including river bank tree zones, and 3) development of the Alcala-Amulung West Pump Irrigation Project, stage 1. Contractors selected internationally will conduct the construction works in the 1st phase excluding tree zones dividing the works into three (3) contract packages for four (4) years construction period to be started in the year 2004. The LGUs concerned will execute tree zone construction. Financial support by foreign aid would be needed.

## Cost Estimate

50. The project cost in the 1st phase of the Lower Cagayan River Flood Control Project and the irrigation project AAWPIP was estimated as presented in the table below including the structural measures, non-structural measures, and supporting measures:

<u>Flood Control</u>

Unit: million Pesos

| Phase | Construction period | Total | FC | LC |
|---|---|---|---|---|
| 1 | 2003-2007 | 2,786 | 1,448 | 1,339 |
| 2 | 2008-2011 | 2,828 | 1,445 | 1.,383 |
| 3 | 2011-2015 | 4,420 | 2,337 | 2,083 |
| 4 | 2015-2020 | 5,347 | 3,156 | 2,190 |
| Total | | 15,381 | 8,385 | 6,996 |
| US$ equivalent | | 308 | 168 | 140 |

FC: Foreign Currency portion, LC: Local Currency portion

<u>Irrigation</u>

Unit: million Pesos

| Phase | Construction period | Total | FC | LC |
|---|---|---|---|---|
| 1 | 2004-2007 <1 | 1,626 | 763 | 863 |
| 3 | 2011-2015 <1 | 982 | 479 | 503 |
| Total | | 2,608 | 1,242 | 1,366 |
| US$ equivalent | | 52 | 25 | 27 |

Note <1: including rice mill plant and drying yard as supporting measures

## Operation and Maintenance Costs

51. Annual Operation and Maintenance Costs (O&M Costs) for the 1st phase flood control project were estimated at Pesos 7.93 million or US$ 158,600 equivalent covering the structural and non-structural measures. Annual O&M Costs for the irrigation project of stage 1 of the AAWPIP were estimated at Pesos 30.0 million or US$ 600,000 equivalent covering the intake and booster pump stations, irrigation and drainage facilities, and rice mills.

## XIV. IMPLEMENTATION PLAN

### Implementing Organization

52.1 It is planned that the projects are to be implemented by a Coordination Committee System with member agencies of DPWH, PAGASA, OCD, DA, NIA and the respective Local Governments. The DPWH is assumed the superintendent for the overall projects. The proposed organization chart is presented in Figure 13.

52.2 It is assumed that DPWH is the responsible agency for flood control project covering all the project components including the irrigation project. Under this, PMOs will be formed for each of the flood control and irrigation components.

Under the PMO for flood control project, 4 sub-PMOs (Sub-PMO for Lower Cagayan Flood Control, Sub-PMO for FFWS, Sub-PMO for Evacuation System, and Sub-PMO for Resettlement & Livelihood Program) will be formed.

The DPWH will directly manage the structural measures of the river improvement works. The PAGASA will be a leading agency for Sub-PMO for FFWS. The respective LGUs will take the lead in the Sub-PMO for evacuation system, resettlement area development and tree zone construction. Furthermore, for the irrigation project component, Sub-PMOs will be established each for irrigation system development and conducting a livelihood program. The livelihood program will be conducted by all the DPWH, NIA and LGUs, among which LGUs should be the leading agencies.

52.3 Land acquisition, tree zone construction, evacuation system and resettlement area development relating to the flood control project will be implemented by LGUs as a leading agencies, however it should be supported by DPWH and NIA regional Office R-2 in terms of finance and engineering.

## XV. PROJECT EVALUATION

### Natural Environmental Assessment

53. The vegetation clearance accompanying implementation of the projects would disturb the habitat of terrestrial flora and fauna, which may cause the decrease of their population. The Ludong, a vulnerable species of the Cagayan River system, goes downstream during October to December and upstream during February to March. Therefore, turbid water flow and siltation, which may be caused by excavation work, should be minimized during their migration period in particular.

The impacts on air pollution and noise will occur during the construction phase in and around the construction site and along the transportation routes. These impacts will be confined to the construction phase and should be mitigated by consideration of an implementation plan of construction. As a conclusion, the proposed projects will not generate serious negative impacts. Therefore, it is considered that they have an environmental validity.

### Social Environmental Assessment

54. The number of households to be relocated will be 2,766 in total, composed of 343 households for the alignment of the flood control structures and 2,433 households being incorporated in the river area between right and left banks. The irrigation projects will also cause small-scale resettlement with nine (9) households. The consultation meetings were held several times with the LGUs concerned and the staff of the DPWH. The LGUs prepared their preliminary resettlement plans and have principally agreed on the project implementation with the required resettlement of all the affected people within the administrative areas in each LGU. The necessary actions including resettlement area development are to be undertaken by the concerned LGUs in cooperation with DPWH, NIA and the relevant government agencies such as NHA as well as further consultation meetings for understanding benefits and impacts of the projects.

As for other impacts on navigation, fisheries, water rights and public health, the magnitude of effects is considered minimal. On the contrary, the proposed projects will bring about lots of positive impacts such as boosting the local economy accompanied by contracts on construction works and the employment of local laborers.

As a conclusion, the proposed projects have an environmental validity, but further consultation meetings with LGUs and local communities should be held.

## Economic Evaluation

55.1 Flood Control Plan

This F/S adopts the following damage components for project benefits taking account of data availability: (1) direct damages, (2) infrastructure damages and (3) indirect damages. In the study, the project benefits were estimated through the bottom-up estimation method. The flood damages were estimated on the basis of the actual distribution of damageable assets in the flood prone areas and hydrologic analysis of the Cagayan River basin.

The projects are proposed to be implemented in four phases. Flood damages of a 25-year flood for the four phases of implementation are shown in the following table:

(Unit: Billion Pesos)

| Socio-Economic Condition | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Under Present Conditions | 1.4 | 3.3 | 5.5 | 8.4 |
| Under Future Conditions | 4.8 | 10.7 | 17.9 | 27.9 |

Based on the estimates of flood damages, the annual benefits of the respective phases are calculated as shown in the table below.

(Unit: Billion Pesos)

| Socio-Economic Condition | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Under Present Conditions | 0.3 | 0.6 | 1.2 | 2.4 |
| Under Future Conditions | 1.1 | 2.0 | 3.5 | 4.8 |

The economic cost of the respective phases was calculated from the corresponding financial cost applying conversion factors for the respective cost items, as recommended in "ICC Project Evaluation Procedures and Guidelines". They are summarized as follows. The costs of the respective phases are estimated as accumulation from the beginning.

(Unit: Billion Pesos)

| Initial Cost | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Financial Cost | 2.8 | 5.6 | 10.0 | 15.3 |
| Economic Cost | 2.0 | 4.3 | 7.9 | 12.1 |

The EIRR of the respective phases was estimated at 27.1%, 25.4%, 26.8% and 27.3%. Thus, the EIRRs are much higher than the social discount rate of 15%.

For the Phase-1 scheme, a sensitivity test was introduced by varying different aspects of the estimates as follows: a) 5% or 10% higher than the estimated cost, b) 5% or 10% lower than the expected benefit, and c) combination of both aspects at the same time. The EIRRs of all cases exceeded 15%. Thus, the proposed project is sufficiently feasible from an economic point of view.

55.2 Irrigation Development Plan

In irrigation development projects, Alcala-Amulung West Project was proposed for the feasibility study. It is to be implemented in two phases, i.e., Phase1 and Phase 3. The economic annual benefit of the proposed project was estimated at 266 million pesos for Phase 1 and 435 million pesos for the entire project. On the other hand, the economic cost of the project was estimated at 1.12 billion pesos for Phase 1 and 1.89 billion pesos for the entire project, which was converted from 1.57 billion pesos and 2.64 billion pesos in financial terms applying conversion factors. In addition, the O/M cost and the replacement cost for components such as pumping system in every 15 years need for management. The EIRR of the respective phases was estimated at 15.6% for Phase 1 and 15.2% for the entire project. Thus, the proposed project is judged as viable from an economic point of view. Furthermore, the values of crops produced in the project sites will rise in accordance with changes in the international and the domestic markets. When these prospects were included, the EIRRs were calculated at 16.4% for Phase 1 and 16.1% for the entire project. Thus, the economic efficiency is expected to improve in the future.

# XVI. CONCLUSIONS AND RECOMMENDATIONS

## Conclusions and Recommendations

56.1 The Lower Cagayan Flood Control Project, including non-structural measures, and the Alcala-Amulung West Pump Irrigation Project have been attested to meet the National and Local Governments policies for the basin development and been found to be feasible technically, economically and environmentally. Therefore, urgent implementation of these projects, especially the first phase, is recommended. The first phase consists of the following:

1) Flood control structural measures including urgent bank protection at 21 sites, riverbank tree zone for a length of 70 km, left dike system from river mouth to Magapit (17.3 km), and right dike system from river mouth to Magapit (26.0 km),
2) Flood control non-structural measures consisting of improvement of evacuation system including flood forecasting and warning system and evacuation center, and resettlement area development,
3) Alcala-Amulung West Pump Irrigation Project, first stage with a service area of 4,090 ha, and
4) Agricultural supporting measures such as rice mill plant and drying yard.

56.2 Prior to implementation of the proposed Lower Cagayan Flood Control Project and Alcala-Amulung West Pump Irrigation Project, the following actions are to be taken by the agencies concerned:

1) Designation of the river area and flood control area for river administration,
2) Preparation of land use regulation in the river area to allow the people to cultivate for agricultural purpose and promulgation thereof to the public,
3) Preparation of Agreements for the project implementation and signing by the agencies concerned,
4) Survey on land owners in the project area and preparation of land acquisition and compensation programs,
5) Obtaining concurrence of the local people on the implementation of the projects and resettlement,
6) Organizing farmers for implementation of agricultural supporting measures such as rice mill plant and drying yards,
7) Conducting environmental impact assessment,
8) Necessary arrangement for receiving approval for the project implementation such as ECC, ICC clearance, and preparation on Implementation Program,
9) Arrangement of financial support by foreign aid, if necessary, and

10) Prior arrangement of operation, maintenance and management system for the projects be made in advance of the project completion.

56.3 Bank erosions in the middle and upper Cagayan River and the major tributaries are very serious. The DPWH Regional Office R-2 has conducted the feasibility study thereof with the technical assistance of the Study Team. These bank protection works are not included in the proposed first phase works, however it is recommended to implement urgently these bank protection works.

56.4 Implementation of the following economically feasible projects is also recommended, although the budgets of these projects are above the targeted strategic investment amount of 30 billion Pesos, considering allocation of regular budget of the agencies concerned and / or looking for private investment:

1) Watershed management including reforestation of 3,188 $km^2$ and construction of 26 sabo dams,
2) Irrigation projects identified in the Reviewed Master Plan beside the Alcala-Amulung West Pump Irrigation Project,
3) Implementation of dam and hydropower projects such as Alimit No.1 Dam Project including provision of flood control space to the existing Magat Dam, and
4) Implementation of the Matuno multipurpose dam project.

56.5 Taking the long-term view, the following actions by the agencies concerned are recommended to advance the economic development of the Cagayan River basin:

1) Review of Water Code and strict application of the Code,
2) Collection of data and establishment of databases for socio-economic data and technical/engineering data for water resources development,
3) Study on the most appropriate organizational arrangements for implementation of basin water resources development and river management. For this purpose, recommended strongly is to formulate a Master Plan of the Nation-wide Flood Control Project.

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME II

**MAIN REPORT**

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## List of Acronyms

| | |
|---|---|
| A&D | Alienable and Disposable Land |
| ADB | Asian Development Bank |
| AFMA | Agriculture and Fisheries Modernization Act |
| AFMP | Agriculture and Fisheries Modernization Plan |
| AFP | Armed Forces of the Philippines |
| Agromet | Agro-meteorological Station, PAGASA |
| AIT | Asian Institute of Technology |
| AO | Administrative Order |
| APDMC | Asia Pacific Disaster Management Centre |
| ARC(s) | Agrarian Reform Committee(s) |
| ASEAN | Association of Southeast Asian Nations |
| B/C | Benefit-Cost Ratio |
| BAS | Bureau of Agricultural Statistics |
| BDCC | Barangay Disaster Coordinating Council |
| BFP | Bureau of Fire Protection |
| BM | Bench Mark |
| BOC | Bureau of Construction (DPWH) |
| BOD | Bureau of Design (DPWH) |
| BOD | Biochemical Oxygen Demand |
| BOI | Board of Investment |
| BOT | Bureau of Telecommunication |
| BRS | Bureau of Research and Standard, DPWH |
| BSWM | Bureau of Soils and Water Management |
| CAR | Cordillera Administrative Region |
| CARP | Comprehensive Agrarian Reform Program |
| CBFM | Community Based Forest Management |
| CBIS | Community-Based Information System |
| CDA | Cooperative Development Authority |
| CDCC | City Disaster Coordinating Council |
| CENRO | Community Environment and Natural Resources Office |
| CEZA | Cagayan Economic Zone Authority |
| CIADP | Cagayan Integrated Agricultural Development Project |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington Treaty) |
| CLUP | Comprehensive Land Use Plan |
| CPDC | City Planning and Development Coordinator |
| CPDO | City Planning and Development Office |
| DA | Department of Agriculture |
| DA-BFAR | Department of Agriculture – Bureau of Fisheries and Aquatic Resources |
| DAR | Department of Agrarian Reform |
| DBM | Department of Budget and Management |

| | |
|---|---|
| DCC | Disaster Coordinating Council |
| DECS | Department of Education, Culture and Sports |
| DENR | Department of Environment and Natural Resources |
| DFA | Department of Foreign Affairs |
| DILG | Department of the Interior and Local Government |
| DO | Department Order |
| DO | Dissolved Oxygen |
| DOE | Department of Energy |
| DOH | Department of Health |
| DOLE | Department of Labor and Employment |
| DOST | Department of Science and Technology |
| DOT | Department of Tourism |
| DOTC | Department of Transportation and Communication |
| DPWH | Department of Public Works and Highways |
| DSWD | Department of Social Welfare and Development |
| DTI | Department of Trade and Industry |
| ECA | Environmental Critical Area |
| ECC | Environmental Compliance Certificate |
| EIA | Environmental Impact Assessment |
| EIAPO | Environmental Impact Assessment Project Office |
| EIS | Environmental Impact Statement |
| EIRR | Economic Internal Rate of Return |
| EMB | Environmental Management Bureau |
| ENRO | Environment and Natural Resources Office (Provincial Government) |
| EO | Executive Order |
| FIDA | Fiber Industry Development Authority, DA |
| FIRR | Financial Internal Rate of Return |
| GA | Government Agency |
| GDP | Gross Domestic Product |
| GIS | Geographical Information System |
| GOJ | Government of Japan |
| GOP | Government of the Philippines |
| GPS | Global Positioning System |
| GRDP | Gross Regional Domestic Product |
| GVA | Gross Value Added |
| HLURB | Housing and Land Use Regulatory Board |
| HUDCC | Housing and Urban Development Coordinating Council |
| IBRD | International Bank for Reconstruction and Development |
| IEE | Initial Environmental Examination |
| IRA | Internal Revenue Allotment |
| IUCN | International Union for the Conservation of the Nature and Natural Resources |
| JAFTA | Japan Forest Technical Association |

| | |
|---|---|
| JBIC | Japan Bank for International Cooperation (Ex-OECF & EXIM) |
| JICA | Japan International Cooperation Agency |
| LARC | Local Amateur Radio Club |
| LBP | Land Bank of the Philippines |
| LGU(s) | Local Government Unit(s) |
| LTO | Land Transportation Office |
| LWD | Local Water District |
| LWUA | Local Water Utility Agency |
| M/D | Minutes of Discussion |
| MDCC | Municipal Disaster Coordinating Council |
| MGB | Mines and Geo-science Bureau |
| MLUC | Municipal Land Use Committee |
| MM | Minutes of Meeting |
| MMSL | Meters above Mean Sea Level |
| MPDC | Municipal Planning and Development Coordinator |
| MPDO | Municipal Planning and Development Office |
| MTPDP | Medium Term Provincial Development Plan |
| NAAD | Network of Areas for Agricultural Development |
| NAMRIA | National Mapping and Resource Information Authority |
| NAPHIRE | National Post Harvest Institute for Research and Extension |
| NAPOCOR | National Power Corporation (or NPC) |
| NCDPP | National Calamities and Disaster Preparedness Plan |
| NCIP | National Commission on Indigenous Peoples |
| NCR | National Capital Region |
| NDCC | National Disaster Coordinating Council |
| NEDA | National Economic and Development Authority |
| NEPC | National Environmental Protection Council |
| NFA | National Food Authority |
| NGA(s) | National Government Agency (Agencies) |
| NGO(s) | Non-Government Organization(s) |
| NHA | National Housing Authority |
| NIA | National Irrigation Administration |
| NIPAS | National Integrated Protected Areas System |
| NPC | National Power Corporation• or NAPOCOR• |
| NPAAAD | Network of Protected Areas for Agriculture and Agro-industrial Development |
| NPAAD | Network of Protected Areas for Agricultural Development |
| NPV | Net Present Value |
| NSCB | National Statistical Coordination Board |
| NSO | National Statistics Office |
| NTC | National Telecommunication Commission |
| NWRB | National Water Resources Board (Ex-NWRC) |
| O&M or O/M | Operation and Maintenance |

| | |
|---|---|
| OCD | Office of Civil Defense |
| PAGASA | Philippine Atmospheric, Geophysical and Astronomical Services Administration |
| PAMB | Protected Area Management Board |
| PAWB | Protected Area and Wildlife Bureau |
| PCA | Philippine Coconut Authority |
| PCM | Project Cycle Management |
| PCG | Philippine Coast Guard |
| PD | Presidential Decree |
| PDCC | Provincial Disaster Coordinating Council |
| PDMO | Provincial Disaster Management Office |
| PDZ | Permanent Danger Zone |
| PENRO | Provincial Environment and Natural Resources Office |
| PFDA | Philippine Fishery Development Authority |
| PHIVOLCS | Philippine Institute of Volcanology and Seismology |
| PHO | Provincial Health Office |
| PIA | Philippine Information Agency |
| PMO | Project Management Office (DPWH) |
| PMO-MFCDP | Project Management Office - Major Flood Control and Drainage Projects |
| PMS | Presidential Management Staff |
| PNP | Philippine National Police |
| PNR | Philippine National Railways |
| PNRC | Philippine National Red Cross |
| PPA | Philippine Port Authority |
| PPDC | Provincial Planning and Development Coordinator |
| PPDO | Provincial Planning and Development Office |
| PPFP | Provincial Physical Framework Plan |
| PRA | Participatory Rural Appraisal |
| PSWDO | Provincial Social Welfare and Development Office |
| PTA | Philippine Tourism Authority |
| RA | Republic Act |
| RDC | Regional Development Council |
| RDCC | Regional Disaster Coordinating Council |
| RPFP | Regional Physical Framework Plan |
| RRA | Rapid Rural Appraisal |
| RSRDAD | Remote Sensing and Resource Date Analysis Department |
| SAFDZ | Strategic Agricultural and Fisheries Development Plan |
| SRA | Social Reform Agenda |
| SS | Suspended Solid |
| SW | Scope of Works |
| TESDA | Technical Education and Skills Development Authority |
| TOR | Terms of Reference |

## Measurements

<u>Length</u>

| | | |
|---|---|---|
| mm | = | millimeter |
| cm | = | centimeter |
| m | = | meter |
| km | = | kilometer |
| LM | = | linear meter |

<u>Area</u>

| | | |
|---|---|---|
| $m^2$ | = | square meter |
| ha | = | hectare |
| $km^2$ | = | square kilometer |

<u>Volume</u>

| | | |
|---|---|---|
| $cm^3$ | = | cubic centimeter |
| l | = | liter |
| kl | = | kiloliter |
| $m^3$ | = | cubic meter |
| MCM | = | million cubic meter |

<u>Derived Measures</u>

| | | |
|---|---|---|
| m/s | = | meter per second |
| $m^3/s$ | = | cubic meter per second |
| kWh | = | kilowatt hour |
| MWh | = | megawatt hour |
| GWh | = | gigawatt hour |
| PPM | = | parts per million |
| kmph | = | kilometer per hour |

<u>Weight</u>

| | | |
|---|---|---|
| g | = | gram |
| kg | = | kilogram |
| ton | = | metric ton |

<u>Currency</u>

| | | |
|---|---|---|
| PHP | = | Philippine Peso |
| ¥ | = | Japanese Yen |
| US$ | = | US Dollar |

<u>Time</u>

| | | |
|---|---|---|
| sec | = | second |
| min | = | minute |
| hr | = | hour |
| d | = | day |
| y | = | year |

<u>Other Measure</u>

| | | |
|---|---|---|
| % | = | percent |
| $^{o}$ | = | degree |
| $^{o}C$ | = | degree(s) Celsius |
| $10^3$ | = | thousand |
| $10^6$ | = | million |
| $10^9$ | = | billion |

<u>Energy</u>

| | | |
|---|---|---|
| W | = | watt |
| kW | = | kilowatt |

<u>Fiscal Year</u>

January 1 to December 31

# *Part-I*
# *GENERAL*

# CHAPTER 1 INTRODUCTION

## 1.1 Background of the Study

The Cagayan River, which is located in the northeastern part of Luzon Island, is the longest river in the Philippines and drains the country's largest watershed of 27,281 $km^2$ as a single river. The Cagayan River basin experiences heavy rainfall during the rainy season that normally occurs from June to November. Flood inundation is frequent in the lower Cagayan River caused by small flow capacity due to the existence of narrows in the river course.

The flood inundation problem has been the main constraint to the promotion of socio-economic development and improvement of the living conditions of the people in the Cagayan River basin, where the domestic output is heavily dependent on agriculture.

The Medium Term Philippine Development Plan identified some major river systems where flood control infrastructure should be given top priority for implementation, and among these is the Cagayan River basin. However, the Department of Public Works and Highways (DPWH) has constructed only some piecemeal flood control structures such as bank protection and spur dikes due to financial constraint.

The Japan International Cooperation Agency (JICA) conducted the Master Plan Study on the Cagayan River Basin Water Resources Development from 1985 to 1987 (1987 Master Plan). The flood control plan was formulated in the Master Plan including flood control dams, diking systems, improvement of narrow river sections, and bank protection. Immediately after completion of the Master Plan Study, the Philippine Government (GOP) requested the Japanese Government (GOJ) for technical assistance on the Feasibility Study of the Lower Cagayan River Flood Control Project. However, an unfavorable peace and order situation and political instability in the basin prevented commencement of the feasibility study.

The peace and order situation improved and hence GOP again requested GOJ for the assistance. In response to the request, GOJ decided to conduct the Feasibility Study of the Flood Control Project for the Lower Cagayan River (the Study). The Implementing Arrangement on the technical cooperation for the Study was agreed upon between DPWH and JICA on December 17, 1999.

In accordance with the Implementing Arrangement, JICA dispatched the Study Team on March 16, 2000 to undertake the Study in the Philippines.

## 1.2 Objectives of the Study

The objectives of the Study are as follows:

1) to carry out the feasibility study for the flood control project including land use planning in the Lower Cagayan River to improve socio-economic status of the area through mitigation of flood, reduction of flood damages and enhancement of efficient land use, and,
2) to conduct technology transfer to the Philippine counterpart personnel during the course of the Study.

The Study also covers a review of the 1987 Master Plan focusing on flood control, watershed management and land use within the objective areas.

## 1.3 Study Area

The area for the feasibility study of the Flood Control is the lower Cagayan River area. It covers the river course and its riparian area between the river mouth of the Cagayan River and Cabagan. The area for review of the 1987 Master Plan, which was conducted prior to the feasibility study, was the whole Cagayan River basin.

## 1.4 Study Schedule and Activities

The Study covers a review of the Master Plan on the Cagayan River Basin Water Resources Development formulated in 1985 to 1987 (1987 Master Plan) and formulation of a technically, economically and environmentally viable flood control plan in conjunction with a land use plan.

In order to achieve the objectives mentioned above, the overall work schedule of the Study was divided into three phases as shown in Figure 1.4.1 and as summarized below:

(1) First Year of the Study (March 2000 - June 2000)

a) Collection and review of existing data and information
b) Workshop (1)
c) Supplemental survey and investigation
    - Hydrological and hydraulic survey
    - River cross section survey and aerial photography
    - River morphologic survey
    - Flood damage survey
    - Geological survey

- Soil survey
- Material survey
- Land use survey
- Environmental and basic social impact survey

(2) Second Year of the Study (July 2000 - March 2001)

a) Continuation of collection and review of existing data and information

b) Continuation of survey and investigation
   - Hydrological and hydraulic survey
   - River morphologic survey
   - Land use survey
   - Aerial photographic survey including mapping
   - Geological survey
   - Environmental and basic social impact survey
   - Flood damage survey
   - Socio-economic survey
   - Institutional survey

c) Workshops (2) and (3)

d) Supplemental survey on river condition and land use during the dry season

e) Study and analysis
   - Socio-economic study
   - River morphologic study and mapping of flood inundation area
   - Hydrological and hydraulic study
   - Estimation of flood inundation damage
   - Environmental study

f) Formulation of draft flood control plan, draft watershed conservation plan, draft land use plan, and supporting programs

(3) Third Year of the Study (April 2001 - January 2002)

a) Technology Transfer Seminars (1) and (2)

b) Workshop (4)

c) Formulation of flood control plan, watershed conservation plan, land use plan and supporting programs

d) Preliminary design, construction planning, operation and maintenance planning, cost estimate and financial planning

e) Environmental survey and study

f) Project evaluation
   - Economic evaluation
   - Environmental and social evaluation

g) Implementation planning

All the investigations and studies mentioned above have been completed, and all the findings and results of the studies are presented in this Report.

## 1.5 Transfer of Technology

The Study Team has made their efforts to transfer technology on investigation/planning methods and skills as well as the basic data/information required for the planning. During the Works in the Philippines, four methods were applied for the technology transfer, which were on-the-job training, Joint Meetings with the counterparts and the Study Team, Workshops, and Technology Transfer Seminars. The following are brief descriptions of the on-the-job training, the Joint Meetings, the Workshops and the Technology Transfer Seminars:

(1) On-the-job Training

On-the-job training has been provided to each counterpart through day-to-day works. Not only each team member undertook their own investigation responsibilities, but provided the counterpart with guidance on the purpose and procedure of the investigation. In addition, each team member explained to and discussed with the individual counterpart, all activities of the investigation and its results based on the knowledge and experience possessed in each team member's area of expertise.

(2) Joint Meeting

Four Joint Meetings during the First Works, two Meetings in the Second Works and one Meeting in each of the Third and Fourth Works in the Philippines were held in Tuguegarao with the counterparts and the Study Team. The dates and main subjects of the Meetings were as follows:

First Joint Meeting held on March 27, 2000

1) Introduction of the Study Team members and counterparts of DPWH Region 2,
2) Explanation of the Inception Report by the Study Team,
3) Confirmation of undertakings of the GOP including the office space and furniture, and supporting staff, and,

4) Preparation for the First Workshop.

Second Joint Meeting held on April 7, 2000

1) Explanation by the Study Team on the work progress including data collection, field reconnaissance, and investigation and survey, and new findings obtained through preliminary reconnaissance,
2) Reporting by DPWH Region 2 about organization and staffing, work experience, ongoing projects, annual budget, medium-term program, and evacuation and resettlement, and,
3) Confirmation of work schedule and office space, etc.

Third Joint Meeting held on April 25, 2000

1) Reporting by the Study Team on movement of the Study Team members/ counterparts, and progress of data collection, field reconnaissance and investigation and survey,
2) Reporting by DPWH Region 2 on the organization and staffing, work experiences, ongoing projects, short/medium/long-term programs and evacuation and resettlement,
3) Explanation by the Study Team on the overall workflow and workflow for socioeconomic development planning, watershed conservation planning, flood control planning and land use planning,
4) Confirmation on security and work schedule, and,
5) Initiatives by the Counterpart to hold the Joint Meeting at the next time and so forth.

Fourth Joint Meeting held on June 6, 2000

1) Reporting by the counterparts on the progress and problems on the investigation and survey,
2) Reporting by the Study Team on the progress of the Study, and,
3) Explanation about hydrological analysis for the Cagayan River basin.

Fifth Joint Meeting held on August 29, 2000

1) Presentation by the Study Team of work progress and the program for the Second and Third Workshops,
2) Presentation of Ibanag Heritage by the Counterpart, and,
3) Presentation by the Study Team of the present condition of the Cagayan River.

Sixth Joint Meeting held on September 21, 2000

1) Presentation by the Study Team of work progress and the program of the Third Workshop,
2) Presentation of Filipino social norms and values by the Counterpart, and,

3) Presentation by the Study Team of poverty incidence in the Master Plan area.

Seventh Joint Meeting held on January 29, 2001

1) Presentation by the Study Team of work progress and the next study schedule, and,
2) Discussion on the urgent works.

Eighth Joint Meeting held on May 10, 2001

1) Presentation by the Counterparts of the study progress on the urgent works,
2) Explanation by the DPWH Region 2 on operational plan for the Regional Equipment Services, and budget and operational plans of DPWH Region 2.

(3) Workshops

Four Workshops were held within the Cagayan River basin during the First, Second and Fourth Works in the Philippines:

First Workshop in Tuguegarao

In order to introduce the Study to local people and local government officials, the First Workshop was held in Tuguegarao on March 28, 2000. The total number of attendees at the Workshop was 61 persons including Provincial Governors and/or their representatives, Municipality Mayors, DPWH Region 2 Regional Director and its counterpart personnel, and the Study Team members.

The first part of the Workshop was the introduction of the Study to explain the Inception Report to the attendees. The second part covered the participation and problem analyses using the Project Cycle Management (PCM) method. The participation analysis aimed to clarify the task and duties of the participants for the flood control works. The problem analysis was to clarify problems being encountered in flood control and river management.

Second Workshop in Tuguegarao, Santiago and Bayombong

The Second Workshop was held during September 5 to 7, 2000 at three different places of Tuguegarao, Santiago and Bayombong with the same agenda. The purpose of the Second Workshop was hearing opinions of the participants in the different areas on 1) needs/demands/requirements for the river basin development, 2) first priority sector/requirement on the basin development, and 3) problems hampering the implementation of the first priority requirement. Before hearing the opinions, an example of the basin development in Indonesia and an outline of the 1987 Master Plan for the Cagayan River basin were presented by the Study Team for participants’ reference.

The conclusions of the Workshop were that flood control is the first priority in all three areas and that the problems/constraints identified are i) financial constraints, ii) inadequate technology, iii) land acquisition problems, iv) political intervention, v) inadequate information/education/campaign, vi) lack of comprehensive plan, vii) inaccurate and inadequate data for planning. As a result there has been no project implementation.

Third Workshop in Tuguegarao

The Third Workshop was held on October 3, 2000 at Tuguegarao for the purpose of hearing opinions on the problems in implementing the priority projects and solutions to cope with the problems. Participants came from three areas in which the Second Workshop was held, gathered in Tuguegarao and discussed with each other. Before hearing the opinions, the issues being encountered in the ongoing river projects in the Philippines were presented by the Study Team, followed by an introduction of the river management in Japan made by JICA expert of DPWH.

The solutions identified were administrative support, sharing of resources, good governance, transfer of technology, formulation of appropriate plans, advocacy, institutional development and infrastructure support.

Fourth Workshop in Tuguegarao

The Fourth Workshop was held on May 22, 2001 at Tuguegarao for the purpose to discuss "community participation" in the implementation of the flood control projects. The number of attendees was 57 consisting of officials of DPWH Central Office, Regional Offices of the line agencies and LGUs such as Province, City and Municipalities. During the Workshop, all the participants expressed their willingness to implement and participate in the Lower Cagayan Flood Control Project in the parts of land acquisition, resettlement area development and resettlement activities. They were also willing to share the cost within their capacity to pay and technical capability. They asked, on the other hand, for the active support of the National Government since they have insufficient capacity and capability.

(4) Technology Transfer Seminars

First Technology Transfer Seminar in Tuguegarao

The First Technology Transfer Seminar was held on May 25, 2001 at Tuguegarao. The number of attendees was 61 consisting of officials of DPWH Central and Region 2 Offices, Regional Offices of the line agencies, and LGUs. The main subjects were 1) Formulation of the Master Plan, 2) Watershed Conservation, 3) land Use Plan, and 4) Flood Control. These are the main components of the Reviewed Master Plan. In addition to the above, the Provincial Planning and Development Coordinator (PPDC) of the Cagayan Province presented 1) history of the Cagayan Valley, 2) organization and function of the PPDC, 3) Medium-term development plan of the Cagayan Province.

Second Technology Transfer Seminar in Tuguegarao

The Second Technology Transfer Seminar was held on December 11, 2001 at Tuguegarao. The number of attendees was 52 consisting of officials of DPWH Central and Region 2 Offices, Regional Offices of the line agencies, and LGUs. The main subjects were presentation on 1) contents of Draft Final Report, 2) difference between Philippines and Japan, 3) planning of irrigation and drainage projects, 4) culture in the Cagayan River basin, 5) lessons learned by the Cagayanos, and 6) river characteristics.

## 1.6 Final Report

The Progress Report (1) was prepared describing findings and progress of the works made from March 16 to June 23, 2000 in the First Works in the Philippines. The Progress Report (2) was prepared containing all the findings and the progress of the works made by the Study Team and DPWH Counterparts from July 27 to October 14, 2000 during the Second Works in the Philippines. The Interim Report was prepared in March 2001 presenting all the findings of the field investigations and the results of the Study including review of the 1987 Master Plan made by the Study Team and DPWH Counterparts. The Draft Final Report was prepared containing all the study results and presented to the Philippine side during the Sixth Works in the Philippines from December 3 to 17, 2001

The Final Report consists of the Executive Summary, Main Report, Supporting Report and Data Book. The Final Report presents all the findings of the field investigations and the results of the Study including the Reviewed Master Plan and Feasibility Study made by the Study Team and the DPWH Counterparts.

This Main Report comprises Part I: General, Part II: Review of 1987 Master Plan, and Part III: Feasibility Study of Priority Projects.

The Part I of the Main Report covers Chapters 1 to 2. Chapter 1 of the Report presents an introductory description such as background, objectives and area of the Study, overall work schedule and progress and transfer of technology. Chapter 2 gives the present condition of the Cagayan River basin in terms of social, natural and institutional aspects.

The Part II of the Main Report covers Chapters 3 to 10. Chapter 3 outlines the 1987 Master Plan. Chapter 4 gives the study results on socio-economic framework plan. Chapter 5 states results of the hydrological study. Chapter 6 shows multipurpose dam projects to be discussed in the review works of the 1987 Master Plan. Chapter 7, 8 and 9 describe the results of sectoral studies on flood control, watershed management and land use, respectively. Chapter 10 presents the results of a review of the 1987 Master Plan integrating the results of the sectoral studies.

The Part III of the Main Report covers Chapters 11 to 16. Chapter 11 identifies the priority projects for the feasibility study. Chapter 12, 13, 14 and 15 describe the results of preliminary design, construction planning and cost estimate, implementation planning and project evaluation in the feasibility study. Chapter 16 states the conclusions and recommendations.

# CHAPTER 2 CAGAYAN RIVER BASIN

## 2.1 Geographical Location

The Cagayan River basin, of which the catchment area is 27,281 km$^2$, is located in the northeastern part of the Luzon Island. The basin lies between 15°52′and 18°25′ north latitude and between 120°51′ and 122°18′ east longitude. It is bounded in its east, west and south by the Sierra Madre, Cordillera Central and Caraballo-Maparang mountain ranges, respectively. The basin faces the Babuyan Channel in the north.

## 2.2 Socio-economy

### 2.2.1 Administration

The Philippines administratively consist of 16 Regions, namely; National Capital Region (NCR), Cordillera Administrative Region (CAR), Autonomous Region in Muslim Mindanao, and Region 1 to Region 12, although Region 13 was separated from Region 10 and 11 recently. These regions are further divided into provinces, the provinces into cities/municipalities, and the cities/municipalities into barangays. The Cagayan River Basin extends administratively over Region 2, CAR and a small part of Region 4. There are nine provinces in the basin, the total territories of which aggregate to 37,561 km$^2$, as shown in the table below.

| Region | Province | Administrative Area | | Cagayan River Basin | |
|---|---|---|---|---|---|
| | | Land Area (km$^2$) | Number of Munici-palities | Land Area (km$^2$) | Number of Munici-palities |
| Region 2 | Cagayan | 9,003 | 29 | 4,251 | 18 |
| | Isabela | 10,665 | 37 | 8,237 | 37 |
| | Nueva Vizcaya | 3,904 | 15 | 3,301 | 15 |
| | Quirino | 3,057 | 6 | 3,057 | 6 |
| CAR | Apayao | 3,970 | 7 | 598 | 3 |
| | Ifugao | 2,518 | 11 | 2,518 | 11 |
| | Kalinga | 3,078 | 8 | 3,078 | 8 |
| | Mt. Province | 2,097 | 10 | 1,844 | 8 |
| Region 4 | Aurora | 3,239 | 8 | 398 | 4 |
| Total | | 37,561 | 131 | 27,281 | 110 |

The Cagayan River Basin area is estimated at 27,281 km$^2$ in total, accounting for 73% of the provincial territories (37,561 km$^2$). The basin consists of 110 cities/municipalities in nine provinces, including two cities of Tuguegarao in Cagayan Province and Santiago in Isabela Province.

### 2.2.2 Population

According to the 1995 census, the Philippines has a population of 68.3 million. This population increased by 8 million as compared with the 1990 census. During the 1980's, the average growth rate was 2.31% per annum. During the 1990's, however, it accelerated to 2.48% per annum.

In Cagayan River Basin, the census population was estimated at 2.55 million or 3.3% of the national population in the 1995 census year. The average growth rate during the 1980's was 2.25% per annum. During the 1990's, it furthermore slowed down to 1.73%. The basin population by province was estimated as follows.

(Unit: 1000)

| Region | Province | 1980 | 1990 | 1995 |
|---|---|---|---|---|
| Region 2 | Cagayan | 423 | 514 | 562 |
| | Isabela | 832 | 1,047 | 1,127 |
| | Nueva Vizcaya | 227 | 284 | 316 |
| | Quirino | 84 | 114 | 131 |
| CAR | Apayao | 12 | 13 | 14 |
| | Ifugao | 111 | 147 | 150 |
| | Kalinga | 117 | 139 | 156 |
| | Mt. Province | 67 | 79 | 89 |
| Region 4 | Aurora | 5 | 8 | 9 |
| Total | | 1,878 | 2,345 | 2,554 |

The distribution of basin population of 2.55 million in 1995 was 2.14 million or 84% of the basin population in Region 2, 0.41 million or 16% in CAR and 9 thousand or very nearly 0% in Region 4. Thus, Region 2 is said to represent the basin's socio-economic character.

Population density of the country was estimated at 244 persosn/km$^2$ in the 1995 census year. Those of Region 2 and CAR were 101 and 73, ranked at 14 and 15 among 15 regions (excluding Region 13, not existed yet in 1995) in the country, respectively.

In Region 2, a population of 15 years old and over in 1998 was estimated at 1.89 million, accounting for 70% of the total population (2.70 million). Of this population, 69% or 1.293 million people participated in the labor force market as economically active people. 96% of the labor force was employed, so only 4% was un-employed in the labor market. However, it was reported that 22% of employed labor force was underemployed.

In the labor force market in Region 2 in 1998, the agriculture sector absorbed 65% of the total labor force. The industry and service sectors absorbed 6% and 29%, respectively. This labor structure is different from the national one, sectoral distribution of which was 40%, 16% and 44%, respectively. In CAR, the agriculture sector had 58% of the total labor force. Thus, the regional economy in the basin is said to specialize in agricultural production.

### 2.2.3 National and Regional Economy

As mentioned above, the economic condition in the basin is also represented by Region 2. Gross Regional Domestic Product (GRDP) of Region 2 was 54.5 billion Pesos in 1998, in 14th position among 15 regions (excluding Region 13). Per capita GRDP of Region 2 was 20,200 Pesos in the same year, in 12th position among 15 regions, being only 55.3% of per capita GDP in the country. Thus, its present regional contribution to the country seems to be low among the Philippines.

The break-up of the GRDP of Region 2 in 1998 is shown in the table below, comparing with the national GDP. As shown in the table, agricultural production attained the largest share (43%) among the major three economic sectors. It accounted for 5.3% of the national agricultural production. Region 2 records an excess of imports over export in regional trade balance. It implies that Region 2 imports a huge amount of various consumer goods and capital materials from outside of the region, despite the fact that the region exports agricultural products.

(Unit: Billion Pesos at 1998 Current Prices)

| Item | Region 2 | | Philippines | | Share of |
|---|---|---|---|---|---|
| | Value | % | Value | % | Region 2 (%) |
| 1. Agriculture | 23.9 | 43 | 449.9 | 17 | 5.3 |
| 2. Industry | 8.0 | 15 | 841.1 | 31 | 1.0 |
| 3. Services | 23.3 | 42 | 1,376.1 | 52 | 1.7 |
| 4. Total (GRDP/GDP) | 55.2 | 100 | 2,667.1 | 100 | 2.1 |

### 2.2.4 Sectoral Economic Profile

(1) Agriculture Sector

The agriculture sector is a leading industry in Region 2. Gross Value Added (GVA) of the agriculture sector accounted for 51% of GRDP in 1997 and 43% in 1998. In terms of labor force, 65% of gainful workers was absorbed in the agricultural sector in the 1998. Since GVAs of fishery, livestock, and forestry sub-sectors accounted for only 3%, 19% and 1% in the total agricultural product respectively against 73% of crop production in 1998, most of the agricultural activity would rely on crop production.

The major crops in the Philippines are paddy (rice), corn, coconut, sugar cane and banana in order of production value. Paddy production has been kept at the almost same annual production level of around 11 million tons in 1996 and 1997, and 8.6 million tons in 1998. On the other hand, the country needed 6.9 million tons of rice in 1998 for the nearly 70 million population, according to "Food Balance Sheet of the Philippines, January 2000, NSCB". To maintain the self-sufficiency of rice, the paddy production is expected to be 11.5 million tons (6.3 million tons of rice equivalent) in 1996. Thus, the country has to import some amount of rice from the point of view of food balance. In fact, the country has recorded excessive rice imports of tens of thousands of tons since 1994, as shown in the below table.

| Year | Import | | Export | |
|---|---|---|---|---|
| | Quantity (1000 Tons) | Value in CIF (Million US$) | Quantity (1000 Tons) | Value in FOB (Million US$) |
| 1994 | 3 | 0.7 | 0 | 0.0 |
| 1995 | 263 | 75.7 | 0 | 0.0 |
| 1996 | 862 | 294.0 | 0 | 0.0 |
| 1997 | 722 | 211.3 | 0 | 0.0 |
| 1998 | 2,171 | 585.9 | 0 | 0.0 |

Source: Trade Statistics in 1994 to 1998, NSO

The major crops in the region are paddy (rice), corn, tobacco, sugar cane, coconut, mango, and banana in order of production value. The paddy production has been kept the top rank of crop production in the region, which accounted for 1.1 million tons in 1998 or 13.0% of the national production. In addition to rice, the corn production has also been kept in the high position among crops, which accounted for 0.6 million tons or 15% of the national production in the same year. Besides, the region produced 9,000 tons of tobacco in 1998, accounting for 13% of the national production. Thus, the province is specialized as a tobacco producing area.

Among four provinces in Region 2, Isabela and Cagayan Provinces are the major producer in terms of cereal production such as rice and corn. In 1998, they produced 0.930 million tons of paddy against 1.109 million tons in the region, accounting for 84% of the region. They also produced 0.485 million tons of corn against 0.571 million tons in the region, accounting for 85% of the region.

In the fishing industry, fishpond is one of the most vulnerable facilities to flood disaster. In the region, however, inland fishery is in a poor condition as compared with the entire national production. The regional production accounted for only 3% of the national one in 1998. In Cagayan and Isabela Provinces, furthermore, there are no major fishponds. The total fishpond area in the basin was reported as 383 ha in 2000. It accounted for only 19% of the total fishpond areas in the region. The top species of fish from freshwater fishpond was tilapia in Cagayan Province in 2000. In addition, major fishes from fishponds are mudfish, catfish, carp, gourami, etc.

The livestock and poultry industry have received a more important position than inland fishery in the basin. The GVA of this industry accounted for 19% of the GRDP in the region as mentioned before. In Cagayan and Isabela Provinces, there were 277,500 heads of carabao, 106,900 heads of cattle, 465,500 heads of swine, 51,900 heads of goat, 751,600 ducks and 7.64 million chickens in 1998.

In these two provinces, there was an estimated human population of 2.18 million in 1998. Of this population, 65% or 1.42 million people were estimated to get their living from agriculture. The family size was reported as around 5.0 persons per household in 1995. Then, the number of agricultural households in the provinces was estimated at about 280,000, an average holding of livestock and poultry was calculated as 1.0 heads of carabao per family, 0.4 heads of cattle, 1.6 heads of swine, 0.2 heads of goat, 2.7 ducks and 27.0 chickens.

(2) Industry Sector

Within the industry sector in the country, the manufacturing sub-sector contributes the largest share to the national economy, accounting for 22.0% of GDP in 1998. In Region 2, however, its share was 3.7% only in GRDP. In spite of the present small share, the manufacturing industry is expected to fulfill an important economic role in the region in future. In Lower Cagayan River Basin, 94 manufacturing establishments registered with Department of Trade and Industry (DTI) to get licenses for their businesses in 1998. Besides, many informal manufacturers exist in the region. The total number of manufacturing firms including informal firms was estimated at around 1,500 establishments in the basin, according to a NSO staff. In addition, there are five large-scale manufacturers in the region. They are distributed as follows: three manufacturers comprising (i) sugar milling, (ii) wood-wool cement board and (iii) poultry integrated products in Cagayan, one manufacturer of feed milling in Isabela and one corporation of mineral exploration in Nueva Vizcaya. In general, the factories usually have a large property for production, which is damageable and vulnerable to flood disaster.

(3) Services Sector

Within the services sector in the country, the trading sub-sector is considered as the most popular and plentiful industry in the national economy. The trading industry accounted for 13.5% of GDP in 1998. In Region 2, the trading industry accounted for 9.4% of GRDP. In the Lower Cagayan River Basin, 1,200 trading establishments and 383 servicing establishments were registered to DTI for business licenses as of 1998. According to NSO, there were around 3,450 trading establishments including informal firms in Lower Cagayan River Basin in 2000.

(4) Household Economy

Living conditions may be derived sketchily from family income and expenditure. As regards average family income, the regional annual average of 86,822 Pesos in

Region 2 was lower than the national average of 123,168 Pesos in 1997, accounting for 70% national family income. This disparity between national and regional figures is not so serious as that found in the per capita GDP, as discussed in Subsection 2.2.3.

Engel coefficient, which is a rate of food expenditure to total income, is said to characterize destitute living conditions. The lower income family shows a higher coefficient. The coefficient of the regional average was calculated at 51%. It was larger than that of the nation, 44%. Thus, the living condition in the region may be fairly lower than the national average.

Housing expenses of the national average accounted for 24% of the total family expenditure, which is higher than those of the region (18%). This means that the regional level still stays at a stage before the diversified spending stage, although the national level has entered the diversified spending stage and approaches the international level.

(5) Cagayan Economic Zone Authority (CEZA)

The CEZA is the agency mandated to supervise and manage the development of the "Cagayan Special Economic Zone and Freeport (CSEZFP)". The CSEZFP is located at the northeastern part of Region 2. It covers the entire area embraced by the Santa Ana Municipality and the Fuga, Barit and Mabbag Islands in Cagayan Province. The total area of CSEZFP is estimated at around 540 $km^2$.

The projects of CSEZFP include the following major schemes:

On-site developments

a) Rehabilitation of Port Irene through BOT.
b) Administration building of CEZA (almost completed).
c) Radio communication facilities.
d) Sta. Ana Regional Agro-Industrial Growth Center (SARAIGC).
e) Development of an airport in the area.

Off-site developments

a) Access highway completed and major road linkages under rehabilitation.
b) Construction of 200MW power generation plant and 69 kV transmission line.

Other supporting programs

a) Endorsements made for the issuance of patents, mining concessions, leases and certificates of stewardship
b) Provision of skills straining

The CSEZFP projects are expected to stimulate local industry sector especially the agro-industry. It also increases activities in the agriculture sector, which means improved production and productivity, development of the export industry and tourism in the region. This is consistent with the plan to develop Fuga Island as one of the region's tourist destinations.

In addition, the socio-economic impacts below are expected in the regional economy.

a) More employment opportunities.
b) More investment opportunities for both local and foreign investors.
c) Technological advancement and transfer.
d) Agro-industrial development brought about by foreign trade.
e) Global competitiveness.
f) Reduction of poverty incidence.

### 2.2.5 Infrastructure

Infrastructure situation in Region 2 was generally backward from the national average as mentioned in the following sections. In particular, coverage of telephone was quite low as compared with the national average.

(1) Educational Facilities

As of school year 1997-98, educational facilities were enumerated as follows:

| Level | Philippines | Region 2 | Cagayan | Isabela |
|---|---|---|---|---|
| Pre-school | 7,590 | 69 | 17 | 27 |
| Elementary | 37,665 | 2,075 | 674 | 917 |
| Secondary | 6,423 | 252 | 94 | 99 |
| Tertiary | 1,316 | 52 | 19 | 21 |

On the average, the rates of elementary schools to population was 5.2 schools per 10,000 population (37,665 elementary schools per 72.56 million population) in the country according to DECS's (Department of Education, Culture and Sports) information, but 7.7 schools per 10,000 (2,075 schools per 2.70 million) in the Region 2. Thus, the elementary school density per population in the region is larger than that in the national average. In the same manner, the national average of secondary and tertiary schools was 0.88 and 0.16, and the regional average was 0.93 and 0.19. Accordingly, the school density per population in the region was larger than that of the country.

(2) Medical Facilities

Medical facilities consist of hospitals, barangay health stations and rural health units. As of 1997, distribution of these facilities in the Philippines, Region 2 and in the Provinces of Cagayan and Isabela are summarized as follows.

| Facility | Philippines | Region 2 | Cagayan | Isabela |
|---|---|---|---|---|
| Hospital | 1,817 | 81 | 29 | 42 |
| Barangay Health Station | 13,096 | 717 | 204 | 322 |
| Rural Health Unit | 2,405 | 98 | 31 | 38 |

Although hospitals are managed by either public or private entity, other facilities such as barangay health station and rural health unit fall under the jurisdiction of LGUs in general. In the region, there are 38 public hospitals and 43 private hospitals. Rural health unit is usually located in a municipal center and barangay health station is located in a barangay center area or sometimes absorbed in a barangay hall.

In terms of bed capacity of hospitals, the national average was estimated at 1.1 beds per 1000 population. The regional average was estimated at 0.9 beds, referring to the provincial averages of Cagayan and Isabela. The regional condition of medical status appeared backward in terms of bed capacity.

(3) Roads

As of 1999, total length of the existing road in the region was 14,878 km. The road density in the region, i.e., the total length of road to the total land area, was 0.480 $km/km^2$. In Cagayan and Isabela Provinces, there were 4,480 km and 5,870 km of roads respectively. The road density in these provinces was 0.498 $km/km^2$ and 0.551 $km/km^2$, respectively.

| Management | Concrete | Asphalt | Gravel | Earth | Total |
|---|---|---|---|---|---|
| National *1 | 794.1 | 208.5 | 789.1 | 25.0 | 1,816.7 |
| Provincial | 117.7 | 154.5 | 1,397.9 | 34.1 | 1,704.2 |
| Municipal | 201.0 | 39.1 | 625.3 | 323.8 | 1,189.2 |
| Barangay | 246.4 | 10.1 | 5,845.8 | 4,065.3 | 10,167.6 |
| Total | 1,359.2 | 412.2 | 8,658.1 | 4,448.2 | 14,877.7 |

Source: DPWH

Concrete surfaced roads are durable to flood disaster. In the region, the total length of this type of road was 1,359 km or 9% of the total length in 1999. On the other hand, the length of asphalt surfaced roads, which are vulnerable to flood, was 412 km or 3% only.

(4) Water Supply

The coverage of potable water supply systems such as point source, communal faucet or piped supply systems to households was 36% in the country in 1999. In the region, this rate was 71%. The piped water supply system covered around 375,000 households in 1997, accounting for 21% of the total regional households. Taking into account of this situation, the coverage of water supply in the region might be considerably higher than the national average. The coverage in Cagayan Province is higher than the regional average, but that in Isabela Province was slightly lower than the regional average.

(5) Electrification

The electricity supply system is divided into two classes, i.e., (1) generation and primary power transmission, and (2) power distribution and connection services. The primary services are covered by National Power Corporation (NAPOCOR) and the secondary services are covered by individual retailers. They are CAGELCO 1 and CAGELCO 2 in Cagayan Province. In the same manner, they are ISABELCO I and ISABELCO II in Isabela Province, VIZELCO in Nueva Vizcaya Province and QUIRELCO in Quirino Province in Region 2.

In Region 2, all the municipalities have electric distribution system. However, electrification at barangay level and individual connection level were considerably backward, 73% and 70% in 1998 respectively. This electrification situation stands almost the same position as the national average. Most of the houses in urban areas are covered by electricity networks, but the more remote rural houses are not covered by electricity distribution network. In the habitual inundation areas, thus, most of houses in rural areas are not electrified by the systems.

(6) Telecommunications

Telephone service penetration in the region was quite backward from expected levels. This is different from electrification. Telephone density, i.e., the number of connections per 100 persons, was 0.3 in the region. This figure was lower than the national average of 3.5. Incidentally, the regional density in NCR was 14.8. At present, the telephone systems are covered by the three corporations; Philippine Long-Distance Telephone (PLDT), Digitel and ETPI (covering Tuguegarao City only).

On the other hand, cellular phone systems are popular these days in the region. There are three cellular phone companies in Region 2. They are SMART, Globe and Mobiline. The systems are spreading throughout the region.

### 2.2.6 Poverty Incidence

In Region 2, the annual per capita poverty threshold was estimated at 9,880 Pesos in 1997 and 185,800 families were included under this threshold, according to "Cagayan Valley Statistical Yearbook 1999, NEDA Region 2". Then, the poverty family incidence was calculated at 31.6%. This was ranked at the fourth lowest percentage among all regions in the country. The table below shows the regional situation of poverty incidence in the country. Incidentally, CAR was ranked at the eleventh among the regions.

| Area | Annual per Capita Poverty Threshold (Pesos) | Magnitude of Poor Families | Incidence of Poor Families (%) | Order of Incidence |
|---|---|---|---|---|
| Philippines | 11,388 | 4,533,387 | 32.1 | - |
| NCR | 14,360 | 140,793 | 7.1 | 1 |
| CAR | 12,744 | 109,646 | 42.3 | 11 |
| Region 1 | 11,981 | 292,764 | 37.6 | 6 |
| Region 2 | 9,873 | 185,768 | 31.6 | 4 |
| Region 3 | 12,837 | 241,865 | 16.8 | 2 |
| Region 4 | 12,507 | 498,536 | 25.7 | 3 |
| Region 5 | 10,497 | 485,099 | 50.1 | 14 |
| Region 6 | 10,558 | 520,200 | 41.6 | 10 |
| Region 7 | 8,726 | 357,715 | 34.2 | 5 |
| Region 8 | 8,755 | 305,750 | 40.7 | 9 |
| Region 9 | 9,670 | 221,330 | 39.8 | 8 |
| Region 10 | 10,455 | 385,337 | 46.8 | 12 |
| Region 11 | 10,489 | 379,344 | 37.9 | 7 |
| Region 12 | 11,155 | 220,526 | 49.1 | 13 |
| ARMM | 11,214 | 208,714 | 58.6 | 15 |

In the meantime, annual per capita poverty threshold means that an annual per capita income required to be spent to satisfy nutritional requirements and other basic needs. Subsistence incidence indicates more serious conditions in terms of poverty level in the region. The subsistence threshold is only to satisfy nutritional requirements. In Region 2, the subsistence threshold was estimated at 6,985 Pesos in 1997. The subsistence incidence was calculated at 17.8% in Region 2.

## 2.3 Topography and Geology

### 2.3.1 Topography

(1) General

The Cagayan River has its source in the Caraballo-Maparang mountain range and flows to the north. It travels 520 km along the Cagayan Valley, which is formed by the western slope of the Sierra Madre mountain range and the eastern slope of the Cordillera Central mountain range. It flows into Babuyan Channel at Aparri.

The basin area is mostly hilly to mountainous land. According to the topographic data, land with a slope of less than 8% is around 6,600 $km^2$, which has been rather well developed as agricultural land. Hilly land with slopes between 8% and 18% covers about 3,400 $km^2$. Substantial parts of the hilly land are left to be grassland. The remaining 17,300 $km^2$ are mountainous.

Tributaries drain the sloping lands and join the Cagayan River. The Cagayan main river flows from south to north through a flat alluvial plain between the slopes of the valley. The alluvial plain is comparatively narrow when compared with the river channel width. It becomes narrowest at Magapit located around 30 km from the river mouth. Low hills extend up to both river banks at Magapit and the river channel forms a gorge. The narrow river channel that extends about 40 km long upstream from Magapit is called the Magapit Narrows.

(2) Surveys

Survey works were conducted during the Study, which consisted of the aerial photography and mapping, and longitudinal profiling and cross sectioning. The photographs taken cover an area of around 3,000 $km^2$ with a scale of 1/10,000 and around 1,000 $km^2$ with a scale of 1/5,000 in the lower Cagayan River. The maps consist of 1/10,000 maps for an area of about 1,000 $km^2$ between Aparri and Cabagan, 1/5,000 maps for an area of about 300 $km^2$ between Magapit and Tuguegarao, and 1/1,000 maps for a total area of about 35 $km^2$ at Tuguegarao, Magapit and Nassiping. The length of surveyed profiles and number of cross sections are 1) 160 km and 368 sections for the lower Cagayan River, 2) 12.5 km and 28 sections for the Chico River and 3) 12.5 km and 25 sections for the Tuguegarao River. All of these survey results have been used for the Study.

### 2.3.2 Geology

(1) General

Rocks of the Cagayan basin are represented by a thick sequence of pre-Tertiary metamorphic and plutonic rocks. These were uplifted by igneous intrusions during the Late Tertiary and Quaternary. An Oligocene to Pliocene Marine section occupies the main basin area. It is up to 9,000 m thick along the flanks but attains a maximum thickness of over 12,000 m at the center of the basin. The Oligocene section consists of basic lava flows, metamorphosed conglomerate, tuff breccia and tuffaceous sandstone and siltstone. Late Pleistocene to Recent sands, silts, gravels and pyroclastics are found generally in the central basin area and the sequence is entirely non-marine as seen in Figure 2.3.1.

(2) Geotechnical Investigation Result

The geotechnical investigation was carried out in the Nassiping and Magapit Narrows, Tuguegarao and Cabagan.

In the Nassiping and Magapit Narrows, five (5) holes and two (2) holes of 50 m long core drilling with the standard penetration and field permeability tests, respectively, were carried out. The laboratory test of the physical/engineering properties was carried out on the samples taken from the above-mentioned bore holes. The investigation result shows that there is no serious problem for excavations to widen of the river channel, although rock excavation may be by partially blasting as required.

In Tuguegarao, the three (3) core borings of 20 m long each with the standard penetration and field permeability tests were carried out to clarify the foundation conditions for the flood control structures. The laboratory tests of the physical/engineering properties were carried out on the samples taken from the above-mentioned bore holes. The investigation result shows that there is no serious problems for foundations of the prospective flood control structures though the pile foundations may be partially required in the case of some heavy structures.

In each of Tuguegarao and Cabagan, six (6) test pits of 3 m depth each were dug and the laboratory test of the physical/engineering properties was carried out on the samples taken from the above-mentioned test pits. The investigation result shows that the earth materials distributed in the investigated areas are usable for the embankment dikes. Sampling and laboratory tests for the river bed materials were also made at 19 sites between the river mouth and confluence with the Magat River along the Cagayan River.

### 2.3.3 Earthquake

In Northern Luzon, many earthquakes are experienced yearly. The epicenters according to magnitude are shown in Figure 2.3.2. The most significant seismic areas are off the Manila Bay and west coastline; which corresponds to eastward subduction of Manila Trench, and southeastern coast; which corresponds to westward subduction of East Luzon Trench. Relatively fewer earthquakes occur within the Cagayan Valley, but nevertheless of significant intensities. On the whole, intense earthquakes are assumed to be of tectonic origin and rarely of volcanic nature.

A major earthquake occurred in July 16, 1990 about 70 km south from Santa Fe. The epicenter of this earthquake was located at 15.68°N latitude and 121.17°E longitude. The magnitude of this earthquake was recorded at 7.8 on the Richter scale. The earthquake was decidedly of tectonic origin due to readjustments of rock strata within the earth’s crust. This earthquake injured seriously stability of the mountain slopes in the southwestern watershed area and has been causing serious debris sediment problem in the tributaries of the Cagayan River in this area.

## 2.4 Meteorology and Hydrology

### 2.4.1 Meteorology

The climate in the Cagayan River basin consists of two tropical monsoons, i.e. the Southwest Monsoon and the Northeast Monsoon. According to the climate classification by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the climate in the Cagayan River basin falls under Type III. This climate type is characterized by not very pronounced seasons with relatively dry weather condition from November to April while the remaining of the year is noted as wet weather.

The basin average annual rainfall is 2,600 mm. It varies from less than 2,000 mm in the lowland to more than 4,000 mm in the mountainous area. The monthly mean air temperature ranges from 23.1°C in January to 29.0°C in May and the annual mean is 26.4°C at Tuguegarao. High relative humidity is observed in the basin ranging between 70% and 90%. The daily evaporation is 4 mm to 5 mm, and the maximum is recorded in April and the minimum is in December. Summary of the meteorological data is presented in Table 5.2.1.

The major storms which struck the Cagayan River basin result from typhoon and monsoon in the area. In the Cagayan River basin, typhoons normally strike during July to December with about 8 times a year on an average.

A primal portion of annual rainfall is, however, ascribed to the southwest monsoon. This monsoon is caused by the thermal variations of the Asiatic mainland, and accompanies humid air mass to the Cagayan basin.

Seasonal extreme climate variability in the Philippines, including the Cagayan basin, is associated with the El Niño phenomenon. Most recent El Niño phenomenon observed is the years 1997-1998, according to PAGASA. In the past, El Niño occurred in the years 1972-73, 76-77, 82-83, 86-87, 91-94 according to the National Oceanic and Atmospheric Administration (NOAA) of US. As the records indicate, El Niño occurs almost every three years while the duration of the phenomenon varies. As experienced in the past El Niño-related drought events, these adverse impacts will collectively cause a certain amount of disruption to the socio-economic well being of the country.

### 2.4.2 Hydrology

The feather-shaped Cagayan River basin, with its drainage area of 27,281 km$^2$, is bounded by the Sierra Madre Mountains in the east, the Cordillera Mountains in the west and the Caraballo Mountains in the South, as presented in Location Map. It travels 520 km in the Cagayan Valley from the south to north in the northern part of Luzon Island. Since the Cagayan River takes route closer to the Sierra Madre Mountains, the right tributaries are generally of steep slope and small scale.

The major tributaries are the Magat river (5,113 $km^2$), Ilagan river (3,132 $km^2$), Siffu-Mallig river (2,015 $km^2$), and Chico river (4,551 $km^2$). The river bed slope in the main river between the river mouth and Tuguegarao is 1/8,680. Average runoff estimated for these basins in the Study are summarized as follows:

| Tributary | Catchment ($km^2$) | Annual Average Runoff ($m^3/s$) |
|---|---|---|
| Upper Cagayan River | 6,633 | 289.3 |
| Magat River | 5,113 | 269.8 |
| Ilagan River | 3,132 | 147.1 |
| Siffu Mallig River | 2,015 | 88.2 |
| Chico River | 4,551 | 256.1 |
| Whole Basin | 27,281 | 1,371.6 |

In the Cagayan River basin, typhoons normally strike during July to December about 8 times a year on average. Flood occurs during these typhoons which bring abundant rainfall in the basin. Past severe flood disasters occurred in 1973 and 1980. The 1973 flood was assumed with the magnitude of 25 years probability. Recent major typhoons which brought floods in the basin include typhoon Loleng in October 1998 and Rosing in November 1995. On the other hand recent drought occurred at the end of 1997 to the beginning of 1998. According to PAGASA, the drought was estimated to be once in 50 years based on the rainfall data.

Water level gauges were installed at 4 sites in the Study area, Magapit, Nassiping, Iguig and Sta. Maria along the Cagayan River. Observation of water level, discharge, suspended sediment and water quality were also conducted at these stations during the Study.

## 2.5 Present River Condition

In this Section 2.5, the present river conditions as individual characteristics of the Cagayan River are described. Major contents of this section are river system, general features of the present river channel, and river morphology including river geomorphology, meandering and variations of the river channel.

### 2.5.1 River System

The main Cagayan originates in the Caraballo mountain range. Passing through the mountainous areas towards north-northeast, it joins the largest tributary, the Magat on the left bank and the right tributary, Ilagan, in succession. The total basin area of the Cagayan at the confluence with Ilagan is around 15,100 km$^2$. Magat dam is located in the gorge of the upper Magat, having two functions namely, irrigation water supply and hydroelectric power generation.

Just downstream of the confluence with the Ilagan River, it changes its direction towards north-northwest, and flows down through the alluvial plain confined by natural levees, terraces, etc., and reaches Alcala. The Cagayan river channel in this reach especially from Tuguegarao to Alcala meanders violently. The major tributaries in this reach are the Siffu-Mallig in the left bank and Tumauini, Tuguegarao and Pared in the right bank. The total basin area at Alcala is around 21,400 km$^2$.

From Alcala to Magapit, it runs further in a north-northwest direction passing through the valley area in around 30 km long gorge called the Magapit Narrows. Particularly, there exist three bottlenecks at Tupang, Nassiping and Magapit.

In the reach of the Magapit Narrows, the Cagayan river joins its second largest tributary, the Chico on the left bank, and minor tributaries, the Zinundungan the left bank and the Dummon on the right bank. The total basin area of the Cagayan at Magapit is around 27,100 km$^2$.

After passing through the Magapit Narrows, the Cagayan flows through the flat area changing its direction towards the north, and finally discharges into the Babuyan channel at Aparri having the total basin area of 27,281 km$^2$.

Figures 2.5.1 to 2.5.2 show the general basin map and schematic river system of the Cagayan River.

### 2.5.2 General Features of Present River Channel

Figure 2.5.3 shows longitudinal profile, river widths, channel depths and estimated channel carrying capacities of the Cagayan river channel, calculated using the river cross-sections newly surveyed in the year 2000.

Channel features of the Cagayan River are summarized below.

*Average Riverbed Slope*

- River mouth to Magapit Bridge: 1/21,000
- Magapit Bridge to Alcala: 1/10,000
- Alcala to Confluence with the Tuguegarao River: 1/9,000
- Tuguegarao River to Cabagan: 1/7,000

*Low Water Channel Width*

- River mouth to Magapit Bridge: 400 to 2,000 m
- Magapit Bridge to Alcala: 300 to 1,400 m

- Alcala to Tuguegarao: 300 to 1,100 m
- Upstream of Tuguegarao: 300 to 1,000 m

*Mean Depth of Low Water Channel*

- River mouth to Magapit Bridge: 3 to 12 m
- Magapit Bridge to Alcala: 5 to 20 m
- Alcala to Cabagan: 3 to 15 m

*Bankful Carrying Capacity of Low Water Channel*

- River mouth to Magapit Bridge: 9,000 to 25,000 $m^3/s$
- Magapit Bridge to Alcala: 4,000 to 20,000 $m^3/s$
- Alcala to Cabagan: 2,000 to 9,000 $m^3/s$

### 2.5.3 River Morphology

(1) Alluvial Plain formed by Cagayan River

1) General

A river geomorphologic study was made based on satellite image, aerial photographs, topographic maps, and site reconnaissance. A river has the individual characteristics based on its unique natural condition. Also the Cagayan River has peculiar characteristics resulted from prehistoric background through repeated upheavals and lowering ground movement.

Notable geomorphologic features of the Cagayan River are the existence of bottlenecks (constricted sections) in the narrows named as Magapit Narrows stretching for 30 km long and river meanders forming in the upstream reaches especially from Alcala to around Tuguegarao.

2) Characteristics of Alluvial Plain formed by Cagayan River

Geomorphologic survey map of the Cagayan River showing classification of flood prone area is presented in Figure 2.5.4. The geomorphologic classification of the Cagayan River is as follows.

*Mountain, hill and terrace*

*Alluvial plain formed by the Cagayan River*

- Higher alluvial plain
- Lower alluvial plain

*Valley plain formed by tributaries*

*Steep slope, cliff*

*Water surface*

The above lower alluvial plain consists of natural levees, back swamps, former river courses, valley plain, etc. The floodwater is principally discharged through the low water channel and the floodplain is limited by natural levees. Further, inundation area due to floodwaters overflowing from the Cagayan River is confined within the limits of the lower alluvial plain. As the water level in the Cagayan River subsides, the stagnated waters naturally flows back into the main channel. On some natural levees with higher ground elevations, residential areas have been created. Small and low natural levees are occasionally submerged. Likewise the valley plain itself is subject to frequent inundations by the main Cagayan River.

Ground elevations of the higher alluvial plain are sufficiently higher than flood water levels in the main channel. Therefore, lands on the higher alluvial plain have been developed as village areas, and irrigated and rain-fed paddy fields.

Further details and relationship with a river planning is described in ANNEX VI.

(2) Variations of River Channel

Variations of river channel are studied from the plan geometric, and longitudinal and cross-sectional viewpoints based on the topographic maps, aerial photographs, and surveyed cross-sections viewpoints as follows.

1) River Course Shifting

Figure 2.5.5 shows the historical river course shifting of the Cagayan River by using available topographic maps and aerial photographs. Based on the above data, the following can be said.

Active shifting resulted from river meander is caused by fairly gentle water surface slope due to backwater at the bottlenecks in the Magapit Narrows. Upstream and downstream of Iguig, the extent of shifting reached 5 km in distance during the past only 50 years. Such shifting is generally caused not gradually over the years but suddenly or accidentally in the flood times. Except in the above reaches, there is no significant shifting.

2) Variations of Longitudinal and Cross-Sectional Profiles

Figures 2.5.6 and 2.5.7 show longitudinal and cross-sectional variations of the main Cagayan River channel based on available river cross-sections. Variations were studied based on the above two limited sets of data.

According to Figure 2.5.6, the general tendency of the longitudinal riverbed elevations is as follows.

a) River mouth to Magapit Bridge: no significant change
b) Magapit Bridge to Alcala: slightly raised
c) Alcala to Confluence with the Tuguegarao River: slightly raised
d) Confluence with the Tuguegarao River to Cabagan: no significant change

From the above, it can be said that the longitudinal riverbed variation is, as a whole, in equilibrium condition.

3) Variations of Sandbars near River Mouth

Figure 2.5.8 presents variation of sandbars in the lower reach of Cagayan near river mouth by using topographic map and aerial photographs.

According to the figure, it can be said that there is no serious increase of the sandbars in the river channel, although local shifting has been observed. The present conditions at river mouth will be explained in Subsection 2.6.1 Bank Erosion and Sedimentation.

(3) River Meander

To meander is to move aimlessly and idly without fixed direction. Therefore, it is so difficult to control river meander. It is a challenging matter in flood control as well as civil engineering.

1) Meandering Rate

In this study, a meandering rate that indicates sinuosity (S) applied by Kouichi Yamamoto, 1988: Kado Tokuseiron, Public Works Hydraulic Research Paper Vol.2662, was used as an index classifying the degree of river meander.

For the said reach from Alcala to Upstream of Tuguegarao, the meandering rate (S) = actual channel length (km)/ straight-line length (km) was checked for four (4) stages from the year 1950 to 2000 as shown in Figure 2.5.9. High value (S) above 1 means meander, and (S) = 1 means straight river channel.

According to the above figures, (S) has gradually decreased from 2.12 calculated on the maps prepared in 1950 to 1.81 on the aerial photographs newly taken in 2000.

The degree of meandering of the river course in the Cagayan has thus changed to straighter river although it is based on a short period of recent 50 years as described above. For this matter, it could be assumed that an upheaval of the Central Mountains is one of major reasons for the decreased meandering rate and such a tendency could continues in the future. Eventually, the river course in this reach is assumed to move and concentrate eventually towards the present right riverbank line having solid foundation. Further details are explained in ANNEX VI.

2) Other Studies on River Meandering

Some studies on river meandering have been made so far. According to such study results, it can be said that a meandering river is theoretically improved by an increase of the surface water slope in the meandering reach. The surface water slope is actually increased by constructions of floodway or cut-off channel and by widening of low water channel. Further details are explained in ANNEX VI. In conclusion, the following 2 measures are considered practicable to control river meandering.

a) Increase of surface water slope by means of construction of cut-off channel, diversion channel and floodway, and
b) Increase of surface water slope by means of river channel improvement accompanying by widening of the low water channel

3) Example of Decrease of Meandering by Flood Control Works

The following are the 2 typical cases by means of construction of floodway and river channel improvement. Further details are explained in ANNEX VI.

*A: Case of the Agano River by Construction of a Floodway*

The following is a case of the Agano River in Japan, as shown in Figure 2.5.10(A). The Agano River flowing in Niigata Prefecture discharges into Japan Sea. The construction of a floodway decreased the meandering rate, that is, to a straighter channel.

*B: Case of the Mogami River by Channel Improvement with a Confined Dike*

Figure 2.5.10(B) presents historical river course shifting of the Mogami River in Japan. The Mogami River discharges into Japan Sea. In this case, comprehensive and continuous river improvement works with confined dike changed the then meandering river channel to a straighter one.

## 2.6 Flood Damages and Flood Control Projects

In this section, flood damages and flood control projects are described. First, bank erosion, sedimentation, flood inundation, flood damages, etc., are explained. Subsequently, ongoing and proposed flood control or disaster prevention projects are presented in view of structural, non-structural and supporting measures.

### 2.6.1 Bank Erosion and Sedimentation

(1) Bank Erosion

Bank erosion is observed in various places in the basin wide and is one of the serious flood control problems involved in the Cagayan River basin.

Several sites are being exposed to destructive damage. Based on inventory surveys conducted by each district office and the study team, 73 candidate sites were selected as presented in Figure 2.6.1.

The average annual bank erosion rate reaches 10 m in the downstream of Magapit Narrows as estimated at 5 serious bank erosion sites. Similarly, that of the upstream of Alcala erosion reaches 24 m per year as estimated at 4 sites. Annual erosion rates at the sites vary from 28 m to 6 m.

(2) Sedimentation

According to site reconnaissance, it proves that vegetation in the mountainous areas extending on the left side (Cordillera Central Mountains) is poor whereas that on the right side (Sierra Madre Mountains), is relatively rich. In addition, violent landslides caused by a historical earthquake in 1990 are widely observed especially in the upper Magat basin.

1) Upper Cagayan River (Magat Dam Reservoir)

As a result of such natural situation devastated, sediment discharges from the upper watersheds have abruptly being increased especially from those of the left tributaries of the Cagayan. Particularly, a rapid sedimentation in the reservoir impounded by the Magat dam is a challenging matter that cannot be overlooked any longer from a viewpoint of effective water supply for irrigation use.

The Magat dam having a basin area of 4,140 $km^2$ was completed in 1982. The live storage capacity and dead storage capacity of the reservoir were originally 1.2 billion $m^3$ and 300 million $m^3$, respectively. Due to increased sediment discharges from the upper basin, the dead storage capacity of the reservoir has significantly reduced to 112 million $m^3$ from the original space of 300 million $m^3$ during the past 18 years. Annual sediment rate is calculated as 10.4 million $m^3$ against the projected rate of 5.5 million $m^3$.

For the above, to decrease sediment inflow from the upper watersheds is an urgent issue from the viewpoint of effective utilization of the live storage capacity of the reservoir.

2) Middle and Lower Cagayan River

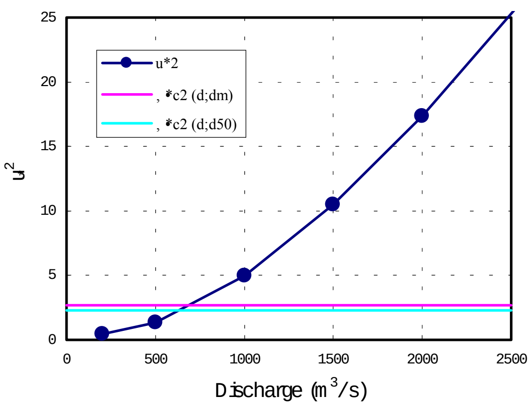
As already explained in Figures 2.5.6 and 2.5.8 in former Subsection 2.5.3, it can be said that the extent of sedimentation in the middle and lower Cagayan is not so serious in view of actual variation and/or variation of sandbars located near the river mouth. In other word, the sediment transport capacity in the middle and lower Cagayan River is in a state of equilibrium although sedimentation can be observed locally at the inlet of the Amulung pumping station and the river mouth of the Appagonan River at Aparri.

3) River Mouth Clogging (block up)

According to the survey results, it can be said that there is no problem with river mouth clogging as explained in the following.

As seen in Figure 2.5.7 of Subsection 2.5.3 showing river cross-sections surveyed in the end of the dry season, cross-sections near the river mouth have sufficient flow area, respectively.

Suspension and wash loads prevail in sediment loads transported in the lower Cagayan River. The following figure shows a relationship between critical shear velocity (initial velocity to move riverbed materials) and river discharge at the river mouth in the Cagayan River. According to the figure, it can be said that in a case of river discharges are less than 500 to 600 $m^3/s$, sediment loads are deposited on the riverbed, and when discharges are more than 500 to 600 $m^3/s$, sedimental loads are flushed out into the sea without deposition.




The sediment loads transported by river discharges that are less than 500 to 600 $m^3/s$ in the dry season are not so much in volume and such sediment loads are easily flushed away by floods in the rainy season. Further details are explained in CHAPTER 1, ANNEX VI.

On the other hand, there exists a spur dike on the right bank of the river mouth. According to site observations, the dike has been functioning in good condition accompanied by a newly created beach in front of the original beach.

### 2.6.2 Flood Inundation

Areas of past flood inundation as well as data on the flood damages and existing disaster management systems were surveyed/ collected by the Study Team. Figure 2.6.2 shows inundation areas by the major floods in the past. The Cagayan river basin has about 1,860 $km^2$ flood prone areas which are presently used as production areas for rice, corn, legumes, and vegetables, according to the data: Integrated Regional Disaster Management, RDCC Region 2.

The flood prone areas of 1,860 $km^2$ were estimated as inundation areas brought by the 1973 flood, the biggest on record.

### 2.6.3 Flood Damages

The disaster damage report issued by the Office of Civil Defense (OCD) Region 2, which is the secretariat of the Regional Disaster Coordinating Council (RDCC) gives the data on the following damages in Region 2 due to recent typhoons and floods:

| | Typhoon ILIANG October 1998 | Typhoon LOLENG October 1998 | Typhoon PEPANG October 1999 |
|---|---|---|---|
| Affected barangays (No.) | 1,367 | 648 | 702 |
| Affected persons (No.) | 925,524 | 417,748 | 186,104 |
| Destroyed houses (No.) | 74,290 | 1,214 | 11,696 |
| Casualties: dead (person) | 36 | 8 | 8 |
| Casualties: injured (person) | 398 | 8 | 14 |
| Casualties: missing (person) | 22 | 4 | 5 |
| Agricultural damage (Pesos) | 1,587,935,930 | 291,539,737 | 273,461,400 |
| Infrastructure damage (Pesos) | 220,500,000 | 198,703,000 | 65,843,000 |

The above agricultural and infrastructure damage values show only the damages to properties and products and do not include opportunity losses such as losses in producing and business activities during suspension period.

Past flood damage reports prepared by the DCC of LGUs have not been kept properly on record by them, except for a few Municipalities.

### 2.6.4 Existing Flood Control Projects (Structural Measures)

(1) Existing Flood Control Projects by DPWH

Tables 2.6.1 and 2.6.2 show the 61 ongoing projects of DPWH Region 2 with a total budget of Pesos 33.1 million and 49 proposed projects with Pesos 93.5 million as of February 2001. The Region 2 Office also has a medium term infrastructure program for the development of national highways, bridges and flood controls for the period from 1999 to 2004 with a total budget of around Pesos 12.46 billion at 1999 price level. On the other hand, there is no ongoing flood control project being assisted by foreign funds as of February 2001.

(2) Existing Flood Control Projects by LGUs

Due to financial constraints, flood control projects by LGUs are limited to a few small-scale riverbank protection works. Aside from financial constraints, the LGUs also report lack and/or insufficiency of capable technical staff for project formulation and preparation of feasibility studies on flood control projects.

Under such circumstances, Table 2.6.3 shows ongoing and proposed flood control projects by the provincial and municipal governments in Region 2 as of February 2001.

Among such proposed projects, it is worthy to note that Tuguegarao City has a proposed flood control project with a total budget of Pesos 111.5 million to be assisted by a foreign loan.

(3) Existing Flood Control Plan by DPWH

The flood control master plan was formulated by JICA in 1987, as one of the components of the Water Resources Development Master Plan. The following CHAPTER 3. 1987 MASTER PLAN explains further details of the plan.

### 2.6.5 Flood Disaster Prevention System (Non-structural Measures)

Disaster action plans and management systems have been established and operated in the Regions, Provinces, City/Municipalities and Barangays. In Region 2, RDCC2 prepared a general plan for typhoons/floods "OPLAN BAGYO/LAYOS" in May 1998. Cordillera RDCC also prepared Cordillera Regional Disaster Management Plan in 1994, which is in the process of revision. The purposes of the disaster action plans are to implement effective disaster preparedness, mitigation and prevention activities to minimize damage to property and human suffering.

Eight committees, which are responsible for communication and warning services, health and medical services, transportation services, welfare and rehabilitation services, price stabilization and security services, relief services, rescue and recovery services, and training services, respectively, have been created under the OPLAN of the Region 2 as presented in Figure 2.6.3.

In the Cagayan River basin, some joint operation on the disaster management is conducted between the RDCC2 and Cordillera RDCC.

The following are present status of the existing flood forecasting system and evacuation system in the Cagayan River basin:

(1) Existing Flood Forecasting System

In the communication and warning services of the OPLAN in Region 2, the Cagayan Flood Forecasting and Warning System is operated by PAGASA. The system consists of Tuguegarao sub-center, 5 rainfall/water level gauging stations and a repeater station as seen in Figure 2.6.4. Among these facilities, 2 water level gauges are not in operation. Repair and improvement of these facilities are required.

The Magat Dam Flood Forecasting and Warning System functions under NIA. The system consists of FFWS center facilities, 5 rain gauges, 2 water level recorders, 2 repeater stations, 15 new warning stations and 7 old warning stations as shown in Figure 2.6.4. Among these facilities, an old warning station is not in operation. Repair and improvement of the facility are required. The warning area is limited to the lower Magat River area between the Magat Dam and Gamu.

(2) Existing Evacuation System

RDCC Region 2 through DSWD and in coordination with the DECS, DOH, LGUs and the religious sectors had identified and designated public elementary and secondary schools, district hospitals, rural health units and churches/chapels in municipalities and barangays adjacent to or near the disaster/flood prone areas as immediate evacuation centers for disaster victims which double as relief distribution centers. The number of the identified evacuation centers is 174 in Cagayan Province, 36 in NuevaVizcaya Province, 56 Quirino Province and 198 Isabela Province.

According to OCD Region 2, the existing problems at the evacuation center are insufficient supply of water and food, and lack of cooking facilities and comfort rooms. The questionnaire survey revealed that the respondents shun away from designated evacuation centers due to lack of these basic facilities. They would rather stay with relatives living at high ground while others prefer to stay home for fear of being looted.

### 2.6.6 Existing Flood Control Supporting Measures

(1) Definition of Supporting measure

Supporting measures are those required for fulfilling functions of structural and non-structural measures and sustain these functions. Supporting measures are closely related to the institutional aspects, such as law and regulation, organization of agencies concerned, budgetary matters, government services, and cooperation by the communities concerned, etc. There are no particular supporting measures for flood control other than disaster management system, which was discussed in the previous subsection.

Given below are the supporting measures currently undertaken in terms of Government services, cooperation by NGOs and private enterprises. Other matters will be discussed in Section 2.12 Institutional Study.

(2) Government Services

Supporting measures for flood control are undertaken principally by the National Government and LGUs. Current services are well functioning in general within available resources, although some strengthening is required. Principal functions of the Governments are enumerated below.

1) National Government

- Project management of flood control structures and its operation and maintenance (by DPWH)
- Flood forecasting and warning information dissemination (by PAGASA and OCD) to LGUs and local communities.
- Disaster preparedness at the emergency case, through Disaster management system so called as the National Disaster Coordination Committee (NDCC) which was explained in the previous section
- Special arrangement of funding allotment in emergency case including arrangement of man-power, equipment, rescue services, food supply, etc. (by respective agencies such as DPWH, PAGASA, OCD, NIA, NPC, DECS, etc.)
- Community awareness building through workshop, consultation meeting, public hearing, etc. (by respective agencies)

2) LGUs (Provincial Government, City / Municipality, Barangay levels)

- LGUs are principal entities for supporting services for flood control activities in disaster management in their administrative areas.

- LGUs have their own calamity fund amounting to 5% of IRA which may be used for emergency cases.
- LGU arranges necessary equipment and materials for emergency activities together with National Government.
- Cooperation / assistance to the National Government to conduct community awareness building

(3) NGOs, Private enterprises and communities

There are many NGOs, which are operating nationwide and / or in local areas, that are actively participating in the disaster management, especially in emergency case. The National Red Cross is one of the representative organizations. Their activities are enumerated below.

1) Preparation of preparedness plan on disaster prevention activities showing their participation on disaster management.

2) Funding support on emergency cases including food and drink supply, etc.

3) Demonstration on disaster prevention activities to the community

4) Preparedness by the communities in Barangay level for emergency

(4) Recommendations by SAPI Study

The SAPI (Special Assistance for Project Implementation) study was carried out in May to August 1999 in accordance with the implementation program agreed upon between DPWH and OECF in March 1999 to recommend the institutional capability building in river sector in the Philippines.

Eight on-going river related projects in the Philippines were selected to clarify problems being encountered, examine causes of the problems and recommend action plans to solve the problems. The principal problems being encountered were enumerated through the SAPI study as follows:

i) Delay of the project implementation,
ii) Difficulty in resettlement of people residing along the river,
iii) Low capability of the contractors,
iv) Delay in the approval processes, and,
v) Opposition by community and/or NGO, etc.

Among the problems on quality, budgetary allocation and construction schedule of the river projects, former two are considered not serious, since appropriate measures have been taken on the quality problems, and OECF provides financial assistance to local currency portion and GOP gives higher priority of local budget appropriation to foreign-assisted projects. Therefore, delay of the construction schedule is the most important and critical problem, say the core problem. The problems enumerated in the above items ii) to v) are regarded as causes of the core problem.

In line with the conceivable scenarios such as 1) preparation of laws and regulations, 2) reorganization of DPWH and 3) human resources development to cope with the core problem and to attain institutional capability building in the river sector, the following short term and long term action plans are proposed in the SAPI study:

<u>Short Term Action Plan</u>

1) Preparation of standard criteria on land acquisition and compensation,
2) Preparation of the standard criteria and procedure for the relocation of squatters,
3) Preparation of the standard criteria for procurement of contractors,
4) Preparation of the check list on actions to be taken prior to requesting for foreign assistance,
5) Strengthening BOD / BOC and other related organizations,
6) Strengthening PMO system,
7) Improvement of TOR for consulting services,
8) Human resources development in possible extent, and,
9) Settlement of the critical works in the on-going projects.

<u>Long Term Action Plan</u>

1) Establishment of comprehensive river basin management system,
2) Re-organization of DPWH,
3) Strengthening Flood Control Management, and,
4) Human resources development.

Finally, the SAPI study recommends immediate implementation of the Short Term Action Plan followed by the Long Term Action Plan, and employment of In-house Consultant.

## 2.7 Present Watershed Condition

### 2.7.1 Watershed Condition

The present forest cover of the Cagayan River basin as estimated is 37% of the total basin area based on the Strategic Agriculture and Fisheries Development Zone (SAFDZ) data of BSWM, or 41% based on the Forest Register (1994) prepared by Japan Forest Technical Association (JAFTA) with the cooperation of DENR, NAMRIA and RSRDAD. The Forest Register also shows that 38% of the total forest area is old-growth forest and 60% is residual forest.

The Land Limitations Map of Region 2 and CAR issued in 1995 by BSWM, which presents erosion condition, shows that the upper Magat, upper Cagayan and upper Chico watersheds are moderate to severe erosion areas with land slope of more than 30%. According to the reconnaissance survey carried out by air and land, less forest cover and denuded areas can be seen in the upper Magat and upper Cagayan watersheds.

In the upper Magat River Basin including the Santa Cruz River, Balilim River and Santa Fe River, issues on land collapses and sediment deposit caused by the earthquake occurred in July 1990 are remarkable. The field survey conducted through interview with the local people residing alongside the rivers revealed the depth of sediment deposited in the river course reached 1 to 6 m after the 1990 earthquake. The above land collapse/sediment as well as severe basin erosion have affected the reservoir capacity of the Magat Dam.

### 2.7.2 Watershed Management Activities

DENR Region 2 has several programs/projects focused on the rehabilitation, development and protection of environmentally and economically critical watersheds in the Cagayan basin. Activities undertaken are establishment of forest plantation, construction of check dams, water impounding dams and bench brush layers, seeding and other similar vegetative and engineering measures. The following are their major activities, of which the locations are shown in Figure 2.7.1:

a) Lipatan watershed rehabilitation project, 850 ha, reforestation,
b) Zinundungan River watershed rehabilitation project, 13,000 ha, reforestation,
c) Dicamay River watershed rehabilitation project, 4,194 ha, reforestation and checkdam construction,
d) Diadi River sub-watershed rehabilitation project, 1,400 ha, reforestation, wattling and checkdam construction,
e) Slope stabilization and protection plan of Dalton Pass section, checkdam construction and brush & seeding works,
f) Upper Casecnan watershed project, 18,268 ha, checkdam construction and reforestation,
g) Kasibu River watershed project, 11,233 ha, reforestation and checkdam,
h) Kirang macro watershed rehabilitation project, 2,600 ha, reforestation, wattling and checkdam construction,

i) Tangliao sub-watershed rehabilitation project, 830 ha, reforestation,
j) Tungcab sub-watershed rehabilitation project, 2,800 ha, reforestation and checkdam construction,
k) Community Based Forest Management Projects (CBFMP), 26 projects in Cagayan, 21 projects in Isabela, 20 projects in Nueva Vizcaya, 32 projects in Quirino (for all Region 2).

DENR CAR has also implemented some projects in the watershed of the Cagayan River such as check dam construction, stone masonry and riprap, and wattling and plantation.

Other government agencies such as NIA, NAPOCOR(NPC), and Local Government Units also worked hand in hand with the DENR in the protection, development and rehabilitation of critical watersheds in the Cagayan River basin as follows:

a) Reforestation by NIA, NPC and DENR for Magat River basin: Areas being reforested and maintained are 2,066 ha by NIA, 1,017 ha by NPC and 1,113 ha by DENR,
b) Watershed development and management for the Casecnan Multi-purpose Irrigation and Power Project (CMIPP) by NIA: Watershed protection, rehabilitation and development,
c) Barobbob Watershed Project (439 ha), Santa Fe Reforestation Project (6,000 ha), Lower Magat Forest Reserve (24,000 ha), and Bangan Hills Reforestation (50 ha) by Nueva Vizcaya Province

Some foreign-assisted watershed management projects were implemented or are ongoing in the Cagayan River basin as follows:

a) Environment and Natural Resources-Sectoral Adjustment Loan Program (ENR-SECAL) in Nueva Vizcaya, Quirino, Cagayan, Isabela, Ifugao, Kalinga, Apayao, and Mt. Province: Project duration of 7 years from 1992 to 1999, Funding agency of World Bank, Activities of local social development, community resources development, infrastructure development, information and education, etc.,
b) Forestry Sector Project (FSP) in Lamut, Mayoyao, Dumayop: Project duration of 7 years from 1993 to 2000, Funding agency of JBIC, Main activities of community organizing and comprehensive site development including tree planting, infrastructure development, etc.,
c) Natural Resources Management Program II–Forest Resources Management Component (NRMP-FRM) in Region 2: Project duration of

7 years from 1995 to 2002, Funding agency USAID, Main activities of CBFM, ancestral domain management, IEC, training, etc.,

d) Philippine-German Community Forestry Project-Quirino (CFPQ): Project duration of 10 years from 1992 to 2001, Funding agency of GTZ and KFW, Activities of agriculture/agroforestry, community forestry, community-implemented infrastructure, etc.,

e) DENR-ITTO (International Tropical Timber Organization) Project at Bayombong, Nueva Vizcaya: The first phase entitled "Plantation Establishment Methods" was implemented from 1995 to 1997 involving the establishment of 16 ha experimental plantation and measurement of growth parameters. The second phase with the title of "Developing Tropical Forest Resources through CBFM" started in July 1998 aiming at 100 ha of new plantation by July 2001 and 3,000 ha of forest protection through CBFM,

f) Conservation of Priority Protected Areas Project (CPPAP) in Northern Sierra Madre Natural Park: Project duration of 7 years from 1994 to 2001, Funding agency of Global Environmental Facility (GEF) thru World Bank, Main activities of forest and biodiversity conservation, and provision of livelihood projects.

g) OISCA (Organization for Industrial, Spiritual and Cultural Advancement) in Karang, Aritao: Main activities of reforestation of 500 ha started in 1993, children's forest program started in 1992,

h) Plan International, Northern Sierra Madre Natural Park Conservation Project: Started from 1996, Financed by the Plan International and Netherlands Government, Project components of livelihood projects and biodiversity research.

### 2.7.3 Existing Watershed Conservation/Management Plans

(1) Government Programs

DENR Region 2 and DENR CAR have respective regional master plan for forestry development. The plan covers forest management and production program, program on man and the environment, institutional development program and implementation program of the regional master plan.

DENR Region 2 has prepared their medium term development plan (1999-2004), that contains forest cover increasing target of 178,500 ha and other programs on vegetative and structural measures.

(2) Preparation of Forest Information in Wide Area and Forest Management Planning in the Republic of the Philippines, JICA, June 1988

The study was conducted by JICA from August 1985 to June 1988 to develop the management plan of the forest resources in the whole Cagayan River basin.

The proposed forest management plan for the entire Cagayan River basin presents the forest management criteria for each of the divided 306 management units. The management criteria were developed by combining the following 5 classifications; a) areas with high potential for natural hazards requiring prohibition of felling for forest protection, b) areas with fairly high potential for natural hazards allowing selective cutting subject to soil conservation, c) areas with low potential for natural hazards permitting clear cutting and afforestation subject to planned management, d) areas with the continuing presence of soil erosion and land hazards requiring active reforestation to prevent hazards, and e) areas with the continuing relative absence of soil erosion and land hazards requiring reforestation stressing soil enrichment.

The forest management plan for the model area provides the technical procedures and guidelines for the effective implementation of the forest management in the model area. In the plan, 6 activities are proposed, which are reforestation, seedling production, timber production, forest road construction, forest conservation, and park/recreation/forest protection.

## 2.8 Present Land Use

### 2.8.1 Present Land Use

(1) Land Classification

Of the Cagayan River basin, approximately a half of the area is more than 400 m above sea level in elevation (Figure 2.8.1). Area with a land slope over 18% covers more than 60% of the basin area as seen in Figure 2.8.2. The flood-prone areas of Region 2 (R-2) are about 186,000 ha within the inundation areas of the Cagayan River and its tributaries in provinces of Cagayan, Isabela and Nueva Vizcaya, in accordance with “Regional Physical Framework Plan (RPFP), 1993-2022, R-2”. Soil survey was carried out on the alluvial plain of about 50,000 ha along the Cagayan River from Alcala to Cabagan including 30 test pitting and 30 auger boring, soil analysis and soil mapping. The mapping results are shown in Figure 2.8.3. Low flat lands in the basin are mostly covered with high fertility soils according to data of BSWM.

According to the latest BSWM data, forest occupies 42%, grassland 31% and agricultural area 25% in the Cagayan River Basin (Figure 2.8.4). After the 1987 Master Plan (1987 MP), agricultural area increased and grassland decreased in the basin.

(2) Agricultural Area

In the Cagayan River basin, present agricultural area of 676,400 ha consists of paddy field (472,500 ha) in gross, corn field (137,300 ha) and other diversified crop fields (66,600 ha). Most of the potentially cultivable area is already used as paddy field, corn field and other diversified crop field. In the Philippines, total irrigation area of national, communal and private irrigation systems in 1999 is reported about 1.34 million ha or 42.7% of total potentially irrigable area of 3.13 million ha (Table 2.8.1).

Based on the National Irrigation Administration (NIA), Central Office (CO) data, irrigable area in the Cagayan River Basin is estimated around 475,000 ha. According to NIA, R-2 data, existing irrigation area in the basin is 218,000 ha or 46% of irrigable area. Corn fields cover lower area near the Cagayan River channel, where inundation occurs more frequently and undulating land surface is not stable in shape due to erosion and sediment.

(3) Grassland, Forest and Others

The grassland covers 849,100 ha, which is derived from BSWM data. The grassland is composed of pasture (103,500 ha), wild grasses (471,400 ha) and brush (274,200 ha). After drastic decrease in 1970s and 80s, the area of forest is comparatively stable in 1990s. Other areas consist of slash-and-burn shift cultivation or “kaingin” (200 ha), artificially developed fishpond (11,900 ha) and built-up areas, etc (52,100 ha). The slash-and-burn cultivation area seems too small according to the site reconnaissance.

### 2.8.2 Problems in Land Use

(1) Geographical Condition

Surrounded by steep mountain ranges, the Cagayan River Basin is rather isolated area because of insufficient transportation system. The main route through Dalton Pass (General Basin Map) was closed down after the Luzon Earthquake in July, 1990. Land slides and temporary closures of Dalton Pass occur commonly in the wet season. So, such closure and isolation may happen anytime.

(2) Mountainous Area

As described in Section 2.7, erosion and land slide bring loss of useful land and road, and also produce sediment causing riverbed heightening and reservoir capacity reduction particularly in the upper Magat basin.

(3) Hilly Area

The hilly areas are also deforested. These areas seem mostly to be underdeveloped and underused, even though they have high potential of livestock industry. One of the reasons is considered to be ineffective use of hilly areas occupied by large land possessors.

The hilly areas do not have sufficient infrastructures, such as road network, water supply system, electricity supply system, and so on.

(4) Plain

Alluvial plains along the Cagayan River and its tributaries are developed as paddy fields and corn fields. However, by frequent occurrence of flood and drought, farming in the plain is vulnerable to damage and unstable. Problems in agriculture are discussed in Subsection 2.8.3.

According to NIA, R-2 office, the most serious problem in irrigation development is insufficient financial sources. Frequent flooding is one of the constraints to extend irrigation systems on the alluvial plain along the rivers, because irrigation facilities could be easily damaged by flood. Flood control measures are essentially necessary for irrigation development on the lower flood plain covered by corn field along the lower Cagayan River. According to NIA, Irrigation System Offices, irrigation water has not reached to a part of the irrigation service area of some National Irrigation Systems (NIS).

### 2.8.3 Present Agricultural Farming Practice

(1) Land Tenure and Agrarian Reform

Total accomplishment of land distribution in the related provinces in the basin is 88% in 2000 to target of 359,300 ha, of which details are presented in Supporting Report.

(2) Agricultural Production

In this section, the Cagayan River Basin is represented by the Master Plan Area (M/P Area) consisting of 8 provinces, namely Cagayan, Isabela, Quirino, Nueva Vizcaya of Region 2 and Kalinga, Apayao, Ifugao and Mountain Province of CAR.

In M/P Area, average production of paddy from 1990 to1999 is 1.40 million metric tons (MT), which correspond to about 0.91 MT in rice or 14% share of the national production. In M/P Area, average production of corn from 1990 to1999 is 0.63 MT or shares 14% of the national production. It is known that rice of several varieties produced in the Cagayan province is highly delicious. More detailed information is described in Supporting Report.

(3) Cropping Pattern

Present cropping pattern is illustrated in Figure 2.8.5.

According to Bureau of Agricultural Statistics (BAS) data, cropping intensity in the M/P Area is estimated at 184% against the physical area of paddy and corn fields. In the irrigated paddy field, the cropping intensity is as high as 195%, while in rainfed paddy field, it is only 127%. Many diversified crops are grown in the rainfed paddy field and corn field as secondary crops.

(4) Irrigation intensity in Region 2

Irrigated cropping intensity (ICI) of 132% in R-2 is calculated as a rate of irrigated area divided by irrigation service area based on NIA, R-2 data. Detailed information is presented in Supporting Report.

(5) Marketing and Processing of Agricultural Products

Region 2 has a large capacity to supply paddy/rice and yellow corn to other areas in the country. According to Office of National Food Authority (NFA) R-2, the target volume to be traded through NFA is approximately 6% of the rice product in the area. The paddy mainly flows to large millers in Isabela, Nueva Ecija, Bulacan and Pangasinan provinces. Then the milled rice is sent to Metro Manila wholesalers.

The major part of the corn is channeled to major demand areas of Central Luzon, Southern Tagalog and National Capital Region (NCR).

(6) Cooperative

According to Cooperative Development Authority (CDA) Tuguegarao Extension Office data in 2000, total number of cooperatives in Region 2 is 2,646, of which 58% are active, 35% are inactive and 7% are cancelled.

(7) Agricultural Credit

Formal and informal financial sources serve as important sources of credit for small-scale farmers in the area. The traders are the main informal source or private financial source of credit to the farmers and playing important role to supplement the shortage of formal credit, though statistical data are not easy to collect.

(8) Problems in Farming

1) Frequent Flood Damage

Along the Cagayan River and its tributaries, relatively lower plain is covered by corn field and higher plain is covered by paddy field. The lower plain experiences flood and inundation frequently or more than once in 5 years but in the higher plain it is not so frequent.

2) Drought and Water Management

In Municipality Quezon, Isabela, drought occurred nearly every 3 years recently, according to a NIS office. Harvested area of paddy field was only 1/6 of planted area in the dry season of 1995. Uneven water distribution is often reported.

3) Insufficient Infrastructure

Due to poor road network, transportation cost is in higher level. Frequent brown-outs due to inadequate and unstable power supply are problematic for poultry raisers, millers operation and so on.

4) Post-harvest Processing and Marketing

Post-harvest loss is reported to be quite high in the Philippines, namely 10-37% in rice, 30% in corn and 40% in vegetables, fruits and others (JICA Report on Aid Research, the Philippines (in Japanese), 1993).

According to information obtained from farmers and officers of the Department of Agriculture (DA), R-2, as well as concerned reports, the problems regarding marketing and post-harvest activities in the area are as follows.

(i) deficit of working capital and insufficient financing system,
(ii) poor condition of farm to market roads and insufficient bridges,
(iii) shortage of labor for harvesting,
(iv) shortage of truck, hand tractor and tractor
(v) lack of thresher, sheller, drying floors, mechanical dryers, warehouse and mill,
(vi) low price of products (small farmers are forced to sell their product to traders at a lower price because of their need for cash and their credit-marketing tie-up with trader-financier),
(vii) high price of inputs.

5) Cooperative and Information System

The problems identified by CDA for the cooperatives are; poor attendance to committee meetings, poor implementation of policies, lack of cooperation or no enrichment of values, and insufficient capital.

Information on market price in the milling and demand areas is not sufficient for the farmers in the basin.

### 2.8.4 Poverty in Rural Area

(1) Low Net Return and Rice Cartel Issue

Existence of agricultural input and product cartel is pointed out commonly by local people and in some reports and documents, while rice traders usually deny the existence. It is broadly believed that agricultural input trader cum product buyer cum financier control market price, setting high input price and low product price.

(2) Loose Connection in Rural Society Members

It is reported that village/barangay people are relatively loosely connected to one another, which is a constraint to organizing farmers. Their willingness to have farmers cooperative seems not so strong in general.

(3) Vicious Cycle in Lower Cagayan River Area

The Study Team summarized poverty related items and problems on farmer's livelihood as a vicious cycle in the Lower Cagayan River area as shown in Figure 2.8.6. Basically the same items in (5) below are common problems here.

(4) Inter-regional Disparity

Isabela and Cagayan provinces are main paddy and corn producing and supplying area. In terms of agriculture, Isabela province is more modernized than Cagayan province. Cagayan province has disadvantageous location with farther distance to transport product through Dalton Pass. Details are in Supporting Report.

(5) Poverty Alleviation

Poverty alleviation is discussed in Subsection 4.3.4.

Countermeasures needed are summarized as below.

1) small financing system for small farmers with reasonable interest and simple and quick procedure,

2) transportation network reinforcement, including farm to market road, bridge and sea route via Port Irene or Aparri.

3) mechanization, including truck, hand tractor, tractor, harvester, etc.

4) improvement of post-harvest facilities: thresher, sheller, drying floors, mechanical dryers, warehouse and mill,

5) promotion of farmers' organization,

6) generation and rehabilitation of irrigation area

7) flood control and drainage improvement

### 2.8.5 Existing Land Use Plan

(1) Land Use Plan

In available PPFPs of related provinces and RPFPs of Region 2 and CAR, specific and concrete plan cannot be found on industrial, commercial and other sectors.

(2) Agricultural Development Plan

1) Crop Production Programs' Coverage Area

The Region 2 is recognized as one of the important granary of the country. The Cagayan, Isabela, Nueva Vizcaya and Quirino provinces of Region 2, and Mountain Province, Kalinga, Apayao and Ifugao provinces of CAR have been covered within the target area of the "Agrikultrang Makamasa" Rice program by DA. In the corn program of DA, provinces of Cagayan, Isabela, Nueva Vizcaya, and Quirino have been targeted as the strategic areas of Region 2.

2) Agriculture and Fisheries Modernization Act (AFMA)

The AFMA is established to realize the purposes listed below. It is led by both agencies of Department of Agriculture (DA) and Department of Agrarian Reform (DAR).

a) Along the government thrust on food security, measures to modernize the agriculture and fisheries sectors in order to enhance their profitability are being spelled out in AFMA.
b) Through AFMA, the agriculture and fishery sectors are being developed for global competitiveness under an environment of

adequate, focused and rational delivery of necessary support services.

c) The agriculture and fishery sector will be transformed from a resource base to technology-based industry.

The AFMA includes the following programs and projects: (a) credit assistance, (b) irrigation and water management, (c) marketing services, (d) national information network, (e) post-harvesting facilities, (f) farm-to-market roads, (g) regulatory services, (h) human resource development, (i) research and development, (j) extension services and training, (k) technical support services and (l) program management.

The AFMA projects are expected to develop the primary sector, particularly agriculture, livestock and fishery sub-sectors. It also supports the development of agro-based industries in the region and increases in the demand for services.

The national government allocated the total sum of 21.67 billion Pesos for AFMA in 2000, accounting for approximately 3.33% of the national budget. Of this total sum, Region 2 has a share of 2.06% or 447.36 million Pesos for the year 2000.

3) Regional Agriculture and Fisheries Modernization Plan (AFMP)

According to AFMP for year of 2000 -2004 in Region 2 and CAR, the vision, goal and objectives were proposed consonant with the national policy provided in AFMA. Target of crop, livestock and fishery productions are presented in Supporting Report. The livestock and fisheries production targets are not set clearly in AFMP of Region 2. But the Region is planning to support animal production through health management and dispersing of upgraded breeders as well as to establish the livestock trading posts and auction markets, modern slaughter houses and abattoirs, cold storage facilities, etc.

(3) Agricultural Supporting Program

1) Comprehensive Agrarian Reform Program (CARP)

DAR launched to accelerate land distribution and improve land tenure for contributing towards increasing incomes and facilitating access to resources among small farmers and workers.

2) Support Services by DAR

DAR in line with the land distribution program continued the provision of support services to the beneficiaries and extension services through information and education programs on value formation and skills development. The provision of support services for beneficiaries in the area are done in coordination with other agencies such as DA, Department of Environment and Natural Resources (DENR), Department of Trade and Industry (DTI), Land Bank, etc. through the projects focused on the communities of beneficiaries of agrarian reform.

(4) Irrigation Plan

In NIA's Indicative Irrigation Development Program from 2000 to 2009, nationwide target areas are 568 thousand ha (Table 2.8.2) for new generation and 761 thousand ha for rehabilitation.

As mentioned in Supporting Report, several ongoing nation-wide programs cover the basin both funded by foreign and local sources.

## 2.9 Existing Flood Control Facilities and River Related Structures

### 2.9.1 Flood Control Facilities

(1) Structural Measures

Table 2.9.1 presents the existing structural measures of flood control in the Cagayan River basin by the respective Districts Offices in Region 2. The major structures are jetty on the right bank at the river mouth, concrete parapet walls on the right bank near the river mouth, cut-off channel in the lower Tuguegarao River, bank protection works in basin wide, etc.

(2) Non-structural Measures

In the Cagayan River basin, there are two existing flood forecasting and warning systems. They are the Cagayan Flood Forecasting and Warning System operated by PAGASA and the Magat Dam Flood Forecasting and Warning System under NIA.

The Cagayan Flood Forecasting and Warning System consists of Tuguegarao sub-center, 5 rainfall/water level gauging stations and a repeater station. The Magat Dam Flood Forecasting and Warning System has FFWS center facilities, 5 rain gauges, 2 water level recorders, 2 repeater stations, 15 new warning stations and 7 old warning stations. Present status of the above facilities is described in Subsection 2.6.5.

Some schools, hospitals, rural health units are designated as evacuation centers in emergency cases as described in Subsection 2.6.5.

### 2.9.2 River Structures

The major related structures are Magat dam, intake weirs for irrigation use named as diversion dam, irrigation pump station, bridge, etc. Those outlines are as follows:

*Multipurpose Dam*

In the Cagayan River basin , the Magat dam exists on the Magat River. The dam has two purposes of irrigation water supply and hydroelectric power generation. The principal features of the dam are summarized in Table 2.9.2.

*Diversion Weir/Intake Weir*

There are two major intake weirs for irrigation use each consisting of a scouring gate and a sluiceway gate named as "MARIS diversion weir" in the Magat River and "Chico diversion weir" in the Chico River as shown in Table 2.9.2 in detail. In addition, there exist Baligatan intake weir, SIFRIS intake weir and two intake weirs on the Mallig River and its tributary.

*Kasecnan Diversion Dam (ongoing project)*

A Casecnan multipurpose irrigation and power project (CMIPP) located in the upper basin of the Cagayan River is presently being implemented under a BOT agreement with the California Energy Corporation as the proponent.

*Irrigation Pump Station*

Major irrigation pump stations along the main Cagayan River are at Magapit, Amulung, Iguig and Solana under the direct administration of NIA as shown in Table 2.9.3.

*Bridges*

There are a lot of road bridges across the main Cagayan River and its major tributaries. Table 2.9.4 summarizes the existing bridges.

On the above, further details are explained in ANNEX VI.

## 2.10 Present Water Uses

### 2.10.1 Irrigation Water Uses

Irrigation water is used mostly for rice cultivation. Main water source is surface running water or water from river, creek or small stream. Other sources are groundwater/well, lake, reservoir/impounding pond, spring and re-use of drained water. Rice field lot to lot irrigation is commonly seen in steep sloped area.

Annual diversion water for irrigation in 2000 is estimated 3.44 billion $m^3$. This is 8% of annual average runoff of 43.3 billion $m^3$ (ref. to 9.2.1 (2)).

### 2.10.2 Other Water Uses

In addition to the irrigation water use in the Study Area, municipal water supply, including both domestic and industrial water use, is a major user. As discussed in Section 4.5, the recent water source requirement for the year 2000 is estimated to be 282,540 $m^3$/day. The said requirement is projected to be 978,651 $m^3$/day in the year 2020.

Municipal water supply in the Study Area is under the responsibility of District Water Office of each municipality. Groundwater from wells and springs are the main sources of municipal water supply. Surface water is generally high in color, turbidity and suspended solids, particularly during the rainy season. Therefore, a treatment facility will therefore be necessary to bring water quality to a level satisfactory for human consumption.

## 2.11 Environment

### 2.11.1 Natural and Physical Environment

Field investigation and data gathering were conducted by the Study Team, Counterparts and subcontractors. The subcontracts covered a part of the investigation and data gathering for terrestrial flora and fauna, aquatic ecology, water quality, air quality and noise.

(1) Terrestrial Flora

1) Inventory Based on Secondary Data

According to the existing secondary data listed or illustrated in literature or documents, the number of families and species recorded was 79 and 298, respectively. Most of the species are rather visible or common ones that are readily identified. Of all the species recorded, there are 7 endangered species which are being pressured by human activities and/or suffering from its habitat loss. Most of them are listed on The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list, classified as the second category, meaning that trade is limited.

2) Results of On-site Survey

An on-site survey was conducted in the middle and lower portions of the Cagayan River basin. Tree species are still dominant in number of species (88) in the lower Cagayan River basin. They are followed by shrubs (24) and then grass species (10). There are three endangered species identified as Dungon (*Heritierra sylvatica*), Tindalo (*Afzelia rhomboidea*) and Kalantas (*Toona calantas*), and two rare species identified as Bamban (*Donaz cannaeformis*) and Bayok (*Pterospermum diversifolium).*

(2) Terrestrial Fauna

1) Inventory Based on Secondary Data

Based on secondary data, a total of 75 families and 182 species of terrestrial fauna were recorded in the Cagayan Valley. Among those recorded, there are 19 species listed in International Union for Conservation of Nature (IUCN) and 29 in Natural Resources and CITES.

2) Results of On-site Survey

The sampling areas are selected in the middle and in the lower portions of the Cagayan River basin, which are the same stations as those for terrestrial flora. A total of 54 species were recorded on sampling areas, including 42 species of birds, 6 of mammals, 4 of reptiles and 2 of amphibians as well as 68 of terrestrial arthropods. Of all the species recorded, 87% were common or fairly common, while 13% were rare or uncommon. There were no endangered species identified, but one rare species, the White Wagtail (*Motacilla alba*), was recorded.

(3) Protected Area

Protected areas refer to identified portions of land and water that are set aside by virtue of their unique physical and biological significance managed to enhance biological diversity and protected against destructive human exploitation as provided for in RA 7586, the National Integrated Protected Areas (NIPAS) Act of 1992.

According to the documents in DENR, Region 2, the Cagayan Basin has eighteen (18) protected areas as illustrated in Figure 2.11.1. None of those are located within the river bed of the Lower Cagayan River although Peñablanca Protected Landscape lies over Pinacanauan de Tuguegarao River, a tributary of the Cagayan River.

(4) Aquatic Ecology

1) Inventory Based on Secondary Data

According to existing secondary data and the results of the ethnological interview with fisher folks, there are around forty nekton species, including Class Pisces, Class Crustacea and Class Mollusca, found in the river system. Figure 2.11.2 depicts the distribution of the listed species. There are many species of migratory fishes in the Cagayan River System. Their migration is ahead to the sea for spawning, and the fry or the juveniles go upstream to replenish the population.

2) Results of On-site Survey

A total of 141 species were noted in the entire Cagayan River System, which is composed of 44 phytoplankton, 18 zooplankton, 15 benthos, 45 fishes, 7 macro crustaceans and 10 mollusca.

There is one endangered species that thrives in the river, which is the ludong (*Cestraeus plicatilis)*. It is not yet listed in the IUCN Red Book since studies are still being conducted. It feeds on algae and sometimes nibbles on aquatic plants. The mature ludong migrates towards the sea to spawn between October to December and its fry migrate upstream from February to March. The government, realizing the importance of this species, has implemented various conservation measures so far (refer to ANNEX V, Supporting Report). Presently, the national status of the ludong is announced to be endangered. The processing of the incorporation of the species in the Red Book of the IUCN is still underway.

Aside from ludong, there are 12 rare species in the river. Rarity may be of two factors: firstly, the fish is just an incidental species in the river and usually found in marine environments, secondly, the endemic species is being dominated by introduced species.

(5) Water Quality

1) Classification of Rivers in the Cagayan Valley

Rivers are classified from A to D set by DAO 34, DENR, depending on the water quality and the beneficial use of water. Regarding the Cagayan River mainstream, the upper part of it is classified as A (Public Water Supply •), while the lower part is classified as C (Recreational Water •, Fishery Water, and Industrial Water Supply •).

2) Results of Water Quality Measurements by DENR and BRS

Most of the rivers in the Cagayan River System were surveyed by DENR and categorized as NP (Not Polluted) and only two rivers were categorized as SP (Slightly Polluted). This indicates that the Cagayan watershed had no significant source of water pollution. According to the water quality measurements of the Cagayan River conducted by DENR, Region 2, Dissolved Oxygen (DO) of the river is higher than 5 mg/L allowing fish growth in it. Results of pH indicate that the river water is within the permissible range.

The measurement results obtained by Bureau of Research Standards (BRS) reveal that in most cases, the river water is within the allowable limits of water quality criteria for Class A (Public Water Supply •) fresh surface water.

3) Results of Water Quality Sampling

Water quality tests were conducted in this study in order to assess the qualities of both surface water and groundwater. Water samplings were done in the following rivers; Lower to Upper Cagayan River, Chico River, Pinacanauan de Tuguegarao River, Ilagan River, and Magat River as well as well water in the following municipalities; Aparri, Alcala, Tuguegarao, Cabagan, and Ilagan.

The results showed that Cagayan River and its tributaries are of good water quality under Class C Category, especially in terms of high DO (more than 6.85 mg/l) and low BOD (less than 2.84 mg/l), EC (less than 0.249 mS/cm) , total nitrogen (less than 6.24 mg/l), and total phosphate (less than 0.28 mg/l). However, microbial quality as Coliform Bacteia (more than 4,300 MPN/100 ml, mostly exceeding 5,000) of surface water generally exceeded the standards, which implies that sewage from residences and buildings including domestic waste are inflowing into the Cagayan River system.

Groundwater quality showed the same tendency as that of river water. On the whole, most of the parameters are within the limits set by The Philippine National Standard for Drinking Water (PNSDW). However, microbial quality indicated the strong coliform contamination, which makes these wells not potable anymore without treatment such as boiling or chlorination.

(6) Air Quality and Noise

1) Ambient Air

The air quality sampling was conducted in order to establish the necessary benchmark information. Air sampling points were established in the residential area and town centers of sampled municipalities/city of Aparri, Alcala, Tuguegarao, Cabagan and Ilagan.

The results obtained indicate that the values of town centers for each municipality or city were higher than those of residential areas in all parameters. Values for all air quality parameters, however, were much lower than the corresponding air quality standards as defined in DAO 14. It suggests that the ambient air quality is possibly not a major concern within the study area at present.

2) Noise

Noise level measurements were conducted to obtain benchmark conditions by direct sampling during the study period. It was measured in the same sites as air quality sampling was conducted.

Noise level figures in residential areas were about one half of those in the town centers, with noise level of between 30 to 40 dBA. These levels are less than any class of Ambient Noise level Criteria provided by DENR. In town centers, on the other hand, noise level varies with time of day in general. Noise levels generally peak in the mornings, with the levels ranging from of 57 to 76 dBA, because of numerous human activities.

### 2.11.2 Social Environment

Investigation and data gathering were conducted by the Study Team, Counterparts and subcontractors. The subcontractors made the investigation and data collection on social environment including income, health, squatter and poverty, cultural heritage, infrastructure, and peoples' intention.

(1) Fisheries

1) The Fishing Industry of Region 2

The total number of fishing households in Region 2 is 31,301 in 1996, occupying 5.7% of total households. Isabela has the largest number, while Quirino has the highest rate except for the province of Batanes that is composed of several islands.

According to Fisheries Profile of Region 2, 1999, Cagayan River and Magat Dam are listed as one of the major fishing grounds in Region 2. Regarding aquaculture, a total of 202 ha of fish cages are installed in the whole region, while more than 3,100 ha of fishponds exists, including almost the same number of brackish water and freshwater fishponds. Among provinces in

Region 2, Cagayan has the largest number in both total area of fish cages and fishponds.

2) Fish Catch in the Cagayan River

According to the BFAR, Cagayan, and other secondary data, at least 30 species of edible fishes and shellfishes are recognized in the lower Cagayan River. From the socio-economic survey conducted in 26 barangays in Region 2 in the course of this study, it was revealed that out of some 500 interviewees, only 38 are fishermen (8%), and their usual fish crop was tilapia with price range between Pesos 20 and 60 per kg. In most cases, farmers dwelling along the Cagayan River do fishing while in between their farming works, meaning that riparian people work as farmers and at the same time they work as fisher folks.

(2) Navigation

At least 18 routes for navigation currently exist along the river (refer to Figure 2.11.3). Out of the 18 routes, No. 13, 14 and 18 on the figure can serve car ferry boats with a capacity of 1 mini-bus and 1 car plus 50 passengers. According to the interview survey among local officials, the draft depth is approximately 50 cm for passenger boats and 1 m for car ferry boats.

The fare of the navigation is between 5 and 15 Pesos per person. The fare in the lower parts of the river, i.e., near the river mouth, is higher (10 to 15 Pesos) than those of upper part (5 Pesos) supposedly due to longer distance of navigation.

(3) Water Rights

The total number of the water permit grantees in Region 2 and CAR is 1,584 as of 1999, including private persons, companies and the Philippine government, i.e. NIA, FSDC, NPC, and so on. Of all the water permit grantees, 405 grantees are located in Cagayan Province, followed by Isabala, Nueva Vizcaya, Mountain Province in number.

Sources of water intake are surface water and groundwater. The surface water is mainly from the Cagayan River mainstream and its tributaries including small creeks and marsh swamps. Groundwater, on the other hand, is derived from deep wells, shallow wells or springs. The main use of water is irrigation with the number at 1,427, accounting for 90.1% of all the water intakes. The rest is for domestic (111), power (26), industrial (7), livestock (6), fisheries (5) and recreational (2) use.

(4) Historical and Cultural Heritage and Recreational Spots

Major historical and cultural heritages and recreational spots are illustrated in Figure 2.11.4. Most of the historical and cultural heritages in the Cagayan Valley are churches, which can date back to Spanish missionaries in the seventeenth century. The oldest Spanish church is supposedly the St. Hyacinth (San Jacinto) Ermita Church, located in Tuguegarao City, which was built in 1604. Other churches were built afterward until the early $19^{th}$ century.

Other than these old churches, rice terraces are the most historically valuable heritage. They are developed in Ifugao province, and have attracted many tourists. Among others, Banaue Rice Terraces, which is registered in the United Nations Educational Scientific and Cultural Organization's (UNESCO) World Heritage List, are the most attractive ones because of their engineering feat and ingenuity.

There are many natural tourist attractions in the Cagayan Valley. Most of them, however, are not developed and not well known as tourist spots or recreational spots. The most well-known and attractive one is the Callao Caves Tourist Zone (CCTZ). CCTZ is considered as the top 25 destinations in the country.

Most of the historical and cultural heritage and recreational spots listed above are located far enough from the lower Cagayan River. However, some are located in the vicinity of, or in and around the river. As the former example, Iguig Calvary Hills and the Parish of St. James the Greater and Alcala's St. Philomene Church are enumerated, while Callao Caves Tourist Zone is of the latter.

(5) Public Health and Sanitation

1) Vital Health Indices

Leading causes of morbidity in Region 2 are the following: focusing on water related disease, diarrhea was recorded at the top with significantly a high number of cases during 1994 and 1998, although it decreased in number to the third place in 1999. Malaria was ranked at the $10^{th}$ place in 1999, showing a notable decrease in number compared to the average of preceding 5 years.

Regarding the leading causes of mortality, on the other hand, diarrhea was ranked 7th place, whereas malaria was ranked below $10^{th}$ place. As for other water-related diseases, typhoid fever is observed but the number of cases is below $10^{th}$ place, while cholera and dysentery are rare. Dengue fever, referred to as a vector transmitted disease, is observed with high frequency, especially from July to September and in Cagayan province.

2) Environmental Health and Sanitation

Although the environmental health and sanitation status has notably improved, they still remain in a bad conditions. Especially, insufficient access rate (73%) to safe water should be improved by all means, because limited access to safe water causes high morbidity and mortality of diarrhea in the Cagayan Valley.

Children's nutritional status has improved substantially during recent several years. However, approximately 5% of children still remained severely or moderately underweight, which is one of the major health problems in the Cagayan Valley.

(6) Education

This section covers current situation of elementary schools and secondary schools.

1) Current Situation on Performance Indicators

The Participation Rate and Completion Rate of elementary schools have been increasing gradually and steadily, year by year, which indicates an improvement in educational performances of elementary schools. Regarding the performance indicators of secondary schools, on the other hand, Participation Rate is increasing gradually, while the Completion Rate and Drop Out Rate show no remarkable improvement. The low Participation Rate of secondary school comparing to that of elementary schools is attributed to the shortage of secondary schools and economic reasons of each household.

2) Information from Elementary School Teacher Interviews

An interview survey with an elementary school teacher of Dungao Elementary School located in St. Niño, Cagayan, was conducted, which clarified the following facts:

In elementary schools, the biggest problem is the lack of educational equipment such as textbooks, maps, and other educational devices. Usually, 3 pupils have to share one textbook. There is no adequate map for class of social science. Pupils do not have any musical instruments. The biggest problem induced by flood in the vicinity of river is that classes are disrupted during floods since schools are used as evacuation centers. Those schools, used as evacuation centers, have to have classes on Saturdays to catch up with class losses.

(7) Minority Tribes

The National Commission on Indigenous People (NCIP), Region 2, is considering indigenous people as a society that the government has a direct concern for uplifting of the mode of living and preservation of their cultural heritage. In this section, terminology of "Indigenous People" is used referring to minority tribes.

The predominant indigenous people dwelling in the Cagayan Valley is Ibanag, accounting for the highest population of approximately 524,000 with a percentage of 52.4% of all the indigenous people, or 20.7% of the entire population in the Cagayan Valley. In provinces of CAR, on the other hand, almost the whole population is comprised of indigenous people.

Despite the fact that most of the people living in Region 2 and CAR are categorized as "Indigenous People," they have been assimilated into Ilocano, non-indigenous people. Hence, their life style and cultures are not distinguished.

(8) Informal Settlers (Squatters)

According to the documents in cities and municipalities, and on-site interview survey, the current situations of informal settlers are summarized as follows:

In **Cagayan Province,** 10 clusters of squatters were documented within the flood prone areas of Cagayan Province. These constitute a total of 1,497 households with a total population of 7,582 excluding Centro Sur, Gattaran, which has no available data on the number of informal settlers. Out of 10 clusters of squatters, 7 clusters are located in the municipality of Aparri, including 93% (7,047 individuals) of all the informal settlers.

In **Isabela Province**, a total of three clusters of squatters were documented in the Province. There are 169 households with a total population of 794 individuals.

In **Nueva Vizcaya Province**, four clusters of squatters have been documented in Barangays Salvacion, Don Mariano Marcos, Vista Alegre, and District 4 in the municipality of Bayombong. Unfortunately, most of the barangays were only able to provide only partial data sets. There are 120 households with a total population of 508 in barangays Salvacion and Don Mariano.

In **Quirino Province**, key informants from the Provincial Government indicated that there are no documented squatters within the Province.

In **Ifugao Province**, the Municipality of Alfonso Lista, being located in the flood prone area of the Cagayan River system, was surveyed to assess the situation to informal settlers. However, during an interview with the Municipal Planning and Development Coordinator, it was certified that there are no documented squatters within the municipal jurisdiction. In **Kalinga, Apayao and Mountain Province**, There are no identified squatters in the area.

(9) Poverty Problem

1) Current Situation on Poverty

According to Philippine Poverty Statistics 1997 Final, National Statistical Coordination Board (NSCB), the poverty family incidence in Region 2 in 1997 is the third lowest grade with 31.6% in population among the 13 regions in the Philippines, while that of CAR is ranked tenth at 42.3%. Approximately 18% of the population in Region 2 could not meet enough income to meet food requirements as of 1997 as shown in Cagayan Valley Statistical Yearbook. Likewise, some 30% could not meet enough in CAR in the same year.

Many of poor families are suffering from such problems as below:

- Low birth weight of newborns and underweight children;
- A variety of health problems such as diarrhea caused by low accessibility to safe water and sanitary toilets; and
- Insufficient education opportunities, lack of education facilities, which result in a lack of working skills.

2) Results of MBN Survey

The Minimum Basic Needs (MBNs) mentioned above has 33 indicators by which Philippine Government identifies and evaluates the community's needs and problems on livelihood. Of the 33 indicators, 5 fundamental ones were chosen and the data derived from CBIS were analyzed. It has revealed that most municipalities of the lower Cagayan River basin do not reach the subsistence threshold level, suggesting that most of families have more or less livelihood problem. Finally, for indicator 28, Amulung might have problems in education and literacy.

Summarizing the results of consolidating the MBNs data, there seem to be poverty problem along the Cagayan River. Particularly, municipalities of Aparri, Alcala and Amullung are severely suffering from poverty problem.

## 2.12 Institutional Study

### 2.12.1 Basic Approach to the Institutional Study

(1) Objectives

The objective of the institutional study is to set-up an effective implementing structure for the river basin development of the Cagayan specifically for implementing the Projects and Programs to be proposed in the Master Plan.

(2) Basic Strategy of the Philippine Government on Institutional Strengthening

Executive Order No. 165 was issued on October 19, 1999 aimed at formulating an Institutional Strengthening and Streamlining Program for the Executive Branch of the Philippine Government.

The objectives of the EO are given below cited therefrom

1) Define the role, scope, level, and focus of government intervention
2) Delineate spectral activities among the government, business sector and civil society
3) Achieve proper distribution of functions
4) Eliminate unnecessary duplication, proliferation and overlapping of agency functions
5) Strengthen organizational, financial and manpower support
6) Improve service delivery system
7) Strengthen standard organizational support services

DPWH as well as all other line agencies are conducting studies on the above. Although, the final features of this program is not formulated yet, the Study Team is conducting an institutional study taking into consideration the above government strategy.

(3) Scope of the Institutional Study

The institutional study covers the study on current institutions and the problems involved therein in terms of;

1) Law and Regulation relating to water resources development particularly flood control,

2) Organization of the related agencies, and

3) Budget thereof

This Chapter presents the results of the study on the present situation of these aspects, their current problems involved therein, and preliminary recommendations / suggestions on these matters.

### 2.12.2 Law and Regulation

(1) Water Code and Related Regulations

Water Code of the Philippines is a basic law on water and rivers in the country. This was promulgated under the Presidential Decree No. 1067 (31 December 1976). Prior to this PD, NWRB (now NWRC) published "Principal Rivers in the Philippines" (October 1976). Following the promulgation of PD 1067, NWRB issued "the Implementing Rules and Regulations (IRR) in June 1979. The main issues / provisions in those publications and regulations are summarily presented below.

1) Major Rivers in the Philippines

There are 421 principal river basins in the country with their drainage areas varying from 42 $km^2$ and above. NWRB defined Major River Basins as those having a drainage area of at least 1,400 $km^2$. There are 18 major river basins in the Philippines.

The Cagayan River basin having a basin area of 27,281 $km^2$ is the largest river in the Philippines. Accordingly the Cagayan is one of the Major River Basins in the Philippines.

2) River Administration

a) The Water Code is nicely provided except for some provisions are discussed below. According to the Water Code, NWRB is fully responsible for all matters related to water management except those functions that are specifically conferred to other agencies of the Government.

b) There are, however, many cases of violation of this Code such as illegal settlers in the river areas, illegal cultivation in the river areas illegal water diversion / ground water extraction, etc.

3) Ownership of water and land

According to the water Code, rivers and their lands belong to the State. This means that water and land along the river are owned by the Government.

4) River Area

River area is defined as the public land along the river measured from the river bank toward the protected areas as 3 meters wide from the bank in urban area, 20 meters wide in agricultural area and 40 meters in forest area. It is not so clear the reason why so wide area is defined as public land. Furthermore, the definition of river bank is not clear in the Water Code.

5) Flood Plain lands and flood control areas

According to the Water Code, DPWTC (now DPWH) may designate the Flood Plain Land and Flood Control Areas. However, there is no river which is designated flood plain lands and flood control areas at present.

6) Use of river areas

The water Code stipulates that no person shall be allowed to stay in the river areas more than required time for recreation, navigation, etc. for temporary use. However, in realty, there are so many people living there with their house buildings.

7) Cultivation in the River areas

The Water Code prohibits the cultivation in the river area without prior permission. Although this provision is not so clear, there are many cultivation activities in the river areas.

8) Water Permit / Authority

Water users shall get approval from the Government prior to extract water. NWRB shall be responsible for giving the permits to the water users on application. According to NWRB, it will give permission within the available water after deducting 10% of available water for river maintenance flow. This also refers to the next paragraph.

9) Minimum stream flow and minimum water level

NWRC shall establish the minimum stream flow and minimum water level necessary for the protection of the Environment, control of pollution, etc. As mentioned in the above paragraph, more precise analysis should be conducted to determine whether 10% retention is sufficient for maintenance of the river.

10) Observation and problems on Water Code

The critical problems with regard to the Water Code is that there are many cases of violation of the law. The followings are the summary of the above discussions.

a) Major rivers
   - Major rivers should be defined together with the river administration who is responsible for river management
   - Rivers to be managed by the National Government and Local Government should be defined.

b) River administration
   - It should be confirmed among the related agencies that NWRB is fully responsible for the water and river administration
   - It should also be clarified what is the responsibilities of NWRB in such cases when some functions are conferred upon other agencies of the Government

c) River areas and flood control areas
   - River area should be clearly designated
   - The Government should acquire land of the river areas

d) Land use regulation
   - Current provisions on land use in the river areas are insufficient to maintain livelihood of the people residing in the river area.
   - It is recommended that special provisions be issued such that the current land use for agricultural purposes could be allowed provided that houses and other structures which will obstruct the flood flow may not be allowed to be built or to be retained there.

e) Others
   - Lack of people's awareness on the existence of such rules and regulations
   - Lack of people's capability to understand the contents and meaning of the provisions
   - Lack of unified responsible water related institutions

(2) Local Government Code (R.A. 7160 issued on October 10, 1991)

1) Basic Policy of the Government

The Local Government Code was issued aiming at enhancing the capacity of local government in sustaining decentralization, local autonomy and better local governance.

Following the Local Government Code, the NEDA is promoting flood control and / or river improvement projects to be undertaken by Local Government Unit (LGUs) as much as possible.

2) Undertakings by the Local Government

a) General Undertaking of LGUs

Despite the Government policy above mentioned, almost all major flood control projects have been undertaken by the National Government since LGUs have insufficient technical and financial capability to undertake river projects.

Local Governments have little implemented few flood control works in the objective area of the Cagayan. Almost all the Local Governments have regarded that major flood control project implementation is the mandate of the National Government, according to the practices so far conducted.

b) Sharing of LGUs

According to the practice in the implementation of large scale flood control projects in this country, which are completed or on-going, LGU shares the cost for land acquisition and resettlement in several cases. This practice may be applied similarly to the Lower Cagayan Flood Control Project.

c) Undertakings by LGUs as new movement

Some Local Governments are intending to implement flood control projects / reforestation projects in their administrative areas with its own finances supported by the National Government financial assistance. This is one of the new movements of the active participation of the Local Government in the flood control sector.

Tuguegarao City, as one of the cases, is intending to implement, not decided yet, flood control project by applying for a loan from the National Government so called LOGOFIND Project (Local Government Finance and Development Project). LOGOFIND will provide financial assistance to the LGU with conditions of financial composition: Loan 35%, Grant 50%, Equity 15%, and repayment conditions: Interest rate 14%, 15 years repayment period with grace period 3 years.

Nueva Viscaya Provincial Government has implemented a reforestation project in its administrative areas. This is also one of the cases of Local Government involvement for watershed management. The Local

Government involvement above mentioned is however limited to specific areas and small-scale projects.

d) No specific regulations on flood control in the Local Government Code

There are no specific provisions concerning flood control / infrastructures in the Local Government Code. As explained previously in the Water Code, classification of rivers is a pre-requisite in which the rivers to be managed by the Local Government should be clearly defined. Otherwise, almost all the local governments may not change their pre-concept that flood control works shall be undertaken only by the National Government.

3) Cost sharing by the Local Government

In relation to the Local Government Code, some local governments are planning to implement small-scale rural area development projects with financial support by lending institutions. Furthermore, DOF is promoting local government finance for development projects and environmental projects including river protection with cost sharing by local governments. Tuguegarao City is the 2$^{nd}$ Class City, which should share at least 15% according to LOGOFIND PROJECT, which is initiated by DOF asking the local government to conceive a loan from the National Government and / or foreign lending institutions.

However, it would be impossible for even Tuguegarao City, the only city in Cagayan Province, to share such an amount for a project as large as the Lower Cagayan Flood Control Project.

(3) NIPAS ACT

National Integrated Protected Area System and its Implementing Rules and Regulations (NIPAS ACT: R.A. No.7586 issued on June 1, 1992 and NIPAS Implementing Rules and Regulations: DENR Administration Order, DAO 25, issued on June 29, 1992)

1) Basic Policy

NIPAS Implementing Rules and Regulations states that the management, protection, sustainable development and rehabilitation of protected areas shall be undertaken primarily to ensure the conservation of biological diversity and that the use and enjoyment of protected areas must be consistent with that principle.

2) Categories of protected areas

NIPAS ACT defines the categories of protected areas as follows.

a) Strict nature reserve
b) Natural park
c) Natural monument
d) Wildlife sanctuary
e) Protected landscapes and seascapes
f) Resources reserve
g) Natural biotic areas
h) Other categories established by law, conventions or international agreements which the Philippine Government as a signatory
i) In the Cagayan River basin, especially in wildlife sanctuaries, a special species of fish “Ludong” is to be protected. According to the local people, there has been illegal catching of “ludong” and therefore fish resources are going to reduce year by year. Furthermore, local people said that “ludong” was available in the Upper Cagayan in the 1980’s, however, it is now no longer available in the upstream areas. The review of the 1987 Master Plan should include this matter. This is discussed in more detail in Section 2.11.

3) Prohibition of cutting trees

In line with NIPAS, the Government promulgated the presidential decree that states the prohibition of tree cutting in the designated primeval forest area and especially in the mountainous areas above 1,000 m in elevation. This issue is also to be incorporated in the review of the 1987 Master Plan.

4) Prohibition of slash and burn agriculture

The government already promulgated the prohibition of slash and burn agriculture. However, it has never been enforced as can be seen everywhere in the basin. This is one of the important issues to be considered in the land use planning.

5) Network of Protected Areas of Agricultural Development (NPAAD)

The Philippines is still insufficient in food supply, relying largely on importation of rice. In principle, the agricultural land may not be converted into other uses and such conversion is subject to the approval of DENR. These conditions should be incorporated in the Study

6) Disaster Management System

The Government has already established a nationwide Disaster Coordinating Council System constituting NDCC, RDCC, C/MDCC, and BDCC, of which the chairman of NDCC is the President of the Philippines. The DCC system is considered well functioning. This was discussed in the previous Section 2.7.

### 2.12.3 River Basin Management

(1) Functions required for River Basin Management

River management should cover the following tasks to ensure sustainable river functions

1) River basin conservation management (Watershed management)
2) Flood control management
3) Water supply management including water resources development and water allocation / water supply
4) River water quality management
5) River environment management

(2) Institutions of River Basin Management

NWRB provides organizational charts for water related works as shown in Figures 2.12.1 and 2.12.2 classifying into two categories; one is for functional relationship and the other is for organizational relationship. It is not so clear what is the difference between these two categories and why they are needed.

1) Tasks and duties of water related agencies

There are many agencies concerned with rivers. The major government departments and agencies related to water are as follows.

***River basin conservation management (Watershed management)***

DENR, NIA, BSWN, NPC, MWSS, LWUA, DPWH, DILG, DA, WD and LGUs

***Water resources management:*** *(Including water resources development and water supply / allocation)*

NEDA, NWRB, LLDA, MWSS, LWUA, DPWH, NIA, DILG, DA, BRS, PAGASA and LGUs

***Flood control management:***

DPWH, OCD, DOST (PAGASA), and LGUs

***Water quality management:***

DOH, EMB of DENR, EHS, MWSS, LWUA and LGUs

***River environment Management:***

DENR, NWRB, DOH, NHA, EMB, MWSS, LWUA and LGUs

The functions of the above are closely related to each other.

As for watershed management, DENR seems to be the leading agency and other agencies listed above are conducting reforestation, forest management, etc. in connection with the projects they have undertaken.

As for water resources management, NEDA is a coordinating agency for project evaluation, NWRB is responsible for overall legislative matters specifically on water allocation and permission. Other agencies are undertaking respective fields of water use, such as NIA for irrigation, NPC for hydropower development, etc. on project basis

The flood control component is undertaken principally by DPWH and LGUs for structural measures, and OCD and PAGASA are undertaking non-structural measures such as flood disaster management and flood forecasting and warning system in cooperation with other agencies

As for river environment management, DENR seems to be a leading agency.

2) Flood control institutions

Among the agencies concerned, specifically, mandates of the NWRB, DPWH, PAGASA and OCD make them the key institutions for flood control as discussed below.

a) NWRB

The NWRB is responsible for the following (only major functions):

- To provide regulation relating to water and river
- To give water permission / right to water users
- To give approval on the construction and rehabilitation of water-related works including flood control

b) DPWH

The DPWH is mandated for the following (only major functions)

- To conduct planning, design, and construction of water / river related works
- To define the flood control areas
- To give approval for river bed cultivation

c) PAGASA

The PAGASA is mandated to undertake establishment, operation and maintenance of Flood Forecasting and Warning System in cooperation with DPWH, NIA, NPC, etc. The main tasks mandated to the PAGASA are enumerated below.

- Observation of rainfall and flood runoff
- Forecasting flood occurrence
- Dissemination of flood warning to related agencies and local people

d) OCD

The OCD is functioning as a representative agency of the National Disaster Coordination Council (NDCC) including flood disaster. Its principal mandates are;

- To establish disaster preparedness plan at the national level
- To transmit to related agencies the flood warning messages which is disseminated from the PAGASA
- To establish flood disaster mitigation measures in emergency cases in cooperation with other agencies, such as DPWH, NIA, NPC, DH, DECS, etc.
- To report to the President on disaster and the countermeasures taken

### 2.12.4 Organization

This subsection presents the organization of the flood-related Government agencies, DPWH central office, DPWH Regional office and LGUs concerned. Organizations of the other agencies such as irrigation, watershed management, etc. are discussed in the respective Chapters.

(1) DPWH Central Office

1) Mandates of DPWH

The DPWH is mandated under Executive Order No.124 issued by the President Corazon C. Aquino on January 30, 1987 to continue to develop its technology for the purpose of ensuring the safety of all infrastructure facilities and securing for all public works and highways the highest efficiency and the most appropriate quality in construction.

As such, the DPWH is designated as “the State’s Engineering and Construction Arm” responsible for the planning, design, construction and maintenance of infrastructure facilities particularly highways, flood control and water resources development system and other public works in accordance with national development objectives.

2) Overall organization of DPWH

Current organization of DPWH is shown in the attached Figure 2.12.3. DPWH constitutes the Department Proper, 6 Services, 5 Staff Bureaus, 16 Regional Offices and 26 Project Management Offices.

The Planning Services under the Department Proper are undertaking project planning in the master plan and feasibility study. Accordingly, the Feasibility Study on the Lower Cagayan Flood Control is undertaken by the Planning Services.

The Project Management Office (PMO) is tasked to undertake project implementation. Recently, PMO-MFCDP was restructured with two clusters, i.e. clusters 1 and 2. Cagayan PMO was newly created under the cluster 2. Organization chart of MFCDP-PMO Cluster 2 is shown in the attached Figure 2.12.4.

3) Manpower of DPWH

a) According to DPWH, the total number of DPWH staff is accounted to about 34,800 persons, of which the regular staff is about 19,100 persons (about 55% of the total), and others are the contractual and daily casuals. Number of engineers by specialty is not known yet since the engineers are classified by their grade and not by specialty.

b) Manpower of PMO-MFCDP
Total number of PMO staff is to about 1,700 persons inclusive of all the PMOs, PMO Clusters and Field PMOs in each project site. Of which the regular staff are very minimal (exact figures are not known yet, but it is said only 1-3 persons of the regular staff for one project).

4) Annual Budget

According to 2001-2004 Medium-Term Public Investment Program (MTPIP), annual investment program of DPWH for the whole country is as shown below.

| Year / Project | Highway | Flood Control | Others | Total | Annual Increase |
|---|---|---|---|---|---|
| 2001 | 21,878 | 5,347 | 7,751 | 34,976 | |
| 2002 | 27,228 | 7,079 | 8,311 | 42,618 | 21.8% |
| 2003 | 37,352 | 7,849 | 11,282 | 56,483 | 32.5% |
| 2004 | 43,464 | 8,546 | 11,330 | 63,340 | 12.1% |
| Total | 129,922 | 28,821 | 38,674 | 197,417 | |
| Share | 65.8% | 14.6% | 19.6% | 100% | |

Source: MTPIP by DPWH

The above budget allocation shows the investment amounts for three sectors, i.e. highway, flood control and others. Shares by sector are 66%, 15% and 20% respectively.

Flood control sector is so limited to less than 15% of the total investment. The above fund allocation is decided upon based on the criteria on the Regional social-economic balance. It is recommended that more detailed study be conducted based on the actual requirements.

Among this budget allocation, total investment of about 197.4 billion Pesos equivalent, foreign assisted project shares 59.4 billion and locally funded shares 40.6% respectively.

(2) DPWH Regional Office, Region 2

1) Overall organization

Overall organization of the Regional Office (R-2) is shown in the attached Figure 2.12.5.

DPWH R-2 office located in Tuguegarao City is headed by the Regional Director. The Regional Office has 6 divisions as follows.

a) Planning and Design Division
b) Construction Division
c) Material and Quality Control and Hydrology Division
d) Maintenance Division
e) Comptrollership & Financial Management Division
f) Administrative Division

Under the management of the Regional Director, there are 10 Engineering District Offices (ED) and Regional Equipment Services (RES)

Regional Office supervises the ED. Almost all the construction works have been implemented by ED Offices under the supervision of the Regional Office.

The RES has undertaken supply of the construction equipment to the construction works for the Regional Office proper and its DEs. When the equipment are available, RES may also lease them to the private sectors as demanded.

2) Authorization of Project Implementation

According to DO 60 in 1998, Regional Office R-2 was authorized to conduct planning and design of projects, which cost less than 50 million Pesos and to implement projects, cost of which is less than 30 million Pesos

Further, DO 61 in 1998 authorized the DE to implement projects with a project cost of less than 15 million Pesos. This delegated authority might be far less than that required to implement the Lower Cagayan Flood Control Project, if Regional Office should implement it.

3) District Engineer's Office (DE)

There are 10 DE Offices under R-2. Those DEs undertake project implementation and maintenance work of the existing infrastructure especially national highways and bridges in the administrative area of respective districts.

4) Regional Equipment Service

Regional Office R-2 has a number of equipment amounting to 261, units including such heavy construction equipment as dump trucks, bulldozers, power shovels / backhoes, road-rollers, graders as well as special / light ordinary equipment as cranes, compressors, ordinary trucks, vehicles, boring machine, etc.

Regional Office has 1-Regional Equipment Service and 4-Area Services / Sub-area Services. The organizational chart of Regional Equipment Service is shown in Figure 2.12.6.

RES manages all the equipment, which belong to R-2 and conducts rehabilitation of these equipment. The Area Service conducts regular maintenance and repair works of the equipment in principle.

Present operation condition of RES may be summarized as follows.

a) Existing construction equipments are almost all old aged ones which majority of which were procured in the latter 1960's-early 1980's. This implies that maintenance and repair could be very costly.
b) According to the data provided by RES, working efficiency of these equipment (actual working hours divided by total workable hours: 8 hours per day) is as low as 29% on annual average, consuming much time for waiting for repairs and waiting for jobs. Renewal of that

equipment if it becomes necessary to utilize such equipment for operation and maintenance of the completed projects.

c) Furthermore, RES informed that road maintenance work (major work of RES equipment) has been implemented on a contract system 70%, and by an administration system 30%.

The above situation implies that it is a waste to use such old equipment with low working efficiency.

This is one of the factors to be considered in the organization of project implementation by force account system, so called by administration. The Study Team requested RES to work out precise Operation Plan of RES. However, at this moment, a complete set of work program has yet been provided .

This is very important to strengthen project implementation capability of DPWH R-2, and it is recommended to study whether RES should continue operation as at present , reduce its capacity, or abolish / restructure.

According to the R-2, most projects are for the construction of highways, i.e. roads and bridges. Flood control project is limited to piecemeal projects such as small-scale bank protection and spar dikes. The Regional Office R-2 has little experiences of large and / or schematic flood control works.

5) Staffing

Number of staff in Regional Office R-2 is summarized in the table below.

| Office | Management Staff | Engineers | Administrative/Supporting Staff | Total | % Share |
|---|---|---|---|---|---|
| R-2 Office | 3 | 80 | 120 | 203 | 18.6 |
| District Eng. Office | | | | | |
| Batanes | 2 | 13 | 46 | 61 | 5.6 |
| Cagayan 1st | 2 | 21 | 63 | 86 | 7.9 |
| Cagayan 2nd | 2 | 10 | 21 | 33 | 3.0 |
| Cagayan 3rd | 2 | 15 | 56 | 73 | 6.7 |
| Isabela 1st | 2 | 14 | 53 | 69 | 6.3 |
| Isabela 2nd | 2 | 7 | 22 | 31 | 2.8 |
| Isabela 3rd | 2 | 16 | 57 | 75 | 6.9 |
| Isabela 4th | 2 | 11 | 28 | 41 | 3.8 |
| Nueva Viscaya | 2 | 22 | 66 | 90 | 8.3 |
| Quirino | 2 | 20 | 66 | 88 | 8.1 |
| RES | 4 | 17 | 218 | 239 | 21.9 |
| Total | 27 | 246 | 816 | 1089 | 100.0 |
| % share | 2.5% | 22.6% | 74.9% | 100% | |

Source: DPWH, Regional Office R-2

The total number of staff is 1,089 persons, of which RES shares 21.9%, Regional Office 18.6%, and District Engineer's Office 59.5% (5.9% each DE on average). The number of RES staff is uncertain. This implies that DPWH recognizes the importance of maintenance work by proper equipment arrangement.

6) Annual Budget

Annual budget of Regional office, R-2 (Release in CY 1999) is tabulated below.

Unit: Million Pesos

| Office | Regular Appropriat-ion | Personnel Cost | Maint. & Other Operating Expenses | Capital Outlay | Special Release | Total |
|---|---|---|---|---|---|---|
| R-2 Office | 327.4 | 40.4 | 5.7 | 281.3 | 113.2 | 440.6 |
| District Eng. Office | | | | | | |
| Batanes | 65.1 | 9.8 | 9.8 | 45.4 | 44.1 | 109.2 |
| Cagayan 1st | 72.3 | 16.6 | 40.6 | 15.0 | 63.1 | 135.4 |
| Cagayan 2nd | 44.8 | 7.1 | 28.5 | 9.2 | 69.9 | 114.7 |
| Cagayan 3rd | 42.3 | 14.8 | 15.6 | 11.9 | 58.0 | 100.3 |
| Isabela 1st | 44.6 | 15.3 | 15.0 | 14.3 | 72.6 | 117.2 |
| Isabela 2nd | 54.0 | 7.2 | 21.0 | 25.7 | 54.3 | 108.3 |
| Isabela 3rd | 29.0 | 12.6 | 6.0 | 10.5 | 122.7 | 151.7 |
| Isabela 4th | 35.3 | 6.7 | 16.5 | 12.1 | 45.7 | 81.0 |
| Nueva Viscaya | 87.3 | 15.2 | 52.8 | 19.3 | 83.6 | 170.9 |
| Quirino | 56.1 | 16.0 | 27.6 | 12.6 | 160.0 | 216.1 |
| RES | 41.2 | 36.7 | 4.0 | 0.6 | 0 | 41.2 |
| Total | 899.4 | 198.3 | 243.2 | 457.9 | 887.2 | 1786.6 |
| % share | 50.3% | 11.1% | 13.6% | 25.6% | 49.7% | 100% |

Source: DPWH Regional Office R-2

Total release in the year CY1999 was 1,786.6 million Pesos including all the offices under R-2.

Annual release consists of Regular Appropriation and Special Release. According to DPWH, R-2, the former "Regular Appropriation" only is counted in the original budget schedule at the beginning of the year. The latter "Special Release", of which financial source is outside of DPWH, i.e. project cost financed by other sources such as DECS, DA, LGU, Office of President, etc. come during the annual operation period. This means that the amount of Special Release is not known at the beginning of the year, thus it might be hard for R-2 to prepare an overall annual operation plan.

Regular Appropriation and Special Release share almost same amount, about 50% each as seen in the above table.

(3) Local Government

The Cagayan River Basin encompasses 9 Provinces, i.e. Cagayan, Isabela, Nueva Viscaya, Quirino, Ifugao, Kalinga, Apayao, Mt. Province, Aurora.

Among those provinces, Apayao and Aurora Provinces share minimal areas within the Cagayan River Basin. Furthermore, it may be said that, mainly Cagayan, Isabela, Quirino and Nueva Viscaya Provinces all of which belong to Region 2 cover the objective areas of the flood control project.

The detailed observations were made on the Cagayan Provincial Office, Tuguegarao City and 10 Municipalities, which are subject to the Lower Cagayan Flood Control Project.

1) Annual Budget of LGUs

Annual budget of each municipality in FY 1999 are as shown in the table below.

| Province/ Municipality/ City | | Revenue | | | Expenditure | | |
|---|---|---|---|---|---|---|---|
| | | IRA | Local | Total | General Exp. | Develop-ment Exp. | Total Exp. |
| Cagayan Province | Baggao M. | 48,908 | 3,811 | 52,719 | 52,719 | 8,600 | 61,319 |
| | Solana M. | 31,554 | 6,219 | 37,773 | 34,952 | 6,972 | 41,924 |
| | Piat M. | 16,094 | 3,410 | 19,504 | 17,626 | 882 | 18,508 |
| | Gattaran M. | 38,000 | 14,600 | 52,600 | 39,045 | 10,054 | 49,099 |
| | Iguig M. | 14,714 | 1,069 | 15,783 | 12,988 | 2,816 | 15,805 |
| | Amulung M. | 23,458 | 1,194 | 24,651 | 21,162 | 4,692 | 25,853 |
| | Sto.Nino M. | 26,758 | 877 | 27,635 | 25,486 | 1,658 | 27,143 |
| | Tuguegarao C. | 44,886 | 57,120 | 102,006 | 81,614 | 24,709 | 106,323 |
| | Cagayan P. | 413,255 | 42,608 | 455,862 | 489,318 | 45,850 | 535,168 |
| Isabela Province | Sta.Maria M. | 15,834 | 862 | 16,686 | 16,390 | 550 | 16,940 |
| | Cauayan M. | 45,903 | 34,770 | 80,673 | 78,617 | ? | 78,617 |
| | Reina M. | 13,012 | 1,035 | 14,050 | 10,675 | 3,238 | 13,914 |
| Simple Average | | 61,031 | 13,964 | 74,996 | 73,383 | 9,168 | 82,551 |
| % Share | | 81.3% | 18.7% | 100% | 88.9% | 11.1% | 100% |

Source: Respective Municipalities

Majority of annual income comes from IRA accounted for more than 80% on the average. Tuguegarao City is an exceptional case where the local revenue is higher than the IRA.

As for the annual expenditure, about 90% is allocated for general expenses consisting of personnel cost, office running cost and administrative cost, and about 10% for development expenditures. Among the development expenses, biggest share is for road and bridge construction, followed by building construction. Flood control and drainage expense is minimal accounting for only 6.1% of the total development expenditure on average.

The Local Governments have realized that flood control works are to be implemented by the National Government. Therefore, flood control program is hardly presented in the annual program of related LGUs even though they have appealed for flood control works as a real necessity requiring topmost priority among others, which were identified by mutual consent in the workshop held in Tuguegarao, Isabela and Bayombong on September 5-7, 2000.

**Tuguegarao City**

Tuguegarao City is rather different from other LGUs in terms of flood control works. Hereunder presented is a brief description of the development program by Tuguegarao City for the year CY 2000.

Tuguegarao City has paid special attention to the flood control project implementation. The City issued its Annual Development Plan for the year 2000 on June 8, 2000. The budget program for development is summarized below.

| | Million Pesos |
|---|---|
| General Fund-Capital Outlay | 74.4 |
| 20% Development Fund | 32.16 |
| Total | 106.56 |

Among this budget, road improvement shares 18.8% (20 Million Pesos) and flood control including drainage shares 19.8% (21.1 Million Pesos), and others are such as buildings, irrigation, Barangay infrastructures, etc. Notably the largest share is in drainage and flood control project. According to the City, the flood control project is the top priority project in the City.

The City implemented infrastructures so far by administration, however, it has turned to the contractor system for more extensive construction works to be implemented from now on.

2) Manpower of LGUs

Some Municipalities have engineering staff, but some have almost none. Numbers of engineers in LGUs are so limited to 1-11 persons per municipality. Some LGUs have Engineers and have been implementing infrastructure projects by force account system and / or contract system.

Among those LGUs, Provincial Office and Tuguegarao City have their own construction equipment.

In case of Tuguegarao City, it has City Engineer's Office. The City has initiated the implementation by contract system after it became a City in January 2000, although it implemented all infrastructure projects by force account system before. The City Engineer's office said that flood control project in the Lower Cagayan would be better to be implemented on contract system for the reason that contract system is more flexible to ensure schedule control by means of project packaging.

All the LGUs have implemented infrastructure projects, but almost all are of small scale ones such as farm to market road, school buildings, other public buildings, etc. They have little experience of flood control projects.

(4) Preliminary Consideration and Recommendations

Based on the present situation of DPWH Regional Office and LGUs, following may be pointed out in summary.

a) According to the current regulations in terms of regulation, budget / experience, and manpower (Engineers), it would be very hard for Regional Office to undertake the implementation of the Lower Cagayan Flood Control Project on its own.
b) Therefore, for the implementation of the flood control project, PMO in Manila or a new PMO, which will be newly established for the specific project, should undertake the project.
c) For the implementation of the Master Plan, a new institution such as a Development Authority would need to be established like a Development Authority.
d) It is suggested that more efficient operation system of R-2 be examined, especially Regional Equipment Service (RES).
e) LGU's participation and its cost sharing for implementation of the Lower Cagayan Flood Control Project should be examined in more detail.

# *Part-II*
# *REVIEW OF*
# *1987 MASTER PLAN*

# CHAPTER 3 1987 MASTER PLAN

## 3.1 Outline of 1987 Master Plan

### 3.1.1 General

The 1987 Master Plan Study for the Cagayan River basin was conducted by JICA from 1985 to 1987. The objective of the Study was to formulate a Master Plan for the water resources development in the entire Cagayan River basin covering an area of 27,281 $km^2$. The target year of the Plan is 2005.

The 1987 Master Plan Study envisaged the development of flood control works, irrigation systems, hydropower generating facilities and water supply systems which would sustain the established regional socio-economic development framework plan. The Study accordingly proposed the construction of several impounding dams as preferred water resources developments.

The formulated 1987 Master Plan included 4 multipurpose projects with dams, 5 flood control projects, 13 irrigation projects and other agricultural development schemes, and 3 hydropower projects, which had been planned to be implemented up to the year 2005. The Short Term Plan consisted of 3 multipurpose projects, 3 flood control projects and 3 irrigation projects selected from the Master Plan, which had been formulated in order to secure the safety against floods and to ensure the achievement of the contemplated socio-economic development target.

### 3.1.2 Socio-economic Framework Plan

In order to formulate the 1987 Master Plan, the target of regional economic development was set to raise the per capita GRDP of Region 2 by the year 2005 up to that of the national average excluding highly industrialized NCR and Region 4. The socio-economic projections and targets envisioned on the basis of MEDIUM TERM PHILIPPINE DEVELOPMENT PLAN are summarized below.

| Items | 1985 | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|---|
| Population ($10^3$) | 2,136 | 2,413 | 2,702 | 2,989 | 3,259 |
| GRDP (Pesos $10^6$) | 1,825 | 2,689 | 4,014 | 5,536 | 7,080 |
| GVA,Agriculture(Pesos $10^6$) | 862 | 1,062 | 1,383 | 1,631 | 1,837 |
| GVA, Industry (Pesos $10^6$) | 272 | 444 | 743 | 1,568 | 2,544 |
| GVA, Service (Pesos $10^6$) | 691 | 1,183 | 1,888 | 2,337 | 2,699 |

Note: GRDP at 1972 constant price,

GRDP in the basin for the year 2005 was projected to be Pesos 7,080 million at 1972 constant price, which was 3.9 times of that for 1985. The per capita GRDP was accordingly set at Pesos 2,172 for the year 2005. The average annual growth rate was estimated to be 7.0% over a 20 year period.

### 3.1.3 Flood Control Plan

Although flood control structural and non-structural measures were contemplated to mitigate flood damages, priority was given to the structural measures because these were expected to become effective within the short time target of 20 years. In establishing an overall Master Plan, a flood control framework plan and a long term plan were formulated.

The framework plan was formulated after comparative studies of the following 6 alternative plans under a design discharge condition of 100 years probable flood. The Alt. 5DM was selected as the framework plan on the least cost basis.

| Alternative | Diking Systems | Flood Control Dams | Improvement of Magapit Narrows | Project Cost Pesos million (US$ million) |
|---|---|---|---|---|
| Alt. 0D | With diking | Without dam | Without improvement | 35,688 (1,878) |
| Alt. 5D | With diking | With 5 dams | Without improvement | 36,466 (1,919) |
| Alt. 9D | With diking | With 9 dams | Without improvement | 45,796 (2,410) |
| Alt. 0DM | With diking | Without dam | With improvement | 38,278 (2,015) |
| Alt. 5DM | With diking | With 5 dams | With improvement | 34,394 (1,810) |
| Alt. 9DM | With diking | With 9 dams | With improvement | 45,603 (2,400) |

Notes; 1) 5 dams are Cagayan No.1, Ilagan No.1, Siffu No.1, Mallig No.2 and existing Magat dam with Alimit No.1 dam.
2) 9 dams are Pinukpuk, Addalam, Chico No.4 and Disabungan dams in addition to the above 5 dams.

The framework plan contemplated alleviating flooding by the flood control dams in the upstream reaches and lowering the flood water levels in the downstream reaches by improvement of the Magapit Narrows. The areas along the middle reaches would be protected from flooding by the diking systems.

The long term plan was formulated on the basis of the framework plan by reducing the design discharge to 25 years probable flood. The long term plan consisted of channel works including dike embankments, revetments, drainage sluices, narrow excavations, cut-off channels, bank protection and appurtenant facilities, and dam works for Cagayan No.1, Alimit No.1, Ilagan No.1, Siffu No.1 and Mallig No.2. The economic cost and benefit for the long term plan were Pesos 27,543 million (US$ 1,450 million) and Pesos 3,834 million (US$ 202 million) /year, respectively at 1985 current price. The EIRR was estimated to be 14.2% under the future condition.

The economic viability of each element selected from the projects in the long term plan was examined for inclusion in the Maser Plan in terms of EIRR as follows:

| Rank | Scheme | EIRR |
|---|---|---|
| 1 | Tuguegarao dike | 23.1% |
| 2 | Narrow improvement (Site-NLL) | 18.9% |
| 3 | Bank protection | 13.7% |
| 4 | Cabagan dike | 13.6% |
| 5 | Narrow improvement (Site-NLR) | 13.5% |
| 6 | Magat/Alimit No.1 dam | 13.1% |
| 7 | Siffu No.1 dam | 12.8% |
| 8 | Cagayan No.1 dam | 11.6% |
| 9 | Mallig No.2 dam | 9.3% |
| 10 | Ilagan No.1 dam | 5.4% |
| 11 | Narrow improvement (Site-NUP) | - |

### 3.1.4 Agricultural Development Plan

The agricultural development plan was envisaged based on the following concepts in order to achieve the development target established in the socio-economic framework plan:

1) The potential paddy fields of 306,000 ha would be fully irrigated through completion of ongoing projects, rehabilitation of existing schemes and development of new schemes.
2) Productivity of rice would be increased by extension of improved farming practices under irrigation.
3) The potential diversified cropland of 170,000 ha would be fully developed, and the increased cropland would be allocated mainly to corn production.
4) Productivity in the diversified cropland would be increased by improved farming practices under rainfed conditions.
5) The upland area would be utilized mainly for production of permanent crops and cattle grazing.
6) Recommended permanent crops were cashew nuts, mango and citrus fruits.
7) Cattle would be grazed in pastures and fattened in feedlots.
8) Fresh water aquaculture would be the main source of fishery products. The production increase of fisheries would be set at 4.5% per annum based on THE MEDIUM TERM PLAN OF BFAR.
9) Forestry production would be maintained at the present selective logging level with due consideration of the Government's policy on environmental conservation.
10) In view of the development policy of the Government of the Philippines, the maximum possible development of agriculture was envisioned by the year 2005. In this connection, 70% of the potential was assumed to be the practicable maximum development.

On the basis of the above mentioned concepts, the agricultural land use plan for the year 2005 was contemplated as follows:

(Unit: 1,000 ha)

| Land Use | Present Land Use (1985) | (1) Future Land Use (2005) | (2) Land Use Plan in P.M.A | (3)=(1)/(2)Ratio of Attainment in 2005 |
|---|---|---|---|---|
| I. Lowland | | | | |
| 1. Paddy field | 247 | 306 | 306 | 100% |
| 2. Diversified cropland | | | | |
| Corn field | 102 | 142 | 142 | 100% |
| Others | 28 | 28 | 28 | 100% |
| 3. Grassland (idle) | 99 | - | - | - |
| Sub-total | 476 | 476 | 476 | - |
| II. Upland | | | | |
| 1. Permanent cropland | 27 | 57 | 200 | 29% |
| 2. Pasture | 127 | 210 | 300 | 70% |
| 3. Grassland (idle) | 450 | 337 | 104 | - |
| Sub-total | 604 | 604 | 604 | - |

Note; P.M.A.= Potential maximum area

Irrigation was considered as the principal scheme for lowland development. The proposed irrigation schemes and those EIRRs are listed below:

| Proposed Irrigation Scheme | Service Area (ha) | EIRR (%) for Cropping Pattern A&C |
|---|---|---|
| I. New Irrigation Scheme | 65,330 | |
| 1. Chico Mallig Irrigation Project | 31,200 | 15.7 |
| 2. Matuno River Development Project | 12,680 | 12.4 |
| 3. Dabubu River Irrigation Project | 1,000 | 19.5 |
| 4. Zinundungan Irrigation Extension Project | 1,750 | 13.4 |
| 5. Alcala Amulung West Irrigation Project | 6,750 | 17.3 |
| 6. Tuguegarao Irrigation Project | 1,400 | 19.4 |
| 7. Lulutan Irrigation Project | 2,950 | 22.8 |
| 8. Ilagan Irrigation Project | 3,200 | 28.0 |
| 9. Gappal Irrigation Project (pump) | 4,400 | 20.2 |
| Gappal Irrigation Project (dam) | | 13.5 |
| II. Rehabilitation/Improvement Scheme | 12,212 | |
| 1. Dummon River Irrigation System | 2,070 | 8.0 |
| 2. Baggao Irrigation System | 1,812 | 7.3 |
| 3. Solana-Tuguegarao Irrigation System | 3,143 | 39.0 |
| 4. Pinacanauan Irrigation System | 1,200 | 75.7 |
| 5. Tumauini Irrigation System | 3,987 | 12.6 |

The priority of each irrigation scheme was determined in terms of net farm income and the number of beneficiaries per hectare for each of the project groups with EIRR of more or less than 15% as follows:

| Proposed Irrigation Scheme | Net Farm Income (Pesos1,000/ha) | Rank -ing | Number of Beneficiaries (Person/ha) | Rank -ing | Overall Rank-in g |
|---|---|---|---|---|---|
| I. With EIRR of more than 15% | | | | | |
| Pinacanauan IS | 33 | 1 | 8.3 | 2 | 1 |
| Chico Mallig IP | 32 | 2 | 3.1 | 8 | 2 |
| Dabubu RIS | 30 | 3 | 5.1 | 5 | 3 |
| Lulutan IP | 29 | 4 | 4.4 | 7 | 4 |
| Solana IS | 28 | 5 | 8.1 | 3 | 5 |
| Gappal IP (pump) | 28 | 5 | 4.8 | 6 | 6 |
| Ilagan IP | 26 | 6 | 8.4 | 1 | 7 |
| Tuguegarao IP | 24 | 7 | 6.1 | 4 | 8 |
| Alcala Amulung West IP | 24 | 7 | 1.9 | 9 | 9 |
| II. With EIRR of less than 15% | | | | | |
| Baggao IS | 33 | 1 | 4.8 | 3 | 10 |
| Dummon RIS | 32 | 2 | 3.2 | 4 | 11 |
| Matuno RIS | 30 | 3 | 6.3 | 1 | 12 |
| Tumauini IS | 27 | 4 | 6.0 | 2 | 13 |
| Zinundungan IES | 27 | 4 | 2.9 | 5 | 14 |

Lowlands which would not be irrigated were to be developed as rainfed diversified crops fields.

In the Study time, only 127,000 ha or 20% of the total cultivable land of 604,000 ha was utilized for cattle grazing in the uplands. This area was to be extended to 210,000 ha, and permanent crop land of 27,000 ha was to be enlarged to 57,000 ha by the year 2005. The recommended crops were cashew nuts, mango and citrus fruits.

Fresh water fisheries were recommended for development of inland water ponds. New reservoirs and ponds proposed might be available for this purpose.

### 3.1.5 Hydropower Development Plan

Demands of the electric power in Luzon Island were projected up to the year 2005. The projected demands were compared with the existing power supply capacities in 1990. The projected demands in the years of 1990, 1995, 2000 and 2005 were 2,927, 3,813, 4,953 and 6,428MW. Meanwhile, the installed capacity in 1990 was 4,101MW which was expected to yield an output of 3,280MW. It was assumed that if the installed capacity was not increased, a certain deficit in the electric power supply would be entailed.

In order to meet the power demands, the following hydropower schemes were envisaged within the Cagayan River basin as the candidate schemes:

| Candidate Scheme | Capacity (MW) | Energy (GWh) | Discharge ($m^3/s$) | Gross Head (m) | Project Cost (US$ million) |
|---|---|---|---|---|---|
| (Casecnan) | (268) | (1,379) | (110.0) | (208.5) | (445.8) |
| Matuno | 180 | 528 | 110.0 | 220.0 | 267.0 |
| Ibulao | 17 | 85 | 7.8 | 274.0 | 29.0 |
| Tanudan | 25 | 130 | 11.9 | 270.0 | 34.0 |
| Diduyon | 352 | 957 | 85.2 | 486.0 | 469.2 |

Note; Casecnan scheme was regarded as an ongoing project.
Time basis of the project cost was December 1985.

### 3.1.6 Municipal Water Supply Plan

Total water demand excluding the agricultural sector was derived from the sum of the water demands of domestic, services and public, and industrial sectors. The target in the year 2005 was the whole urban population and 85% of the rural population should be covered by water supply systems. The projected water demand by sector is summarized below.

(Unit: $m^3$/day)

| Sector | 1985 | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|---|
| Domestic | 82,465 | 111,495 | 143,504 | 179,761 | 211,343 |
| Services & Public | 17,258 | 23,722 | 31,307 | 39,872 | 49,182 |
| Industrial | 41,538 | 59,193 | 85,227 | 200,757 | 380,986 |
| Total | 141,261 | 194,410 | 260,038 | 420,390 | 641,511 |

From the above table, the projected total water demand in 2005 is 641,511 $m^3$/day. The total source water requirement was calculated by applying a loss rate to the total demand. The following table shows the total water source requirement.

(Unit: $m^3$/day)

| Sector | 1985 | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|---|
| Domestic | 126,869 | 165,178 | 205,006 | 247,946 | 281,791 |
| Services & Public | 26,551 | 35,144 | 44,725 | 54,996 | 65,577 |
| Industrial | 63,905 | 87,693 | 121,753 | 276,906 | 507,981 |
| Total | 217,325 | 288,015 | 371,484 | 579,848 | 855,349 |

In 2005, the total source requirement would reach 855,349 $m^3$/day.

### 3.1.7 Multipurpose Dam Development Plan

In order to augment the natural flow and to complement the water deficit, the following dams were proposed:

1) Dams to compensate and supplement Magat reservoir: Siffu No.1 dam, Matuno No.1 dam and Alimit No.1 dam.
2) Water supply and hydropower dams: Dummon dam, Paranan dam and Zinundungan dam.
3) Water supply dams: Mallig No.2 dam, Santa Maria dam, Calaocan dam, Colorado dam, Santo Niño dam and San Vicente dam.
4) Hydropower generating dams: Casecnan dam, Diduyon dam and Matuno No.1 dam.

Among the above dams, Siffu No.1, Mallig No.2, Matuno No.1 and Alimit No.1 dams were proposed as multipurpose dams. Although the Dummon, Paranan and Zinundungan dams had two purposes of irrigation water supply and hydropower generation, the main purpose of the dams was irrigation water supply, and accordingly these were defined as single purpose dams.

The least costly alternative to meet the deficit of the Magat project (94MCM) and to allocate a part of the Magat reservoir space to flood control (139MCM) was found to be the optimum combination of the proposed Siffu No.1, Matuno No.1 and Alimit No.1 dams.

The flood control capacity was accumulated at the obtained optimum scale of Siffu No.1 and Mallig No.2 dams.

The storage capacities of the proposed multipurpose dams are summarized below.

(Unit: million $m^3$)

| Storage Capacity | Siffu No.1 | Mallig No.2 | Matuno No.1 | Alimit No.1 | Total |
|---|---|---|---|---|---|
| Own water supply | 52 | 545 | 61 | 0 | 658 |
| Water supply to complement to Magat | 41 | 0 | 36 | 156 | 233 |
| Flood control | 115 | 112 | 0 | 0 | 227 |
| Total | 208 | 657 | 97 | 156 | 1,118 |

The multipurpose projects served by the multipurpose dams had the following schemes with different purposes:

| Multipurpose Project | Schemes | EIRR (%) |
|---|---|---|
| Siffu Project | Siffu flood control scheme<br>Siffu hydropower scheme<br>Siffu water supply<br>Supplement of deficit in Magat project | 14.5 |
| Mallig Project | Chico-Mallig irrigation scheme<br>Mallig flood control scheme | 15.2 |
| Matuno Project | Matuno hydropower scheme<br>Matuno irrigation scheme<br>Municipal water supply<br>Supplement of deficit in Magat project | 15.3 |
| Alimit Project | Alimit hydropower scheme<br>Supplement of deficit in Magat project<br>Compensation of flood control space of Magat dam | 12.1 |

### 3.1.8 Master Plan

In order to select schemes for inclusion in the proposed Master Plan, the following principles were employed:

1) Although the economic viability of a multipurpose project was of importance, high priority must be given to projects which satisfied a deficit in water or hydropower.

2) To achieve the GVA target in 2005, it was assumed that more than 10% of the projected flood damage of Pesos 8,998 million in 2005 at 1985 constant prices should be prevented.
3) To develop the lowlands fully, all the proposed 9 irrigation development and 5 irrigation rehabilitation schemes should be selected.
4) The uplands were to be developed and the present land use area of 154,000 ha should be extended to 267,000 ha by 2005.
5) The least costly alternative schemes should be selected to satisfy the hydroelectric demands.

In conformity with these principles, the following projects and schemes were selected for inclusion in the proposed Master Plan:

| | | |
|---|---|---|
| Multipurpose Projects | | |
| 1) | Siffu Project | (Siffu No.1 Dam) Earthfill type, 58 m high, 1.7 million $m^3$ in embankment volume, 93 million $m^3$ in effective storage volume, 115 million $m^3$ in flood control space,<br>(Siffu Hydropower Scheme) Installed capacity of 5.4MW, energy output of 41.1GWh, gross head of 40 m,<br>(Project Cost) Pesos 1,057 million (US$ 55.6 million) |
| 2) | Mallig Project | (Mallig No.2 Dam) Rockfill type, 84 m high, 2.4 million $m^3$ in embankment volume, 545 million $m^3$ in effective storage volume, 112 million $m^3$ in flood control space,<br>(Chico Mallig Irrigation Scheme) Service area of 31,200 ha, Transbasin diversion tunnel with a diameter of 4 m and a length of 4 km, headrace channel with a length of 1.6 km, diversion canal with a discharge capacity of 59.3 $m^3$/s and a length of 34.7 km,<br>(Project Cost) Pesos 3,715 million (US$ 196 million) |
| 3) | Matuno Project | (Matuno No.1 Dam) Rockfill type, 147 m high, 10 million $m^3$ in embankment volume, 97 million $m^3$ in effective storage volume,<br>(Matuno Hydropower Scheme) Installed capacity of 180MW, energy output of 528GWh, gross head of 220 m,<br>(Matuno Irrigation Scheme) Service area of 12,860 ha, main canal with a discharge capacity of 12.6 $m^3$/s and a length of 90.4 km,<br>(Project Cost) Pesos 5,855 million (US$ 308 million) |
| 4) | Alimit Project | (Alimit No.1 Dam) Concrete dam, 89 m high, 0.65 million $m^3$ in concrete volume, 156 million $m^3$ in effective storage volume,<br>(Alimit Hydropower Scheme) Installed capacity of 12.2MW, energy output of 80.6GWh, gross head of 75 m,<br>(Existing Magat Dam) To provide a flood control space of 139 million $m^3$ ,<br>(Project Cost) Pesos 2,037 million (US$ 107 million) |
| Flood Control Schemes | | |
| 1) | Tuguegarao Dike | (Dike) To protect Tuguegarao town proper from 25 years flood and bank erosion, dike length of 22.1 km, embankment volume of 2.35 million $m^3$, revetment of 190,000 $m^2$, 33 units drainage sluices,<br>(Project Cost) Pesos 554 million (US$ 29.2 million) |
| 2) | Narrows Improvement (Nassiping left bank, NLL) | (Widening) To lower flood water level by widening the narrow sections, channel length of 3.8 km, excavation volume of 5.83 million $m^3$,<br>(Project Cost) Pesos 978 million (US$ 51.5 million) |

| | | |
|---|---|---|
| 3) | Cabagan Dike | (Dike) To protect Cabagan town proper from 25 years flood and bank erosion, dike length of 15.4 km, embankment volume of 1.24 million $m^3$, revetment of 82,200 $m^2$, 23 units of drainage sluices,<br>(Project Cost) Pesos 307 million (US$ 16.2 million) |
| 4) | Narrows Improvement (Nassiping right bank, NLR) | (Widening) To lower flood water level by widening the narrow sections, excavation volume of 17.62 million $m^3$,<br>(Project Cost) Pesos 2,957 million (US$ 156 million) |
| 5) | Bank Protection Works | (Bank Protection) 75 sites, total length of 112.3 km, revetment of 838,000 $m^2$, 1,880 units of groynes,<br>(Project Cost) Pesos 970 million (US$ 51.1 million) |
| Agricultural Development Schemes | | |
| 1) | Irrigation Development/Rehabilitation Schemes | |
| a) | Pinacanauan Irrigation Scheme | (Rehabilitation) Service area of 1,200 ha,<br>(Project Cost) Pesos 23 million (US$ 1.2 million) |
| b) | Dabubu Irrigation Scheme | (Development) Service area of 1,200 ha, main canal with a discharge capacity of 1.2 $m^3$/s and a length of 13.6 km,<br>(Santo Niño Dam) Earthfill type, 18 m high, 0.15 million $m^3$ in embankment volume,<br>(Project Cost) Pesos 99 million (US$ 5.2 million) |
| c) | Ilagan Irrigation Scheme | (Development) Service area of 3,200 ha, main canal with a discharge capacity of 7.2 $m^3$/s and a length of 16.9 km,<br>(Project Cost) Pesos 166 million (US$ 8.7 million) |
| d) | Solana Irrigation Scheme | (Rehabilitation) Service area of 2,829 ha,<br>(Project Cost) Pesos 73 million (US$ 3.8 million) |
| e) | Lulutan Irrigation Scheme | (Development) Service area of 2,950 ha, 4 units of pumps with gross head of 26 m,<br>(Project Cost) Pesos 184 million (US$ 9.7 million) |
| f) | Gappal Irrigation Scheme | (Development) Service area of 4,400 ha, main canal with a discharge capacity of 5.98 $m^3$/s and a length of 40.3 km,<br>(Santa-Maria Dam) Earthfill type, 26.5 m high,<br>(Calaocan Dam) Earthfill type, 30.5 m high,<br>(Colorado Dam) Earthfill type, 32.5 m high,<br>(Project Cost) Pesos 606 million (US$ 31.9 million) |
| g) | Alcala-Amulung Scheme | (Development) Service area of 6,750 ha, 6 units of pumps with gross head of 28.6 m, main canal with a discharge capacity of 9.4 $m^3$/s and a length of 27.8 km,<br>(Project Cost) Pesos 434 million (US$ 22.8 million) |
| h) | Tuguegarao Irrigation Scheme | (Development) Service area of 1,400 ha, main canal with a discharge capacity of 1.5 $m^3$/s and a length of 9.5 km,<br>(Project Cost) Pesos 99 million (US$ 5.2 million) |
| i) | Baggao Irrigation Scheme | (Rehabilitation) Service area of 1,812 ha, main canal with a discharge capacity of 2.2 $m^3$/s and a length of 24.8 km,<br>(Paranan Dam) Rockfill type, 50 m high, 0.64 million $m^3$ in embankment volume, 18.1 million $m^3$ in effective storage volume, Paranan Hydropower Scheme with installed capacity of 0.6MW, energy output of 4.96GWh and gross head of 39 m,<br>(Project Cost) Pesos 451 million (US$ 23.7 million) |
| j) | Dummon Irrigation Scheme | (Rehabilitation) Service area of 2,070 ha, main canal with a discharge capacity of 4.9 $m^3$/s and a length of 20.4 km,<br>(Dummon Dam) Rockfill type, 36 m high, 0.49 million $m^3$ in embankment volume, 24.1 million $m^3$ in effective storage volume, Dummon Hydropower Scheme with installed capacity of 0.6MW, energy output of 4.21GWh and gross head of 25 m,<br>(Project Cost) Pesos 449 million (US$ 23.6 million) |

| | |
|---|---|
| k) Zinundungan Irrigation Scheme | (Development) Service area of 1,750 ha, main canal with a discharge capacity of 5.9 $m^3/s$ and a length of 27.6 km,<br>(Zinundungan Dam) Concrete gravity type, 48 m high, 60,500 $m^3$ in concrete volume, 53.1 million $m^3$ in effective storage volume, Zinundungan Hydropower Scheme with installed capacity of 1.4MW, energy output of 10.21GWh and gross head of 33 m,<br>(Project Cost) Pesos 418 million (US$ 22.0 million) |
| l) Tumauini Irrigation Scheme | (Rehabilitation) Service area of 3,987 ha, main canal with a discharge capacity of 9.2 $m^3/s$ and a length of 23.5 km,<br>(San Vicente Dam) Earthfill type, 30 m high, 0.38 million $m^3$ in embankment volume, 6.9 million $m^3$ in effective storage volume,<br>(Project Cost) Pesos 378 million (US$ 19.9 million) |
| 2) Diversified Crops Development | 170,000 ha under rainfed condition, |
| 3) Permanent Crops Development | 57,000 ha with small impounding, |
| 4) Pasture Land Development | 210,000 ha with small impounding, |
| 5) Magat O&M | Improvement of Magat River Integrated Irrigation System operation and maintenance, service area of 97,400 ha,<br>(Project Cost) Pesos 1,060 million (US$ 55.8 million) |
| (Chico Mallig and Matuno Irrigation Schemes are outlined in Multipurpose Projects.) | |
| Hydropower Development Schemes | |
| 1) Ibulao Hydropower Scheme | (Scheme) Installed capacity of 17MW, energy output of 85GWh, gross head of 274 m,<br>(Project Cost) Pesos 551 million (US$ 29.0 million) |
| 2) Tanudan Hydropower Scheme | (Scheme) Installed capacity of 25MW, energy output of 130GWh, gross head of 270 m,<br>(Project Cost) Pesos 646 million (US$ 34.0 million) |
| 3) Diduyon Hydropower Scheme | (Scheme) Installed capacity of 352MW, energy output of 957GWh, gross head of 486 m,<br>(Project Cost) Pesos 8,915 million (US$ 469 million) |
| (Matuno, Alimit and Siffu Hydropower Schemes are outlined in Multipurpose Projects. Hydropower developments of Dummon, Paranan and Zinundungan are incidental to the relevant irrigation schemes.) | |

Total cost for the proposed Master Plan was estimated to be Pesos 32,983 million (US$ 1,736 million). The location of the selected projects and schemes are shown in Figure 3.1.1. The implementation schedule and assumed cost disbursement for the Master Plan are shown in Figure 3.1.2 and Table 3.1.1.

The effects of the Master Plan might be summarized as follows:

1) Increase of job opportunities, and family income and consumption.
2) Land enhancement due to flood protection.
3) Improvement of sanitary conditions due to flood control and improved municipal water supply.
4) Improvement of cultural situation and life style due to electrification.
5) Technical innovation by industrialization and agricultural management.
6) Evolution of urbanization.
7) Environmental pollution due to industrialization, livestock industry and agricultural chemicals.

### 3.1.9 Short Term Plan

Schemes proposed for implementation within 10 years were selected among the projects in the Master Plan for inclusion in the proposed Short Term Plan. The preparation of project proposals and implementation programs was recommended. Related preparatory work such as topographic surveys, geological investigations and budgetary arrangements was specified and recommended.

The selected schemes for the Short Term Plan were as follows:

| | |
|---|---|
| Multipurpose Projects | 1) Siffu project<br>2) Mallig project<br>3) Matuno project |
| Flood Control Schemes | 1) Tuguegarao dike<br>2) Narrows improvement (Nassiping left bank, NLL)<br>3) Bank protection works |
| Agricultural Development Schemes | 1) Pinacanauan irrigation scheme (rehabilitation)<br>2) Dabubu irrigation scheme (development)<br>3) Model developments in the uplands with Santor dam and Carmencita pond |

The implementation schedule of the proposed Short Term Plan is shown in Figure 3.1.3.

## 3.2 Change in Cagayan River Basin after 1987 Master Plan

### 3.2.1 Socio-economic Condition

(1) Population

A population in the Cagayan River Basin was estimated at 1.88 million in the 1980 census year, which was considered as a basic figure for basin framework in the 1987 Master Plan. In the 1995 census year, the basin population increased to 2.55 million, considered as a basic figure for this reviewed master plan. Its increment was 0.67 million for 15 years. Its annual growth rate was 2.07% on average. The population change by province in the basin was summarized as follows.

(Unit: 1000)

| Province | 1987 Master Plan*1 | Reviewed Master Plan*2 | Increment | Average Growth Rate (%) |
|---|---|---|---|---|
| Cagayan | 422.6 | 562.2 | 139.6 | 1.92 |
| Isabela | 831.7 | 1,127.0 | 295.3 | 2.05 |
| Nueva Vizcaya | 227.1 | 316.1 | 88.9 | 2.23 |
| Quirino | 84.0 | 131.1 | 47.1 | 3.01 |
| Ifugao | 111.6 | 149.6 | 38.0 | 1.97 |
| Kalinga | 117.0 | 156.1 | 39.2 | 1.94 |
| Apayao | 12.3 | 14.5 | 2.2 | 1.11 |
| Mt. Province | 66.8 | 88.6 | 21.8 | 1.91 |
| Aurora | 4.8 | 8.8 | 4.0 | 4.13 |
| Basin | 1,877.9 | 2,554.2 | 676.2 | 2.07 |

Note: *1 1980 Population and Housing Census
*2 1995 Population and Housing Census

As shown in the table above, the basin population within Region 2 accounted for 83% in the 1987 Master Plan and 84% in the reviewed master plan against the total basin population. Thus, its growth rate was slightly higher than other parts, i.e., CAR and Region 4 in the basin.

An urban population in the basin was estimated at only 0.34 million in the total population of 1.88 million in the 1987 Mater Plan. It accounted for 17% only. In the 1990 census year, the urban population accounted for 22% of the basin population. In the basin, thus, some rural population migrated to urban areas in the basin for 10 years.

(2) Regional Accounts

GRDP of Region 2 in 1985 in the 1987 Master Plan was 15.3 billion Pesos. In 1999 in the reviewed mater plan, GRDP of Region 2 was 17.5 billion Pesos at 1985 constant prices. Then, 2.2 billion Pesos or 14% of the 1985 GRDP value increased for 13 years between these master plans. The regional growth rate was calculated at 1.0% on average, which was considerably lower than the national average growth rate of 3.4%. The respective GRDPs were composed of the following GVAs of the main economic sectors.

(Unit: Million Pesos)

| Province | 1987 Master Plan*1 | Reviewed Master Plan*2 | Increment | Average Growth Rate (%) |
|---|---|---|---|---|
| Agriculture | 6,843 | 8,225 | 1,382 | 1.43 |
| Industry | 3,093 | 2,767 | -326 | -0.85 |
| Manufacturing | 783 | 691 | -92 | -0.96 |
| Other Sub-sectors | 2,310 | 2,076 | -234 | -0.82 |
| Services | 5,372 | 6,460 | 1,088 | 1.43 |
| GRDP | 15,309 | 17,473 | 2,164 | 1.02 |
| Per Capita GRDP (Pesos) | 7,225 | 6,441 | -784 | -0.88 |

Note: *1 1985 GRDP in Region 2
*2 1998 GRDP in Region 2 at 1985 constant prices

As shown in the table above, agriculture and services sectors increased 1.3 billion Pesos and 1.1 billion Pesos for 13 years, respectively. Industry sector, however, decreased 0.3 billion Pesos for 13 years. In particular, manufacturing sub-sector decreased by 0.09 billion sector or grew at an average rate of –0.96% per annum.

Per capita GRDP was 7,225 Pesos in 1985 and 6,441 Pesos in 1998 at 1985 constant prices. It decreased 784 Pesos for 13 year at 1985 constant prices. Its annual growth rate was negative 0.88% on average.

Price indices between 1985 and 2000 were summarized as follows. A consumer price index (CPI) in Region 2 increased 3.3 times between the 1987 Master Plan and the reviewed master plan. For the same period, a wholesale price index also increased 2.54 times. Foreign exchange rate changed from 20.6 Pesos per US$ in 1985 to 44.9 Pesos per US$ in July 2000.

| Year | CPI (1994=100) | WPI (1985=100) |
|---|---|---|
| 1985 | 45.9 | 100.0 |
| 2000 | 153.0 | 253.5 |
| Ratio | 3.33 | 2.54 |

Note: *1 Consumer Price Index in Region 2
*2 Wholesale Price Index in Metro Manila in July 2000

### 3.2.2 Flood Control

River channel condition in the recent 10 years has been aggravated based on the study results on the river channel variation. Especially, serious riverbank erosions have increased to 73 sites as identified in the present study from 43 sites in the study in 1987. Hence, various sites have continuously been damaged. On the other hand, low-lying areas in the alluvial plain formed by the Cagayan River have been continuously suffering from frequent inundation, especially in the upstream reaches at Alcala.

Apart from the above, sediment discharges from the upper basin of the Magat River have increased according to the current data. Such increases in sediment discharge are the results mainly of deforestation in the watershed and land collapse caused mainly by the 1990 earthquake.

The JICA study in 1987 recommended the implementation of the urgent works as priority projects selected from the said Master Plan to mitigate flood damage in the basin. However, due to budget limitations, they have not yet been realized. Small-scale and piecemeal flood control works only have been carried out mainly by the DPWH.

From the above, it is concluded that the present situation of the flood control/damage mitigation in the basin has not changed for the better, compared with that in 1987.

### 3.2.3 Watershed Management

The forest cover of the Cagayan River basin was 11,528 km$^2$ equivalent to 42.3% of the basin at the 1987 Master Plan Study stage. The present forest cover is 10,975 km$^2$ equivalent to 40.2% of the basin according to SAFDZ of BSWM (1999). The change in the forest cover mentioned above reveals that the forest area in the basin has gradually decreased.

Land collapse and sediment deposit caused by the earthquake occurred in July 1990 are remarkable in the upper Magat River basin including the Santa Cruz

River, Balilim River and Santa Fe River. Depths of the sediment deposited in the river courses reach 1 to 6 m after the 1990 earthquake.

The land collapse/sediment as well as severe basin erosion have affected the reservoir capacity of the existing Magat Dam. The accumulated sediment volume is 188MCM in 1999, of which 98MCM deposits in the dead storage space and the remaining 90MCM deposits in the live storage space.

The recent global trend on environmental conservation has highlighted a need to restore forest so as to protect the environment and mitigate $CO_2$.

### 3.2.4 Agriculture

(1) Agricultural Production

Paddy and corn production change is estimated by comparing 1982-84 averaged value (A) in the Basin in 1987 MP with 1990-99 averaged one (B) in M/P Area. During this period, paddy production increased due to increase in yield and harvested area. The share of the M/P Area in the nation became 13.8%. Corn production increased due to increase in yield even though harvested area decreased slightly. The share of the M/P Area in the nation became 14.0%. In 1987 MP time, white corn of traditional variety as food occupied over 90%, however yellow corn as feed shares around 87% recently.

(2) Irrigation

At the time of 1987 MP, three on-going national irrigation projects (NIPs) were under construction, which were completed and four national irrigation systems (NISs) were installed in the Basin. After that, no NIP was completed, though Adalam River Irrigation Project is on-going and a part of another on-going NIP is included in the Basin. Some of the NISs reduced their service areas because of deterioration of the system facilities, though part of nationwide rehabilitation programs have been implemented. The total service area of NIS and communal irrigation system (CIS) changed only little from 209,100 ha (NIS: 150,800, CIS: 58,300) to 218,200 ha (NIS: 140,000, CIS: 78,100).

### 3.2.5 Other Sectors

Gross energy generation in the Luzon grid was 30,732 million KWh in 1999 according to NAPOCOR. At present, no energy deficit is seen in the Cagayan River basin except for minor power cutoff due to inferior distribution system.

The 1987 Master Plan Study projected the source water requirement to be 579,848 $m^3$/day for the year 2000 in terms of the municipal water in the Cagayan

River basin. The review of the 1987 Master Plan leads to a requirement of 282,540 $m^3$/day for the year 2000, which is about half of the projection of the 1987 Master Plan owing to low population increase and stagnant economic activities in the basin.

## 3.3 Need of Review of 1987 Master Plan

### 3.3.1 Updating of the 1987 Master Plan

About 14 years have passed since the 1987 Master Plan was formulated for the Cagayan River basin. Difference between the projected socio-economic bases for the 1987 Master Plan such as population, GVAs or GRDP and the actual values have appeared during these 14 years. No major flood control projects proposed in the 1987 Master Plan have been implemented. Only 9,000 ha of irrigation area have been added since the year 1987 in the national irrigation system and communal irrigation system in the basin. The watershed conservation has been recognized to be one of the important sectors in the basin development plan. The above mentioned facts lead to the necessity for review of the 1987 Master Plan.

### 3.3.2 Basic Approach of the Review of the 1987 Master Plan

The review of the 1987 Master Plan has been conducted by incorporating candidate projects studied in the sectors of flood control, watershed management and land use. In these sectors, the Long Term Plans formulated in the 1987 Master Plan were reviewed considering the present basin situation on the basis of the Framework Plan of the 1987 Master Plan.

The Framework Plan is a potential development plan with future prospect scale. In the review of the 1987 Master Plan, the Framework Plan of the 1987 Master Plan has been adopted for that of the Reviewed Master Plan without modification, because potentials of the Cagayan River basin have not changed since the formulation of the 1987 Master Plan.

The Long Term Plan is a sectoral development plan consisting of socially, economically and environmentally viable projects. For the sector of the flood control, the Long Term Plan has been formulated under the condition of 25 years probable flood.

The Master Plan is an integrated development plan with the projects selected among those in the Long Term Plans. The Reviewed Master Plan has been formulated incorporating the selected projects to be implemented up to the target year 2020. The selection of the projects has been made considering a strategic investment amount, urgency, contribution to equitable development of the basin and environmental aspects.

# CHAPTER 4 SOCIO-ECONOMIC FRAMEWORK PLAN

## 4.1 Basic Policy of Socio-economic Development

### 4.1.1 National Development Policy

Under the new administration in 1999, the "Medium-Term Philippine Development Plan 1999-2004" proposes the following policies for sustainable development and growth with social equity:

(a) Acceleration of agricultural growth through modernization programs;

(b) Delivery of basic social development services such as health/nutrition, education/training, housing, social welfare and social safety net programs;

(c) Strengthening competitiveness of domestic markets by means of privatization, deregulation and liberalization;

(d) Support of infrastructure development mainly by the private sector with government intervention as necessary in rural areas;

(e) Ensuring macroeconomic stability to bring the regional economy back to positive growth; and

(f) Reforming political, economic and administrative governance for stability of the political environment, reducing crime, and protection of basic human rights.

Promoting the new policies above, the latest plan proposes that the government aim is to attain the following economic growth in GDP and GRDP figures during the planning period.

| Scenario/ Area | 1998 (Actual) (Billion Pesos) | Projection (Billion Pesos at 1998 Prices) | | Ave. Growth Rate (% Per Annum) |
|---|---|---|---|---|
| | | 1999 | 2004 | |
| GDP Growth Scenarios in Country | | | | |
| High Growth | 2,667 | 2,752 | 3,628 | 5.3 |
| Low Growth | 2,667 | 2,736 | 3,505 | 4.7 |
| Low Growth Scenario without El Nino occurrence in 2001 and 2004 | | | | |
| NCR | 925 | 949 | 1,268 | 5.4 |
| CAR | 60 | 62 | 93 | 7.7 |
| Region 2 | 55 | 57 | 77 | 6.0 |
| Other Regions | 1,628 | 1671 | 2,175 | 5.0 |
| Philippines | 2,667 | 2,738 | 3,613 | 5.2 |

Incidentally, GDP per capita in 2004 is estimated at 43,800 Pesos at 1998 constant prices under a low growth scenario without an El Niño occurrence between 2001 and 2004. In the same manner, the GRDP per capita of Region 2 was estimated at 25,600 Pesos in 2004, accounting for 58% of the national average.

### 4.1.2 Regional Development Policy

Corresponding to the "Medium-Term Philippine Development Plan 1999-2004", the "Cagayan Valley Strategic Development Plan 1999-2004" was published by NEDA Region 2 in 1999. The plan declared its long-term vision for development stated by the plan, was as follows: "Cagayan Valley is a region of world class, empowered and productive citizenry with competitive agri-industrial economy, modern infrastructure, responsive basic services and well-managed ecosystem in peaceful and orderly communities with one god among themselves and with the rest of the world".

In the plan, the government proposed three development strategies for regional development. They are (1) balanced regional agro-industrial and natural resources (BRAIN) development strategy, (2) decisive people empowerment (DPE), which focuses on improving the quality of life of the people and on ensuring people participation in the overall decision-making for regional development, and (3) mid-rib peripheral/growth center development strategy, which provides a rational prioritization and direction of physical and socio-economic development in the region. The development strategies aim at the national twin goals of global competitiveness and people empowerment.

Promoting the strategies, the latest plan suggested that the government would attain the following economic growth in GRDP and gross value added (GVA) of the major economic sectors during the planning period.

| Item | 1999 | 2004 | (% Per Annum) |
|---|---|---|---|
| GRDP at 1985 Constant Prices | | | |
| GRDP (Billion Pesos) | 17.97 | 24.50 | 6.4 |
| Agriculture | 9.12 | 11.71 | 5.1 |
| Industry | 2.21 | 3.83 | 11.6 |
| Services | 6.64 | 8.96 | 6.4 |
| GRDP per Capita (1000 Pesos) | 6.53 | 8.09 | 4.4 |
| GRDP at 1998 Constant Prices | | | |
| GRDP (Billion Pesos) | 56.77 | 77.48 | 6.4 |
| GRDP per Capita (1000 Pesos) | 20.62 | 25.57 | 4.4 |

GRDP in Region 2 was estimated as 77.5 billion Pesos at 1998 constant prices, growing at 6.4% per annum on average during the planning period. GRDP per capita was estimated as 25,600 Pesos, growing at 4.4% per annum on average. The agriculture sector was expected to grow at 5.1%, which was the lowest rate among the major three economic sectors, so its GVA share decreased from 51% in 1999 to 48% in 2004 although it still was the leading economic sector in the region. On the other hand, since the industry sector was expected to grow at 11.6%, its GVA share increased from 12% in 1999 to 16% in 2004.

## 4.2 Regional Development Plans

### 4.2.1 Existing Development Plans

There are three types of development plans in the Philippines. They are (a) physical framework and comprehensive land use plan (PFCLUP), (b) socio-economic development plan (DP) and (c) investment program (IP). From the viewpoint of time series, the PFCLUP is released in the first place among the plans. The present PFCLUPs cover a planning period of 10 years from 1993 to 2002. The DP is organized for developing socio-economic activities in the territory. The IP is drawn up to support the activities by means of budgetary appropriation from treasury. These plans are provided in the respective government levels in principle, i.e., national, regional, provincial/city and municipal levels. In principle, the plans are formulated under bottom-up policy from municipal level to national level.

Under the "Medium-Term Philippine Development Plan 1999-2004", the "Cagayan Valley Strategic Development Plan 1999-2004" is an existing DP in use in Region 2. It includes economic development strategies and targets in the region. NEDA Regional 2 also publishes a regional IP, named as "Cagayan Valley, Regional Development Investment Program 1999-2001". The respective provinces publish their DP and IP, corresponding to the regional ones.

### 4.2.2 Economic Development Projection by NEDA Regional Office 2

The JICA study team made a request to NEDA Region 2 for an economic growth projection in the region, since no information in terms of long-term economic development was available. They drew up a long-term economic growth projection beyond 2004, after our repeated requests. The projection includes two scenarios, that is, high and low. The GRDP in Region 2 was projected as follows.

| Scenario | MTDP | NEDA Projection | | | Growth Rate (%) | |
|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2010 | 2020 | 2005/'10 | 2010/'20 |
| Low Scenario | | | | | | |
| GRDP (Billion Pesos) | 77.5 | 83.1 | 100.6 | 143.0 | 3.9 | 3.6 |
| GRDP per Capita (1000Pesos) | 25.6 | 26.9 | 30.1 | 38.2 | 2.3 | 2.4 |
| High Scenario | | | | | | |
| GRDP (Billion Pesos) | 77.5 | 83.1 | 126.6 | 268.3 | 8.8 | 7.8 |
| GRDP per Capita (1000Pesos) | 25.6 | 26.9 | 37.9 | 71.7 | 7.1 | 6.6 |

In order to draw up the growth projection, NEDA staff assumed the following conditions.

a) The agro-fishery modernization act (AFMA) is implemented on schedule. It will have a direct impact on the agriculture sector in the region. The fishery sector is expected to undergo rapid development for better production.
b) The Cagayan Economic Zone Authority (CEZA) is expected to develop the industry sector, especially manufacturing. Its on-site developments have provided job opportunities in the area. Once in operation, its investment invites skilled local labor to tend to all the needs of industries and has an accordion effect to the services sector. In addition to the public sector, the private sector is expected to take the initiative in implementation of these development works through BOT (Build-Operate-Transfer) system.
c) The dual effect of AFMA and CEZA supported by the increasing economic activities promises a sound services sector.

## 4.3 Socio-Economic Framework

### 4.3.1 Target Year

In the inception report, the target year of this project was set as 2015. The Steering Committee suggested extending the planning target year to 2020 instead of 2015 in accordance with other long-term development plans in the Philippines, which have set their target year at 2020. After the Advisory Committee agreed to extend the target year to 2020, the target year was set as 2020.

### 4.3.2 Population

The NSO presents population estimates for the country and for its subdivision down to provincial level for 25 years from 1996 to 2020 in the publication of "1995 Census-Based National, Regional and Provincial Population Projections" in May 1998. The national population is projected under the three assumptions, i.e., high, medium and low. The regional and provincial population projections are based on the medium growth scenario. The following table shows the future basin population estimated on the basis of the said projection.

| Province | 1995 Census Population (1000) | Projected Population in Cagayan River Basin (1000) | | |
|---|---|---|---|---|
| | | 2000 | 2010 | 2020 |
| Cagayan | 562 | 617 | 715 | 790 |
| Isabela | 1,125 | 1,262 | 1,505 | 1,672 |
| Nueva Vizcaya | 314 | 352 | 425 | 483 |
| Quirino | 131 | 151 | 191 | 226 |
| Apayao | 14 | 16 | 19 | 21 |
| Ifugao | 150 | 168 | 202 | 232 |
| Kalinga | 154 | 171 | 201 | 222 |
| Mt. Province | 89 | 97 | 113 | 127 |
| Aurora | 9 | 10 | 12 | 14 |
| Cagayan R. Basin | 2,548 | 2,844 | 3,383 | 3,787 |

The future basin populations projected in the years 2000, 2010 and 2020 are 2.84 million, 3.38 million, and 3.79 million, respectively. The respective annual growth rates are 2.22%, 1.75% and 1.13% on average.

### 4.3.3 Economic Conditions

Referring to the economic development projection by NEDA Region 2, the JICA study team drew up a presumable growth scenario in Region 2. In its scenario, the goal for per capita GRDP in Region 2 is for it to attain the national average excluding the National Capital Region (NCR) by the target year 2020. The economic growth scenario was drawn up on the basis that the following economic events could be implemented during the planning period.

a) The national economy grows at the same rate of 5.2% as proposed under the low growth scenario without any El Niño occurrence from 2001 to 2004 in the "Medium-Term Philippine Development Plan 1999-2004".

b) As a result, the target of economic development in Region 2 is estimated at 56,100 Pesos per capita in the target year 2020.

c) At least, Region 2 grows at least in accordance with the low growth scenario, drawn by NEDA Region 2 on the basis of the past regional trend.

d) The central government already appropriated an initial funding of 447 million Pesos for AFMA for Region 2. The fund is expected to increase in proportion to the national economic growth of 5.2% annually until the target year.

e) CEZA estimates the total investment for the entire project as around 120 billion Pesos, including private and public investment. Of the total amount, approximately 50% or 61 billion Pesos are invested by the public sector. In 2000, the government appropriates 108 million Pesos. By the target year, at least half of the public investment will be implemented.

f) An incremental capital-output ratio (ICOR) of Region 2 will be maintained at 5.9 till 2005, the same rate as the present one. It is assumed to be improved to the national level, of 5.5, by the target year 2020. Regarding the ICORs, refer to Table 4.3.1.

In addition to these projects, "Water Resources Development Projects" were proposed to push up the regional economy in the basin since the 1987 Master Plan was adopted by the government. However, progress has been meager, even though the existence of the plan was well known among the agencies concerned. The plan is an important component to encourage the regional economy. Thus, the plan should be implemented as soon as possible for promotion of the regional economy.

g) Once the government invests 30 billion Pesos by the target year 2020, it would produce the economic goal of 56,100 Pesos per capita in Region 2. To attain the economic goal of 56,100 Pesos in 2020, the government should invest its fund of approximately 30 billion Pesos in Water Resources Development Projects in addition to the projects above by the target year 2020. Incidentally, this corresponds to one-third of the total investment costs of 90.6 billion Pesos at 1998 constant prices.

h) In pursuance of these special projects, ripple effects and private capital formation will take place in the region. For instance, many CEZA projects lead the investment from the private sector through the BOT system. The detailed CEZA projects are listed in the Supporting Report ANNEX I. In addition, the private development activities related to the proposed projects will be induced by the major CEZA development works. In the water resources development projects, the same effects will be expected in accordance with their implementation. Thus, the total amount is estimated applying the past trend of gross fixed capital formation, i.e., four points of private investment against one point of public investment. The total amount is expected at 327 billion Pesos in total by 2020.

The total amount of the investment required in the region during the planning period is summarized in the table below.

(Unit: Billion Pesos)

| Item | Investment | | Accumulated Investment | | |
|---|---|---|---|---|---|
| | 2010 | 2020 | 2000-'10 | 2011-'20 | Total |
| 1. Current Projects | 15.2 | 32.4 | 258.8 | 250.1 | 508.9 |
| 2. Special Projects | 20.0 | 33.3 | 141.7 | 267.6 | 409.3 |
| • AFMA | 0.7 | 1.2 | 6.4 | 9.9 | 16.3 |
| • CEZA | 1.6 | 2.7 | 13.3 | 21.9 | 35.2 |
| • Water Resources | 1.6 | 2.7 | 8.6 | 21.7 | 30.3 |
| • Other Capital Formation | 16.0 | 26.6 | 113.4 | 214.1 | 327.4 |
| 3. Total | 35.2 | 65.7 | 400.6 | 517.7 | 918.2 |

The investment required to attain the target growth was projected on the basis of a simple model applying past growth trend data and ICOR in the region. This is one of the simulation methods for projection. Once another simulation model were applied for the projection, the predicted investment required would be different. As a reference, hence, a simulation trial is conducted and its report is attached in the Supporting Report, ANNEX I.

### 4.3.4 Poverty Alleviation

(1) Vicious Cycle of Farmer's Livelihood

A vicious cycle of farmer's livelihood was identified through interview survey of farmers engaging in the flood prone area. Farmers are suffering from ceaseless stress at all stage of farming. The factors affecting the farmer's livelihood are itemized as below:

a) Natural calamity of flooding and drought;
b) Shortage of dryers and storage facilities;
c) Traditional way of tenant farming system; and
d) Landless/jobless farmers.

In addition to these factors, the social environment in their livelihood should be considered, that is, the custom of holding extravagant feast, or celebration, beyond their means. Most farmers hold seasonal fiestas such as barangay feast, town fiesta, Christmas feast, New Year feast, and so on, inviting dozens of their relatives and friends. They usually spend more than 10,000 Pesos for one feast. They try to hold such a seasonal feast by borrowing money when they do not have enough money.

According to the farmers interviewed, in most cases, they are willing to hold such a feast even if they have to borrow money to hold it. In this respect, the habit might not be considered as a problem, but that this habit is oppressing their livelihood is an undeniable fact, and most of farmers do not recognize it.

(2) Development Expectation of Poverty Alleviation

The first step to poverty alleviation is to let the farmers to recognize the vicious cycle where they have got into. Moreover, the following actions would be possible solutions:

a) Construction of infrastructure to prevent crop damages by flooding and drought, such as irrigation and flood control facilities;
b) Promotion of a land reform program with appropriate support to the small-scale beneficiary farmers, that would enable them to continue

sustainable farming;

c) Establishment of farmer's organizations to promote cooperative activities for farming and for negotiating with landowners and traders; and

d) Strengthening of the formal financial assistance that enables farmers accessible to loans to solve the shortage of drying and storage facilities by themselves;

As shown in these actions, the water resources development schemes could help the farmers get out of the vicious cycle. Thus, the water resource development projects take an important role in solving the poverty alleviation.

The second step to poverty alleviation is to strengthen information, education and communication providing farmers with opportunities to recognize the situation that they are in and with possible solutions for each stage of the vicious cycle. Improvement of economic situation in the region could be effective for them to recognize their poverty situation and to identify solutions. By the year 2020, GRDP per capita in Region 2 is expected to reach to 56,100 Pesos at 1998 constant prices. This is almost 2.8 times that of 1998, and equal to the national average excluding NCR. This condition could be effective finally to alleviate poverty conditions. In fact, the poverty conditions in the region are being improved in accordance with the regional economic growth, as mentioned in the "Cagayan Valley Strategic Development Plan 1999-2004".

## 4.4 Investment for Water Resources Development

As discussed in the previous section, the government should invest approximately 30 billion Pesos for water resources development including flood control projects by the target year 2020, in order for the economic level to reach the target per capita GRDP in 2020. The implementation of projects among many components of water resources development would rather be selected on the basis of urgency, equitability and economic priority in the region.

As a result, the regional economy is expected to grow at an average rate of 6.2% during the planning period. Region 2 experienced this economic growth rate in 1987, 1994 and 1997 since 1985, as shown in the figure above. Although this level has not been reached very often, it would be possible for the region to manage its regional economic development with prudence. In 2020, the GRDP per capita is estimated at 56,100 Pesos. A summary of the projection is shown in Table 4.3.2.

# CHAPTER 5 METEOROLOGY AND HYDROLOGY

## 5.1 Scope of Meteorological and Hydrological Study

Meteorological and hydrological analysis for the Cagayan river basin was conducted during the 1987 Master Plan Study in mid-1980s. Approximately 15 years have passed since the analysis was conducted. Therefore, objectives of the meteorological and hydrological analysis in this JICA Study comprise the following major items:

(1) Study on meteo-hydrological observation network;
(2) Flood runoff analysis;
(3) Streamflow analysis;
(4) Water balance analysis;
(5) Sediment analysis;
(6) Riverbed fluctuation analysis; and
(7) Salinity Intrusion analysis.

## 5.2 Meteorological and Hydrological Observation System

### 5.2.1 Observation Network

(1) Meteorological Observation Network

Climate data such as temperature, humidity, evaporation, wind velocity and sunshine hours are collected by PAGASA. In addition, National Irrigation Administration (NIA) collects climate data at experimental stations, such as APC compound in Iguig, Cagayan. There are 17 meteorological observation stations in the Study Area as presented in Figure 5.2.1. 15 stations are maintained by PAGASA while the remaining 2 stations are maintained by NIA.

(2) Rainfall Observation Network

Daily rainfall data were collected at 64 PAGASA gauging stations during the 1987 Master Plan period. In addition, during this JICA Study, additional data were collected from 6 newly established gauging stations. The locations of these rainfall gauging stations are illustrated in Figure 5.2.1.

The hourly rainfall data are available for a relatively long period at Aparri and Tuguegarao during the 1987 Master Plan Study. However, since PAGASA commenced their rainfall data collection every three hours, the only hourly rainfall data available after the 1987 Master Plan are the ones observed at Magat

Damsite, Dantor, Halong, Buyoc, Dumayup (Baretbet) and Sto. Domingo. All stations are located in the upstream of Magat Dam and are maintained by NIA Magat operations room.

(3) Water Level and Discharge Observation Network

During the 1987 Master Plan, daily mean water level and river runoff data were collected at 76 gauging stations. The locations are shown in Figure 5.2.2. However, majority of observations has ceased and DPWH currently continues water level and discharge observations at 10 gauging stations (Lamo, Baliling, Bato, Ilut, Careb, Baretbet, Beti, Pingkian, Rosario and Upi). Hourly water level is observed at Tuguegarao by PAGASA during the rainy season.

Hourly discharges during typhoons were observed at Magat damsite, Matuno damsite, Palattao, Cabulay, Ibulao and Gabong during 1987 Master Plan. Presently, NIA observes hourly discharges during typhoons at Magat damsite only.

(4) Water Quality and Sediment Discharge Observation Network

DPWH observes water quality and sediment discharge simultaneously when the discharge measurements are made. Locations of these stations are given in Figure 5.2.2.

In general, there is no government agency with a clear mandate for observing and maintaining meteorological and hydrologic records. As mentioned above, related agencies such as NIA, DPWH and PAGASA collect data for their organizational purposes. As meteorological and hydrologic data are not shared among government agencies, duplication of efforts in data collection is seen. On the other hand, gauging stations are not uniformly distributed spatially.

### 5.2.2 Available Data

(1) Climatological Data

Availability of climatological data is summarized in Figure 5.2.3. Aparri and Tuguegarao gauging stations have records of 50 years. PAGASA observes rainfall, air temperature, relative humidity, sunshine duration, evaporation and wind velocity. NIA experimental stations observe solar radiation in addition to other items observed by PAGASA. Summary of meteorological records are presented in Table 5.2.1.

(2) Rainfall Data

Among the daily rainfall data obtained from 70 gauging stations in the Cagayan basin, 46 stations are used for further hydrological analysis, while the remaining 24 stations are rejected by double-mass curve analysis (refer to Supporting Report). Among these 46 stations, only 5 stations, namely Aparri, Tuao, Tuguegarao, Naneng, and Consuelo cover the observation period of 34 years from 1963 to 1998 as presented in Figure 5.2.4. Discontinuity of data collection as well as small number of gauging stations existing in the Cagayan river basin makes it difficult to conduct hydrological analysis for the basin with a catchment area of 27,281 $km^2$. Isohyetal map obtained from these data are presented in Figure 5.2.5.

Regression analysis was made with the rainfall data collected during the 1987 Master Plan Study period and additional rainfall data collected during this JICA Study. Correlation factor calculated for the rainfall data obtained during the 1987 Master Plan Study, i.e. 1960 to 1985, do not differ much from the additional rainfall data obtained during this JICA Study, i.e. 1986 to 1999.

(3) Water Level and Runoff Data

Among the daily mean water level and/or runoff data are collected at 78 gauging stations during the 1987 Master Plan Study, 23 stations are used for further hydrological analysis, while remaining 55 stations have been rejected by double mass curve analysis (refer to Supporting Report). List of streamflow gauging station is listed in Figure 5.2.6. Availability of the hydrograph and hourly rainfall records observed at damsites are listed in Table 5.2.2.

(4) Sediment Runoff and Water Quality Data

The suspended sediment load is observed at 25 stations in the tributaries of Cagayan river basin. No data is observed along the mainstream of Cagayan river. The list of stations collecting sediment load observation records and water quality record are presented in Figure 5.2.7. Detailed discussion on wash load is presented in Section 4.6 – Sediment Analysis.

(5) Tidal Level Data

The tide levels were observed at Aparri by National Mapping and Resource Information Authority (NAMRIA) during the 1960s. However, NAMRIA has since ceased tidal level observations. Therefore, no additional records of tidal level at Aparri have been obtained during this JICA Study.

### 5.2.3 Establishment of Gauging Stations and Measurement

During this JICA Study, pressure type automatic water level gauges and staff gauges have been installed at Magapit, Nassiping, Iguig and Sta. Maria along the Cagayan River mainstream. The Study Team has done operation and maintenance of the gauges together with DPWH counterpart personnel during the Study. Operation and maintenance of these gauges have been transferred to DPWH counterpart personnel.

(1) Water Level

Figure 5.2.8 presents the water levels measured at these four gauging stations. As shown in the Figure, Magapit gauging station shows the tidal effect in the water level measured. Measurement of River Water Level at the four (4) automatic gauging stations is being continued by DPWH counterpart personnel.

(2) River Runoff

Discharge measurement were undertaken on four occasions under the sub-contract works at four automatic gauging stations. In addition, discharge measurements are being continued by the DPWH counterpart personnel on a bi-monthly basis and during flood occurrence in order to obtain water level – discharge relationship at the four gauging stations.

## 5.3 Flood Runoff Analysis

### 5.3.1 Available Data

For rainfall analysis, hourly rainfall records of Aparri, Tuguegarao, as well as upstream of Magat dam at Sto. Domingo, Dumayup, Buyoc, Dantor, Halong and Magat Damsite are examined to analyze the storms, which struck the area. Flood hydrographs at Magat damsite are available to establish the flood runoff simulation model.

### 5.3.2 Methodology

As shown in the flow chart presented in Figure 5.3.1, the flood runoff analysis consists of establishment of river system model, rainfall analysis and flood runoff analysis. The storage function method has been applied for the runoff analysis.

### 5.3.3 River System Model

The basin division and the river system model used in the 1987 Master Plan Study have also been used in this JICA Study. The basin division is presented in

Figure 5.3.2 whereas the river system model is presented in Figure 5.3.3. A total of 9 Base points are defined at immediately upstream and downstream of the confluences of the Cagayan river and its major tributaries, i.e. Chico, Siffu, Ilagan, Magat river. As presented in Figure 5.3.3, Cagayan River basin is divided into 50 sub-basins and 30 river channels.

### 5.3.4 Rainfall Analysis

The rainfall duration for the flood runoff analysis, at base points 1 to 9 is decided to be 4 days, considering the past rainfall durations during typhoons. On the other hand, the duration is determined to be 1 day for runoff analysis at damsites considering lag time.

The mean probable basin rainfall is calculated from annual maximum basin rainfall by Pearson Type III method. The calculated probable rainfalls at the base points are shown in Table 5.3.1.

As in the Master Plan, the hourly rainfall distribution of probable 4-day rainfall is estimated. Comparison of the same figure with Master Plan Study is presented as follows:

| Volume ratio | 1987 Master Plan | This JICA Study |
|---|---|---|
| 1hr. rainfall/24hr.rainfall | 20.14% | 20.26% |
| 6 hr. rainfall/24 hr. rainfall | 65.90% | 65.63% |

As shown above, hourly rainfall distribution of the 1987 Master Plan and this JICA Study showed only a slight difference.

Since there is not enough rainfall data to examine areal distribution pattern of storm, the pattern of the probable rainfall is assumed to give the intensive rainfall to each of the basins of major tributaries. Among these rainfall patterns studied, the areal distribution which gives the largest runoff at the downstream end of the Cagayan River is adopted for flood runoff analysis. The distribution type of intensive rainfall in the Upper Cagayan basin is adopted to estimate the flood runoff in the main river because this type induces the largest runoff.

### 5.3.5 Flood Runoff Analysis

Based on the rainfall analysis presented above, the probable flood discharge was computed by the same method applied in the 1987 Master Plan. 100-year probable flood peak discharge for the base points and damsites are compared for the 1987 Master Plan and this JICA Study as given below.

**Comparison of Flood Peak Discharge (100 year probable flood) at Base Points**

| Base Point | 1987 MP ($m^3/s$) | this Study ($m^3/s$) | Remarks |
|---|---|---|---|
| BP-1 | 21,400 | 19,000 | Mouth of Cagayan Main Stream |
| BP-2 | 21,000 | 18,400 | Conf. of Cagayan and Chico (Nassiping) |
| BP-3 | 25,300 | 21,200 | Conf of Cagayan and Siffu |
| BP-4 | 23,500 | 20,200 | Conf of Cagayan and Ilagan |
| BP-5 | 14,700 | 13,600 | Conf of Cagayan and Magat |
| BP-6 | 8,700 | 8,000 | Chico River Mouth |
| BP-7 | 3,300 | 3,200 | Siffu River Mouth |
| BP-8 | 9,400 | 8,200 | Ilagan River Mouth |
| BP-9 | 10,600 | 9,900 | Magat River Mouth |

**Comparison of Flood Peak Discharge (100 year probable flood) at Damsites**

| Damsite | 1987MP ($m^3/s$) | this Study ($m^3/s$) | Damsite | 1987 MP ($m^3/s$) | this Study ($m^3/s$) |
|---|---|---|---|---|---|
| Casecnan | 20,700 | 18,900 | Ilagan | 8,950 | 7,300 |
| Cagayan 2 | 19,400 | 17,300 | Disabungan | 7,600 | 7,300 |
| Cagayan 1 | 17,200 | 17,000 | Siffu No.1 | 1,950 | 1,900 |
| Diduyon | 7,500 | 6,200 | Mallig No.2 | 1,100 | 1,100 |
| Addalam | 5,650 | 5,400 | Chico No.2 | 3,550 | 3,500 |
| Matuno | 2,050 | 2,000 | Chico No.4 | 4,500 | 4,500 |
| Alimit | 1,650 | 1,600 | Pinukpuk | 3,150 | 2,900 |

Owing to the fact that probable rainfall has shown similar results between 1987 Master Plan and this JICA Study, the probable peak discharge obtained in this JICA Study showed same results or slightly lower than that of the 1987 Master Plan.

As noted in the section of hydrological observation system, since PAGASA no longer observes hourly rainfall, availability of hourly rainfall data is limited. Considering the very limited number of rainfall data available for this JICA Study, no conclusion could be made that the probable flood peak discharge obtained in this JICA Study has higher accuracy than that obtained during 1987 Plan Study.

Therefore, adopting a conservative side of the plan, it is concluded that no changes are made to the probable flood flow obtained during the 1987 Master Plan and all the calculated floods in the 1987 Master Plan will be adopted in this JICA Study as well. Figure 5.3.4 presents the probability distribution of flood peak runoff by return period at each base point. Figure 5.3.5 illustrates 100 years probable flood hydrographs estimated at base points under the present river condition.

## 5.4 Streamflow Analysis

### 5.4.1 Available Data

From the available runoff data presented in Subsection 5.2.2, representative gauges have been selected for each of the six sub-basins as below to develop runoff simulation model:

| Basin Number | Basin | Selected Gauge |
|---|---|---|
| Basin 1 | Upper Cagayan | Dippadiw |
| Basin 2 | Magat | Dulao |
| Basin 3 | Ilagan | Minanga |
| Basin 4 | Lower Cagayan | Tuguegarao |
| Basin 5 | Upper Chico | Ampawilen |
| Basin 6 | Lower Chico | Saltan |

### 5.4.2 Methodology

In the 1987 Master Plan, runoff for the years 1963 to 1984 has been estimated. In this JICA Study, runoff for the additional years from 1985 to 1998 is estimated. The following procedure is applied:

a) Simulation of runoff for the years 1985 to 1998 at the selected runoff gauge by the runoff simulation model using Tank Model;
b) Estimation of runoff for the years 1985 to 1998 in the sub-basin by applying the catchment and rainfall ratio of the above gauge and the sub-basin to the simulated runoff; and
c) Verification of the estimated runoff.

### 5.4.3 Simulation Model

River system model based on the 53 sub-basin divisions applied in the 1987 Master Plan Study is presented in Figure 5.4.1. These sub-basin divisions are applied in this JICA Study as well.

Tank Model is prepared for each of the 6 basins mentioned in Section 5.4.1. The same tank coefficients and evaporation ratio is applied in both the 1987 Master Plan and this JICA Study.

The 10-day runoff is simulated at 6 selected runoff gauges for 22 years from 1985 to 1998 by applying the rainfall data obtained for the same period. Comparison of simulated flow duration curves during the 1987 Master Plan Study and the same obtained during this JICA Study reveals similar curves at each gauge. Therefore, it is concluded that the long-term flow characteristics in the Cagayan River basin does not change significantly after 14-additional years of data were added.

### 5.4.4 Estimate of Runoff in Sub-basin

Applying the sub-basin divisions as well as the additional long term naturalized 10-day mean runoff for 1985 to 1998, runoff for each sub-basin is estimated as follows, while the duration curve of the sub-basins is presented in Figure 5.4.2.

| Tributary | Catchment ($km^2$) | Annual Average($m^3/s$) | |
|---|---|---|---|
| | | 1987 MP | This JICA Study |
| Upper Cagayan River | 6,633 | 291.6 | 289.3 |
| Magat River | 5,113 | 262.6 | 269.8 |
| Ilagan River | 3,132 | 143.9 | 147.1 |
| Siffu Mallig River | 2,015 | 85.8 | 88.2 |
| Chico River | 4,551 | 251.4 | 256.1 |
| Whole Basin | 27,281 | 1,343.2 | 1,371.6 |

No significant difference is obtained when annual average runoff for each sub-basin is compared. Result of the streamflow analysis is applied to update the water balance review.

## 5.5 Water Balance Analysis

### 5.5.1 Basic Conditions of Water Balance Study

The water balance analysis is conducted with the representative runoff of 1/5 return period and future water demand. To conduct the analysis, Cagayan river basin with the drainage area of 27,281 $km^2$ is divided into 48 sub-basins as indicated in Figure 5.5.1, considering the national irrigation system intakes, municipal water supply intakes, damsites, estuary and confluence of the mainstream and tributaries. The naturalized river runoff from each of the divided 48 sub-basins is applied to the water balance analysis. As in the 1987 Master Plan Study, the specific discharge of 0.0046 $m^3/s/km^2$, which is obtained from the maintenance flow requirement of the entire river basin, is applied to determine the maintenance flow at each balance points. Balance points are defined at irrigation intakes, damsites, confluence of tributaries and municipal water demand points.

Return flow from each sectoral water supply is assumed as follows:

a) Irrigation water supply 30%
b) Hydropower scheme 100%
c) Municipal water supply scheme 40%

Return flow from the communal irrigation system and the municipal water supply is assumed to return just downstream of the balance point where the demand water is taken. Return flow from the national irrigation system is returned as indicated in Figure 5.5.2.

### 5.5.2 Water Demand

Water demand in the Cagayan river basin comprises municipal water demand and irrigation water demand. Net municipal water demand at municipal water user-end, has been projected based on the projected population up to the year 2020. Moreover, in projecting water source requirement, the following water loss applied during the 1987 Master Plan study have been applied in this JICA Study:

| Year | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Loss Factor | 1.54 | 1.48 | 1.43 | 1.38 | 1.33 |

As the water intakes in the Study Area comprise of similar facilities throughout the Study Area, above loss factors are applied throughout the Study Area.

Hence, the water source requirement, i.e. gross municipal water demand, is calculated by multiplying the net municipal water demand and the loss factor for the target year. Table 5.5.1 presents the water source requirement by municipality. The projected total water source requirement for the year 2020 is estimated to be 978,651 $m^3$/day for the study area.

Irrigation water demands have also been reviewed to reflect the current and future water demand in the sector. Table 5.5.2 presents future irrigation water demand for the years 2005•2010•2015 and 2020.

### 5.5.3 Water Balance Analysis

The water demand and supply balance study is performed in order to: 1) determine theoretically whether there are enough river runoff to protect the intake of Magapit pumping station from salt water intrusion at low streamflow condition by projecting the water deficit under the present basin runoff and the future water demand conditions; and to 2) examine the required storage volumes of the required dams.

The water deficit estimated is the balance of the representative runoff of 1/5 return period and future water demand, which is computed as a sum of the irrigation water requirement, municipal water requirement and the river maintenance flow. These future water requirements are determined by computing the deficit volume against the requirements for the years 2005, 2010, 2015 and 2020.

### 5.5.4 Projected Water Deficit

Water deficit against the demand conditions in the years 2005, 2010, 2015 and 2020 have been obtained, as presented in Table 5.5.3. According to the results of the deficit calculation and their evaluation, the water deficit supply is required at the following 12 balance points:

| Balance Point | Irrigation Scheme | Annual Deficit (million. $m^3$) |
|---|---|---|
| 6 | Dabubu River Irrigation Project (IP) | 9 |
| 8 | Gappal IP | 7 |
| 11 | Matuno IP | 113 |
| 13 | Magat River Irrigation System (RIS) | 93 |
| 23 | Chico RIS | 62 |
| 30 | Chico Mallig IP | 162 |
| 31 | Mallig RIS | 18 |
| 33 | Tumauini Irrigation System (IS) | 14 |
| 40 | Baggao Pared IS | 11 |
| 42 | Baggao IS-Paranan | 31 |
| 44 | Zinundungan RIS | 24 |
| 45 | Dummon IP | 12 |
| 46 | Dummon RIS | 33 |

As in the 1987 Master Plan Study, the following combinations of water deficit and supply dams are selected, considering the points and amounts of deficits and the available water supply dam candidates:

| Deficit Supplied by Balance Point | | Supply Dam |
|---|---|---|
| 6 | Dabubu River IP | Santo Niño |
| 8 | Gappal IP | Gappal<br>(Sta. Maria, Calaocan, Colorado) |
| 11 | Matuno IP | Matuno No.1 |
| 13 | Magat RIS | Matuno No.1, Alimit No.1, Siffu No.1 |
| 23, 30, 31 | Chico RIS,<br>Chico Mallig IP<br>Mallig RIS | Mallig No.2 |
| 33 | Tumauini IS | San Vicente |
| 40 | Baggao Pared IS | Paranan |
| 42 | Baggao IS-Paranan | Paranan |
| 44 | Zinundungan RIS | Zinundungan |
| 45 | Dummon IP | Dummon |
| 46 | Dummon RIS | Dummon |

## 5.6 Sediment Analysis

### 5.6.1 Objective of Sediment Analysis

Objective of sediment yield analysis is to review the sediment yield estimated in the 1987 Master Plan, by using additional data collected. In the 1987 MP, the sediment yield was estimated by the representative volume of the sediment yield from the entire Cagayan River Basin. In this review work, the validity of the sediment yield presented in the 1987 MP, i.e. 1.5 mm/year, is discussed.

### 5.6.2 Available Data

Suspended sediment record at 3 stations, i.e., Pasonglao (Chico River), Oscariz (Magat River) and Dippadiw (Cagayan River) are used to generate the sediment rating curves in 1987 Master Plan. In addition, sediment data from Nagutipunan gauging station has been added.

### 5.6.3 Methodology

In the 1987 MP, following two methods were applied in order to estimate the sediment yield from the basin.

a) Application of empirical formulas (Tanaka formula and Ishige formula)
b) Application of sediment rating curve

As concluded in the 1987 MP, empirical formulas such as Tanaka Formula or Ishige Formula, which are commonly applied in Japan, did not have enough validity to estimate the sediment yield from this Cagayan River Basin. Thus, these empirical formulas are not applied to the estimation in this review work, and the sediment yield is estimated by applying the sediment rating curve and sediment record of the Magat dam reservoir.

### 5.6.4 Sediment Yield and Discharge

The sediment rating curve newly generated at Dippadiw (Nagtipunan) is shown in Figure 5.6.1 together with the estimated rating curves of the other 2 stations in the 1987 MP.

The summary of above discussion is tabulated below. The runoff data of Guinalvin, selected in the 1987 MP, is used for the estimation of the suspended load from Cagayan River since no additional runoff data are available. The bed load is assumed to be 20% of the estimated suspended load. This assumption is same as that in the 1987 MP.

Unit : $m^3/km^2/yr$

| River Name | Stage* | Runoff Gauge | Suspended Load | Bed Load | Total Sediment |
|---|---|---|---|---|---|
| Chico River | 1987 MP | Ampawilen | 880 | 180 | 1,060 |
| (Pasonglao) | RMP | Ampawilen | 880 | 180 | 1,060 |
| Magat River | 1987 MP | Oscariz | 1,270 | 250 | 1,520 |
| (Oscariz) | RMP | (Magat Res. Data) | 1,330 | 270 | 1,600 |
| Cagayan River | 1987 MP | Guinalvin | 1,070 | 210 | 1,280 |
| (Dippadiw and Nagtipunan) | RMP | Guinalvin | 910 | 180 | 1,090 |

* 1987 MP : the 1987 Master Plan
RMP : the Reviewed Master Plan (this JICA Study)

Comparing the above results, the estimated sediment runoff from whole of Cagayan Basin in the 1987 MP, i.e. 1.5 mm/year, remains to be valid. Therefore, the study results of other sectors based on this value, such as dam planning, are considered to be valid as well.

The total sediment volume shown above may contain wash load in some degree. The rough estimation of wash load is made in the next subsection.

### 5.6.5 Sediment Balance

(1) Sediment Transport

The annual sediment transport is reviewed at 26 points selected in the 1987 Master Plan. Einstein-Brown formula is applied to estimate the annual sediment transport, as in the 1987 MP. The specific gravity and the mean diameter of the riverbed material are determined to be 2.61 and 0.04 cm on the basis of the result of the riverbed material survey carried out in this JICA Study. Ten days mean runoff simulated in streamflow analysis is applied to Einstein-Brown formula.

The computed annual sediment transport in the present river condition is shown in Figure 5.6.2. No significant change in the annual sediment transport is observed from the figure. The annual sediment transport presented in Figure 5.6.2 (solid lines and white dots) seems to be small comparing with this amount, considering that no serious aggradation of riverbed, except for upstream river channel of the Magat dam, is reported during the field investigations conducted by the Study Team.

(2) Estimation of Wash Load

The estimation result of wash load at each selected point is shown in Figure 5.6.2 (dotted lines and black dots) and summarized below.

| Point | (1)<br>Bed Material Load<br>($10^6$ $m^3$/yr) | (2)<br>Wash Load<br>($10^6$ $m^3$/yr) | (3) = (1) + (2)<br>Total Sediment Load<br>($10^6$ $m^3$/yr) | (4) = (2) / (3)<br>Share of Wash Load to the Total Sediment Load |
|---|---|---|---|---|
| No.1 ~ No.4 | 7.79 | 22.89 | 30.68 | 74.6% |
| No.5 ~ No.14 | 5.53 | 11.04 | 16.57 | 66.6% |
| No.15 | 5.01 | 6.41 | 11.42 | 55.2% |
| No.16 | 4.43 | 3.99 | 8.42 | 47.4% |
| No.17 ~ No.22 | 6.87 | 0.90 | 7.77 | 11.6% |
| No.23 (Chico) | 5.48 | 0.85 | 6.33 | 13.4% |
| No.24 (Siffu) | 4.99 | 0.10 | 5.09 | 2.0% |
| No.25 (Ilagan) | 6.34 | 0.26 | 6.60 | 3.9% |
| No.26 (Magat) | 5.62 | 0.90 | 6.52 | 13.8% |

The ratio of wash load to the total sediment load indicates a high value in lower reach of the Cagayan Mainstream, while it is small in upper reaches and in the tributaries. The ratio of wash load to the annual runoff volume of water is

0.05% at most, and that of the total sediment load to the annual water runoff ranges from 0.05 to 0.07%.

## 5.7 Riverbed Fluctuation

### 5.7.1 Objectives of the Riverbed Fluctuation Analysis

Objective of the riverbed fluctuation analysis is to compare the extent of fluctuation in riverbed under 1) the natural condition and 2) the condition when the channel widening is implemented. The following 3 cases are considered as alternative channel widening plans. Detailed description of these 3 cases is made in Flood Control Section.

Case-1 : Widening the river channel of Tupang site to 500 m
Case-2 : Widening the river channels of Tupang and Nassiping sites to 500 m
Case-3 : Widening the river channels of Tupang, Nassiping and Magapit sites to 500 m

### 5.7.2 Available Data

The following data will be used for the analysis:

- River cross section data measured in 1986;
- River cross section data measured in 2000;
- River cross section data of each channel widening case (3 cases);
- Grain size distribution data measured in 1986;
- Grain size distribution data measured in 2000;
- 10 days runoff data at a base point; and
- 10 days water level data of the lowest river cross section.

### 5.7.3 Methodology

General procedure of the study is shown in Figure 5.7.1. One dimensional riverbed fluctuation model is applied to predict the riverbed fluctuation caused by the imbalance of sediment carrying capacity along the river course. After the confirmation of model validity, the riverbed fluctuation under 4 cases including natural condition will be simulated. Fluctuation depth is calculated based on the followings:

1) difference of sediment transport capacity between downstream and upstream river sections; and
2) extraction volume.

### 5.7.4 Simulation Result and its Evaluation

Figure 5.7.2 presents the simulated and measured riverbed elevation and grain size distribution in the year 2000. As seen in the figure, the simulation model shows its validity.

The simulation results of long term riverbed fluctuation are shown in Figure 5.7.3. It is concluded that all three cases considered will not cause any drastic riverbed change by its implementation.

## 5.8 Saline Water Intrusion

### 5.8.1 Objectives of Saline Water Intrusion Analysis

The objective of the survey is to determine the distance of salinity intrusion from the Cagayan river mouth. Type of saline water intrusion analysis has been confirmed as week wedge, i.e. saline water wedge is formed near the riverbed.

### 5.8.2 Available Data

During the 1987 Master Plan Study, field investigation was conducted on March 8 and 9, 1986. Electric conductivity of river water at variable water depth was measured together with temperature of water and discharge at reference sections. Field measurement was conducted during this JICA Study as well.

### 5.8.3 Methodology

Field observation of saline water intrusion is conducted on a 24-hour basis in order to detect the actual intrusion length and type of wedge formed. Thereafter, saline water intrusion analysis is made based on the hydraulic calculation to examine the intrusion length.

### 5.8.4 Field Observation and Measurement

On January 10 to 11, 2001, 24-hour continuous salinity intrusion survey was conducted by DPWH Region 2 engineers and Hydrologist of the Study Team. The observation stations consist of six (6) stations with staff gauges along the Cagayan River from its river mouth at Aparri at every 5 km distance to Magapit Bridge. Details of the observation are presented in Supporting Report. However, no salinity intrusion was observed during the period. No additional field observation was conducted by the Study Team as the Study Period in the Philippines did not coincide with dry season. However, it is reported that salinity intrusion exists along the Cagayan River (e.g. refer to Cagayan Integrated

Agricultural Development Project, Appendices to the Feasibility Report, JICA 1976).

### 5.8.5 Saline Water Intrusion Analysis

Saline water intrusion analysis was conducted in order to estimate the intrusion length and the shape of wedge. Figure 5.8.1 shows the general procedure of the analysis. Target runoffs ($Q_t$) were determined taking the results of lowflow analysis into account. Selected six target runoffs are tabulated below:

| No. | $Q_t$ ($m^3/s$) | Description |
|---|---|---|
| 1. | 137 | Minimum 10-day runoff simulated from rainfall records from 1963 to 1998 |
| 2. | 173 | 5-year probable drought runoff (10-day runoff) |
| 3. | 207 | 95% dependable 10-day runoff |
| 4. | 416 | 75% dependable 10-day runoff |
| 5. | 949 | 50% dependable 10-day runoff |
| 6. | 1,606 | Measured runoff in the field observation (January 10 ~ 11, 2001) |

In applying basic formulas, following assumptions were introduced in conducting saline water intrusion analysis:

- Tidal level was set at EL. 0.71 m from the tidal level data at Aparri, which is the average high tide elevation.
- Average current velocity of tidal stretch was estimated by non-uniform flow calculation.
- According to the longitudinal distribution of chloride concentration measured in the 1987 MP, average resistance factor was set to 0.0037.
- The densities of fresh and saline water were set to 1.000 $g/cm^3$ and 1.025 $g/cm^3$ respectively.
- Water depth at the tip of wedge (H) was set to 10 m for every target runoff considering the actual riverbed elevation and the results of non-uniform flow calculation.

### 5.8.6 Result of Analysis

Figure 5.8.2 shows the result of analysis. This figure indicates that the tip of salt water wedge for each target runoff cannot reach Magapit Bridge due to the topographical barrier existing about 22 km upstream from the river mouth.

The wedge tip reaches only about 1 km from the river mouth for the runoff of 1,606 $m^3/s$, which was measured in the field observation conducted from January 10 to 11, 2001. This is consistent with the fact that no saline water intrusion was observed even at a point 5 km upstream from the river mouth in the field observation.

As long as the deepest riverbed elevation is not altered, salinity intrusion length will not be elongated, even if the Magapit narrow is excavated.

## 5.9 Flood Inundation Analysis

### 5.9.1 Past Flood Events

The largest floods in recent years occurred in November 1973 by typhoon Openg, in November 1980 by typhoon Aring, and in October 1998 by typhoon Iliang. Inundation Area map of these floods are presented in Figure 2.6.2. Magnitude of these floods are discussed in the supporting report.

Flood marks of 1973 and 1980 have been surveyed during the 1987 Master Plan Study. Furthermore, flood marks of 1998 has been surveyed during the flood damage survey during this JICA Study, as discussed in Flood Control Section.

### 5.9.2 Methodology and Simulation Model

(1) Applied Simulation Method

Flood inundation model simulates a wide-spread flooding in the lower Cagayan River from Cabagan to Aparri. The flood inundation area has been well defined due to the constricted flood plain of the lower Cagayan River. In the lower Cagayan River, instead of the areal distribution of the inundation area, it is important to determine the inundation depth and time which differ depending on the magnitude of the flood.

Considering the above characteristics of the Cagayan River floods, non-uniform flow calculation method is applied for the analysis inputting estimated flood hydrographs to the calculation.

(2) Available Data and Information for the Analysis

The following are the data and information applied for the analysis:

- Flood marks of past events
- River profile and cross-section data measured in the year 2000
- Flood hydrographs at 11 points along the Cagayan mainstream obtained by storage function method
- DEM (Digital Elevation Model) data generated from aerial photograph and supplemental survey result obtained in the year 2000

(3) Simulation Procedure

The flood inundation area in the lower Cagayan basin is divided into a mesh of 1 km × 1 km using the newly developed topographic map in 2000. In order to express the spatial movement of flood flow in the inundation area, non-uniform flow calculation model is adopted as mentioned above. The model simulates the flood level propagation through divided mesh blocks by obtaining the flood level by non-uniform flow analysis at every reference point of the individual mesh.

The maximum inundation depth for a mesh is calculated from the flood water depth obtained for the mesh minus the average elevation of the mesh. Similarly, the inundation time required for the flood damage study is the time required for the maximum inundation depth to dissipate completely from the mesh.

(4) Calibration

The parameters incorporated in the proposed inundation model are calibrated by use of flood marks obtained for selected flood records. Calibration of the flood level of the model was conducted by developing flood occurred by typhoon Aring in 1980. Simulated inundation duration was compared with the same obtained by the Flood Damage Survey conducted in the year 2000.

### 5.9.3 Result of Analysis

With the return period of 2, 5, 10, 25, 50 and 100 years, flood inundation analysis was made to obtain maximum inundation depth and inundation period for each mesh. Results for the return periods of 2 and 100 years are presented in Figures 5.9.1 and 5.9.2. The result of flood inundation analysis is applied to estimate flood damage.

The following shows the maximum inundation area in the reach between the river mouth and Cabagan for each probable flood:

| Probable Flood | 2-Year Flood | 5-Year Flood | 10-Year Flood | 25-Year Flood | 50-Year Flood | 100-Year Flood |
|---|---|---|---|---|---|---|
| Inundation Area ($km^2$) | 350 | 650 | 740 | 810 | 840 | 870 |

# CHAPTER 6 MULTIPURPOSE DAM PROJECTS

## 6.1 Review of Multipurpose Dam Projects Proposed in 1987 Master Plan

All of five multipurpose dams proposed in the 1987 Master Plan, which are Siffu No.1, Mallig No.2, Matuno No.1 and Alimit No.1 Dams as well as the existing Magat Dam, have been included in the review work of the Master Plan. The review is made in terms of flood runoff, water balance and economic viability.

After reviewing, the project features of the dam have remained unchanged from those of the 1987 Master Plan for all the dams because of the following reasons:

1) All the dams were formulated to utilize the maximum potential at the dam sites in the 1987 Master Plan.
2) The reviewed design discharge for the flood control planning is based on the flood control space set in the dams in the 1987 Master Plan.
3) Schemes of irrigation projects relating to the multipurpose dams have not been changed so irrigation water requirements of the schemes, which is a major requirement in the water balance study, is also unchanged.
4) The results of reviewing the economic viability by updating the cost and benefit show that all five dams are confirmed to be economically viable with EIRRs higher than 15%. Details of the economic evaluation are presented in Subsection 10.8.3.

## 6.2 Reviewed Multipurpose Dam Projects

Five multipurpose dams proposed in the 1987 Master Plan are incorporated in the review of 1987 Master Plan without modification as mentioned in the preceding subsection. The following is an outline of each of the selected multipurpose dams:

(1) Siffu No.1 Dam

The Siffu project comprises the schemes of Siffu flood control, Siffu hydropower generation with a capacity of 5.4 MW and energy output of 41.1GWh, and the supplemental water supply to meet the forecast deficit in Magat reservoir. The project is to be supported by the proposed Siffu No.1 multipurpose dam.

The Siffu No.1 dam is proposed on the Siffu River which is a left tributary of the Cagayan River. Foundation rock at the dam site is pebble-conglomerate of Pliocene. The earthfill type dam would have a height of 58 m, an embankment volume of 1.7 million m$^3$, an effective storage capacity of 93 million m$^3$, and a flood control space of 115 million $m^3$. A layout of the proposed dam is presented in Figure 6.1.1 and its principal features are shown in Table 6.1.1.

(2) Mallig No.2 Dam

The Mallig project comprises the schemes of Chico Mallig irrigation with a proposed service area of 31,200 ha and Mallig flood control. In order to support the project, Mallig No.2 multipurpose dam is to be constructed.

The Mallig No.2 dam is proposed on Mallig River which is a left tributary of the Cagayan River. The foundation rock of the dam site is sandstone with conglomerate and mudstone of Upper Miocene. The dam is proposed as a rockfill type dam with a height of 84 m, an embankment volume of 2.4 million $m^3$, an effective storage capacity of 545 million $m^3$, and a flood control space of 112 million $m^3$. A layout of the proposed dam is presented in Figure 6.1.2 and principal features are shown in Table 6.1.2.

(3) Matuno No.1 Dam

The Matuno project comprises the schemes of Matuno hydropower generation with a capacity of 180MW and energy output of 528GWh, Matuno irrigation of 12,860 ha, municipal water supply and supplementary supply of water to meet the deficit forecast in the Magat reservoir. The Matuno No.1 dam will serve for the multipurpose project.

The Matuno No.1 dam is proposed at Barat, Nueva Vizcaya on the Matuno River, a left tributary of the Magat River. Foundation rocks at the dam site are composed of hard to moderately hard conglomerate and sandstone of Middle Miocene. The dam design is for a rockfill type with a height of 147 m, a required embankment volume of 10 million $m^3$, and effective storage capacity of 97 million $m^3$. A layout of the proposed dam is presented in Figure 6.1.3 and principal features are shown in Table 6.1.3.

(4) Alimit No.1 Dam

The main purpose of the Alimit project is to provide a flood control space of 139 million $m^3$ in the existing Magat reservoir. In order to subrogate the storage volume of the Magat reservoir ceded to flood control volume, Alimit No.1 dam is proposed. The project also includes schemes of power generation of 12.2MW and energy output of 80.6 GWh, and a role of supplemental source to meet the water deficit forecast in the Magat reservoir.

The Alimit No.1 dam is proposed on the Alimit River which is a left tributary of the Magat River just upstream of the Magat reservoir. The foundation rock of the dam site is agglomerate and andesite of Cretaceous-Paleogene. The dam will be a 89m high concrete type with an effective storage capacity of 156 million $m^3$. The concrete volume is estimated to be 0.65 million $m^3$. A layout of the proposed dam is presented in Figure 6.1.4 and principal features are shown in Table 6.1.4.

(5) Existing Magat Dam

The Magat Dam of rockfill type has a maximum height of 114 m, a crest length of 4,160 m, and earth embankment volume of 18 million $m^3$. The effective storage volume is 795 million $m^3$ and existing flood control space is 164 million $m^3$. The installed capacity of the hydropower is 360MW and irrigation area is 95,000 ha.

The scheme to provide an additional flood control space for the existing Magat reservoir has been studied and recommended in the 1987 Master Plan since the Magat Dam is situated at a suitable site for flood control. The proposed flood control space is 139 million $m^3$.

# CHAPTER 7 FLOOD CONTROL

## 7.1 Basic Concept of Flood Control Plans

### 7.1.1 Framework Plan, Long-term Plan and Master Plan

The flood control plans proposed in the 1987 Master Plan for the Cagayan River basin consist of the framework plan, long-term plan and master plan. The framework plan is a potential development plan with future prospect scale. The long-term plan is a development plan consisting of socially, economically and environmentally viable projects formulated under 25 years probable flood. The master plan is an integrated development plan with the projects selected among those in the long-term plan.

This Chapter presents review results of flood control framework plan and long-term plan proposed in the 1987 Master Plan.

### 7.1.2 Target Area

The target area of the flood control framework plan and long-term plan is the whole Cagayan River basin including watersheds in the upper basin and major tributaries.

### 7.1.3 Hazard and Vulnerability

Flood damage or disaster may be conceptually given by the following equation.

$$\text{Flood damage} = \text{Hazard} \times \text{Vulnerability}$$

Hazard is a risk of natural disaster and may be reduced by structural measures of flood control. Vulnerability is a social weakness for coping with hazard. If there is no people in the hazardous area and no property therein, no damage will occur. The vulnerability may be reduced by means of relocation of affected people and/or evacuation at risk of emergency hazard. Evacuation and resettlement are called here as non-structural measures.

The target of the flood control project is to prevent casualties and damages to assets from disasters resulting from inundation, river course shifting with river meander, riverbank erosion, etc., likewise to increase agricultural products for improvement of the regional economy in the Cagayan River basin which has considerably high poverty incidence of 40 to 60 %.

Figure 7.1.1 presents a concept of flood damage mitigation measures to be applied in the study and those basic concepts are outlined below.

a) Flood damage mitigation measures consist of structural measures, non-structural measures and supporting measures.
b) Flood control projects are implemented with a stage wise (phase-by-phase) aiming at the target year of 2020 from the technical aspect of flood control and financial aspect of funding constraints.

## 7.2 Present River Condition and Approach to Flood Control Plan

### 7.2.1 Upper Cagayan

The remarkable flood control problems in the watershed of the upper Cagayan especially in the upper Magat River are deforestation, voluminous sediment yields and sedimentation. Further, other flood control problems in this reach including the Ilagan River are local inundation in the low-lying areas limited to the riverside areas and local riverbank erosions.

The most important role of this reach is to store floodwaters not only for reduction of peak discharges towards the downstream reaches but also for irrigation developments.

To cope with such problems, the following measures are incorporated in the flood control plan:

- Reforestation (watershed management) in the mountainous areas,
- Reduction of flood peaks by dams, and,
- Riverbank protection.

The watershed management programs are explained in the following Chapter 8 Watershed Management.

### 7.2.2 Middle Cagayan

The remarkable flood control problems in the middle reach of the Cagayan upstream of Cabagan including tributaries of the Ilagan, Magat and Siffu-Mallig are inundation in the low-lying areas along the river courses and local riverbank erosions.

In order to alleviate such problems, in this reach, it is ideal to retain a part of flood in view of reduction of flood peaks towards the downstream reaches. Regrettably, this flood retention scheme is not taken up in the plan because of non-availability of appropriate and suitable land. However, the retaining or storage functions available in the existing river channels of the lower Magat and middle Siffu-Mallig Rivers are kept as they are.

Accordingly, the following measures are incorporated in the middle Cagayan:

- Riverbank protection, and,
- Dike systems including Ilagan, lower Magat and lower-most of the Siffu-Mallig as proposed in the 1987 long-term plan.

### 7.2.3 Lower Cagayan

(1) Preliminary Review of Proposed Schemes of 1987 Master Plan

A preliminary review on the selected structural schemes in the lower reach proposed by the Master Plan in 1987 was made for the 6 components categorized as a river channel improvement aiming at selection of conceived schemes for further review as described in Section 10.8 in detail.

The following would be component schemes for review:

- A widening scheme of the bottlenecks in the Magapit narrows,
- A dike scheme in the upstream at Alcala, and,
- A bank protection works scheme.

(2) Basic Approach of Flood Control in the Lower Cagayan

An approach of flood control in the lower reach of Cabagan is to discharge floodwaters promptly to the sea. Considering the above components reviewed, conceived schemes are examined below.

*River Mouth to Magapit Bridge*

The Cagayan River in this reach runs in an average river width of 1.5 to 2 km. Hilly areas on the left bank and a national highway on the right bank confine the main channel with a sufficiently high elevation against floodwater levels in the main channel. In addition, there exists no river mouth clogging although local sedimentation accompanied by shifting of sandbars in the lower reach can be observed. It can be said that this reach is presently not facing any urgent flood control problems except for local riverbank erosion. However, channel capacity in this reach is locally less than the design discharge of 25-year probable flood.

From the above, the following measures are incorporated in the review:

- Riverbank protection, and,
- Dike system as proposed in the 1987 long-term plan.

*Magapit Bridge to Upstream of Tuguegarao*

The remarkable flood control problems in this reach are frequent inundation over the extensive floodplain upstream of Alcala resulting from bottlenecks in the Magapit narrows and river course shifting with local riverbank erosions.

In order to mitigate such damage and stabilize low water channel, the following river channel improvements are examined in this review in detail:

- Widening of bottlenecks in the Magapit narrows,
- Dike system with cut-off channel as channel normalization, and,
- Riverbank protection.

*Upstream of Tuguegarao to Cabagan*

In this reach, the Cagayan River runs with an average flow width of 1.5 to 2 km including floodplains confined by the high natural levee on the left bank and a national highway on the right bank with a sufficiently high ground elevation against floodwater levels of the main channel. Also the backwater from the bottlenecks in the Magapit narrows has not affected this reach. According to interviews with residents at Cabagan town, it is reported that the town area has not been damaged from inundation after completion of the Magat dam.

There exists no remarkable and urgent flood control problems except for local bank erosion. Further, flood peaks in this reach are so much reduced owing to flood control spaces provided by the multipurpose dams especially by the Magat dam. However, channel capacity in this reach is, as a whole, less than the design discharge of 25-yr probable flood.

Accordingly, the following measures are incorporated in the review:

- Riverbank protection, and,
- Dike system as proposed in the 1987 long-term plan.

*Chico River*

The Cagayan River joins its left tributary, the Chico River at Nassiping. The lower Chico River from its river mouth to 10 km upstream runs in an average low water channel width of 400 m. The bankful carrying capacity of the low water channel is estimated to be varying from 5,000 to 10,000 $m^3/s$. Hilly area on the left bank and a provincial road on the right bank confine the river channel including the floodplain, with a sufficiently high elevation against floodwater levels in the Chico and Cagayan Rivers.

According to interviews with the inhabitants residing near the confluence, it is reported that water overflowing from the Chico and Cagayan has not affected residential areas and paddy fields in this reach.

Consequently, special countermeasures are not contemplated for this reach with the assumption that the existing retarding function of the Chico River will remain as it is. The bank protection works proposed in the middle of Chico River is taken up as it is in the flood control plan.

## 7.3 Review of Framework Plan

The framework plan in the 1987 Master Plan contemplated alleviating flooding along the Cagayan River for the design flood of 100-year probable flood. The major flood control schemes proposed are a) flood control dams in the upstream reaches to reduce flood magnitude, b) the Magapit Narrow improvement (widening) in the Lower Cagayan River increasing discharge capacity, c) dike systems along the middle and lower reaches to prevent flooding in the low-lying areas, and d) retaining of natural flood retarding effect in tributaries.

The framework plan proposed in the 1987 Master Plan is also applied for the Reviewed Master Plan without modification, because the fundamental relevant characteristics of the Cagayan River and its basin have not changed since the 1987 Master Plan was formulated.

## 7.4 Review of Structural Measures for Long Term Plan

### 7.4.1 Long Term Plan in 1987 Master Plan

The long-term plan of the 1987 Master Plan was formulated on the basis of the framework plan by reducing the design discharge to a 25-year probable flood as a more economically effective scale. The long-term plan consisted of a) dike embankment including revetment and sluice along the main Cagayan River and major tributaries (the Siffu, Ilagan and Magat), b) narrow excavation at Nassiping (a portion of the Magapit Narrows), c) cut-off channel works (Gabut and San Isidro), d) bank protection, e) flood control dams (Cagayan No.1 and Ilagan No.1), and f) food control function in the multipurpose dam projects (Siffu No.1, Mallig No.2, and Magat) in addition to the above.

### 7.4.2 Conditions for Review

The following are conditions for a plan formulation:

1) A design flood with 25 years return period is adopted, based on the current criteria being applied in the ongoing flood control plans and projects under the direct control of the DPWH (same as 1987 Master Plan).
2) Multipurpose dams of Mallig No.2, Siffu No.1 and Magat, and flood control dams of Cagayan No.1 and Ilagan No.1 in the upper Cagayan including tributaries are incorporated.
   Allocated flood control spaces are 112 million $m^3$ for Mallig No.2, 115 million $m^3$ for Siffu No.1 and 139 million $m^3$ for Magat Dam, respectively.

3) For the middle reach of the Cagayan, a dike system as proposed in 1987 Master Plan is incorporated for smooth and swift drainage of floodwaters.
4) For the lower reach of the Cagayan, a dike system is provided including river channel improvement to accelerate smooth and swift drainage of floodwaters.
5) In the major tributaries of Ilagan, lower Magat and lower-most of the Siffu-Mallig in the middle Cagayan, dike systems proposed in 1987 Master Plan are incorporated as they are. On the other hand, in the Chico and middle Siffu-Mallig Rivers, special countermeasures are not taken up under the condition that the existing retarding functions of the respective channels are remained as they are.
6) The bank protection works are taken up as they are in the long-term plan. Two types of a slope protection and a spur dike are applied in the bank protection works. The slope protection principally consists of a riprap foot protection and a slope protection of gabion or dry masonry.
7) The river width between continuous dike scheme and its alignment shall be the same as proposed in the long-term plan in 1987. In the 1987 Master Plan, the river width was estimated to be more than 10•A, where A is basin area in $km^2$. According to this criterion, the river width in the lower Cagayan will be approximately from 2 km near the river mouth to 1.5 km in the upstream of Alcala. This relationship is developed in the design of rivers in Japan under comparable conditions.
8) The standard dike section is a trapezoidal section with riverbank tree zone as shown in Figure 7.4.1. The riverbank tree zone is planned with around 30 m in width along the dike alignment on the riverside.
9) The design high water level is planned, based on the water level calculation by non-uniform flow method.
10) The design discharge distribution proposed in the 1987 Master Plan as shown in Figure 7.4.2 is adopted as it is.
11) Manning's roughness coefficients are 0.04 for low water channel, 0.10 for floodplain and 0.06 for flood plain with a confined dike, as applied in the 1987 Master Plan.
12) Widening of bottlenecks in the Magapit narrows is planned as follows. The riverbanks at the bottlenecks are widened up to the low water channel width of 500 m with an average bank slope of 1 to 2 and the excavation level is planned at design riverbed elevation considering the present mean riverbed elevations in the lower reach.

13) Cut-off channel upstream of Alcala is planned as follows.
The width of cut-off channel (low water channel with compound section) is planned at 500 m estimated as an average low water channel width in the upstream and downstream reaches of the proposed cut-off channel.
The riverbed elevation of the channel is planned at design riverbed elevation considering the present mean riverbed elevations in the upstream and downstream reaches.

14) Topographic maps prepared in 1979 are used as the basic maps in the planning. The river cross-sections surveyed by the study team in 2000 are used for hydraulic study of river planning.

### 7.4.3 Alternative Study of Structural Measures from Magapit to Tuguegarao

(1) Objective Reaches of Alternative Study

Based on the concepts and considerations made in the above Section 7.1 to 7.3, a review of the 1987 long-term plan for the reach from Magapit to upstream of Tuguegarao is made in this Section. The alternative plans are examined for the divided reaches considering river characteristics and problems described in the former Subsection 2.5.3 River Morphology. Objective reaches will be 3 reaches as shown below.

- In the reach of Magapit Narrows (Magapit bridge to Alcala)
- In the reach from Alcala to Buntun bridge
- In the reach from Buntun bridge to Tuguegarao

(2) Flood Control Plan in the Magapit Narrows

According to the calculation of backwater due to the bottlenecks in the Magapit narrows as described in ANNEX VI, the following are the exact locations of the bottlenecks (defined as river reach which has an average low water channel width less than 500 m that is estimated in the upstream reach at Alcala), as shown in Figure 7.4.3:

- Tupang site (upper end of the narrows)
- Nassiping site (upstream of Nassiping bending and upstream of the confluence with the Chico River)
- Magapit bridge site (lower end of the narrows)

Widening of the bottlenecks is planned with the following in view:

1) To lower floodwater levels and to shorten their durations in the upstream reach at Alcala for mitigation of flood damage due to frequent inundations and enhancement of land use conditions.

2) To stabilize river course from shifting incidentally, by increase of surface water slope resulting from widening of the bottlenecks (that is, towards a more straight channel in combination with construction of cut-off channel, riverbank tree zone, and bank protection works to be considered in the upstream reach at Alcala).

From the above, the following 5 cases are adopted in the later alternative study:

- Case 1: Without widening (present condition)
- Case 2: Widening of 1 bottleneck at Tupang (channel width: 500 m)
- Case 3: Widening of 2 bottlenecks at Tupang and Nassiping (channel width: 500 m)
- Case 4: Widening of 3 bottlenecks at Tupang, Nassiping and Magapit (channel width: 500 m)
- Case 5: Widening of 3 bottlenecks at Tupang, Nassiping and Magapit (channel width: 700 m)

The above 5 cases are proposed in the alternative study for formulation of the flood control long-term plan combined with optimum plans to be selected in the upstream reaches at Alcala, which will be described in a later Section. Further details are explained in ANNEX VI.

(3) Flood Control Plan in the Reach from Alcala to Buntun Bridge

Alternative plans in this reach are prepared with the following viewpoints considering geological features in this reach, which were described in the former Subsection of 2.5.3 River Morphology.

1) To stabilize low water channel by means of cut-off channel and riverbank tree zone with incidental effect by the widening of bottlenecks in the downstream narrows.
2) To mitigate flood damage due to frequent inundations by means of dike system.

Accordingly, the following 4 cases are taken up in the comparative study:

- Case1: Construction of 2 cut-off channels (Gabut and San Isidro) and 1 continuous dike system with riverbank tree zone (Alcala to Buntun)
- Case2: Construction of 1 cut-off channel (Gabut) and 2 dike systems with partial levee (Amulung and Solana)
- Case3: Construction of 1 cut-off channel (Gabut) and 2 dike systems with partial levee (Amulung and Solana)
- Case4: Construction of 2 dike systems with partial levee (West Amulung and Solana)

The above 4 alternatives are examined through comparative study to select an optimum scheme in this reach. Finally, Case 1 is selected as the optimum plan and further alternative study combining with the above alternatives in the Magapit narrows is made for the formulation of a flood control plan in the later Subsection.

The Case 1 consists of construction of 2 cut-off channels as channel normalization and 1 dike system with riverbank tree zone in the floodplain. Further details are explained in ANNEX VI.

(4) Flood Control Plan in the Reach from Buntun Bridge to Tuguegarao

The alternatives to cope with the problems involved in this reach are examined from the following viewpoints:

1) To regulate flow directions of Cagayan for protection of Tuguegarao city from attacking the direct flow of the Cagayan and Tuguegarao Rivers.
2) To mitigate flood damage due to frequent inundations.

From the above, the following 3 cases are considered in the comparative study:

Case1: Improvement of the present Cagayan River channel and construction of two dike systems (Tuguegarao and Enrile)

Case2: Construction of Tuguegarao diversion channel and one dike system (Tuguegarao)

Case3: Construction of cut-off channel (Tuguegarao) and two dike systems (Tuguegarao and Enrile)

The above 3 countermeasures are comparatively studied. The Case 3 is selected as the optimum one in and around the capital city. The selected Case 3 consists of construction of 1 cut-off channel as channel normalization and 2 dike systems. Further details are explained in ANNEX VI.

(5) Selection of Optimum Plan

By combining the 5 alternatives in the narrows with the 2 selected optimum plans in the reaches from Alcala to Tuguegarao, a comparative study is made to select an optimum scheme in the following.

1) Alternative Schemes

The five alternative schemes as summarized below are comparatively examined.

| Alternative | Component to be combined | | |
|---|---|---|---|
| | In the reach of Magapit narrows | In the reach from Alcala to Buntun bridge | In the reach from Buntun bridge to Tuguegarao |
| Alternative 1 | Without widening | Alcala~ Buntun dike with Gabut and San Isidro cut-off channels | Tuguegarao ~ Enrile dike with Tuguegarao cut-off channel |
| Alternative 2 | Widening of Tupang (to 500 m) | | |
| Alternative 3 | Widening of Tupang and Nassiping (to 500 m) | | |
| Alternative 4 | Widening of Tupang, Nassiping and Magapit (to 500 m) | | |
| Alternative 5 | Widening of Tupang, Nassiping and Magapit (to 700 m) | | |

2) Selected Scheme

Through economic evaluation of the above alternatives with the combined schemes of the 4 irrigation projects, the evaluation results under future condition are summarized below.

| Alternative | Construction Cost (Million Pesos) | | Benefit (Million Pesos) | | Economic IRR (%) | |
|---|---|---|---|---|---|---|
| | Flood Control | Irrigation | Flood Control | Irrigation | Under present condition | Under future condition |
| 1 | 10,436 | 3,018 | 865 | 1,300 | 12.5 | 22.5 |
| 2 | 14,904 | 3,194 | 872 | 1,542 | 10.5 | 19.4 |
| 3 | 16,895 | 3,194 | 875 | 1,544 | 9.6 | 18.2 |
| 4 | 18,486 | 5,020 | 881 | 1,734 | 9.0 | 16.9 |
| 5 | 57,918 | 5,020 | 899 | 1,823 | 2.9 | 8.4 |

Note: The detailed information; refer to Section 10.8 CHAPTER 10.

Alternative 1 indicates the highest economic internal rate of return. Accordingly the Alternative 1 is selected as the reviewed flood control long-term plan. The widening of Magapit narrows is excluded from the reviewed long-term plan although the scheme will remain as one of the components in the framework plan.

The lowering of floodwater levels by construction of 3 cut-off channels is estimated and the result is around 0.5 m at Amulung, 1.4 m at Iguig, 0.9 m at Buntun bridge, and 0.7 m at Namabbalan respectively, compared with those in the present condition. Details and other impacts are described in ANNEX VI.

### 7.4.4 Structural Measures from River Mouth to Magapit, and Upstream of Tuguegarao

The structural measures for the reach between the river mouth and Magapit consist of bank protection and dike systems proposed in the 1987 long-term plan. The structural measures for the reach upstream of Tuguegarao are also bank protection and dike systems proposed in the 1987 long-term plan.

### 7.4.5 Structural Measures of Reviewed Flood Control Long-Term Plan

(1) General

The reviewed flood control long-term plan is a sectoral development plan with socially, economically and environmentally viable projects. It consists of the reviewed schemes of basin wide as shown in Figure 7.4.4.

(2) Features of Flood Control Structural Measures in Reviewed Long-Term Plan

The identified structural measures in the reviewed plan are summarized below.

1) Dike embankment
   - In the main Cagayan River including Alcala-Buntun Dike, Tuguegarao Dike, and Enrile Dike as shown in Figure 7.4.5, and Lower Reach Dike
   - In the major tributaries, the Siffu, Ilagan, and Magat Rivers
2) Cut-off channel works
   - In the main Cagayan River at Gabut, San Isidro and Tuguegarao
   - In the Magat, Siffu and Mallig Rivers
3) Bank protection at 73 sites as presented in Figure 2.6.1
4) Flood control dams
   - Cagayan No.1 dam
   - Ilagan No.1 dam

The details are explained in ANNEX VI.

(3) Major Modification from 1987 Master Plan

The major modification of the long-term plan between the 1987 Master Plan and this Study are as enumerated below.

1) Magapit Narrow Improvement Scheme which had been proposed in the 1987 Master Plan was reviewed in detail by using river cross sections and topographic maps surveyed in this Study. It was concluded that this scheme showed lower economic efficiency, hence was discarded in the reviewed long-term plan.
2) The Gabut Cut-off Channel and San Isidro Cut-off Channel had been included in the 1987 Master Plan. The Tuguegarao Cut-off Channel was newly proposed in the reviewed long-term plan.
3) Bank protection works were counted for 75 sites in the 1987 Master Plan. In this Study, 73 sites needing bank protection works were identified and included in the long-term plan.

### 7.4.6 Cost Estimate

The estimated project cost is finally Pesos 30.5 billion consisting of Pesos 10.3 billion for the scheme in the middle lower Cagayan from Alcala to Tuguegarao, Pesos 4.4 billion for bank protection works scheme in basin wide and Pesos 15.8 billion for the other schemes in the lowermost, middle and upper Cagayan. Breakdown of the costs are summarized in ANNEX VI.

## 7.5 Non-structural Measures of Flood Control Long Term Plan

The conceivable measures for the flood control plan are structural measures and non-structural measures. The structural measures mitigate the hazards, while the non-structural measures reduce the vulnerability. The components of the non-structural measures to be discussed below are evacuation system, resettlement and hazard map preparation.

### 7.5.1 Evacuation System

(1) Flood Forecasting and Warning System

A reliable warning, based on an accurate forecasting, is fundamental to an effective evacuation of people at risk to reduce vulnerability. The flood forecasting and warning system comprises several activities such as observation and forecast of floods, judgement of risks, and preparation, issuance and transmission of warning.

Problems of Existing Flood Forecasting and Warning System

Two flood forecasting and warning systems exist at present in the Cagayan River basin, which are the Cagayan Flood Forecasting and Warning System (FFWS) operated by PAGASA and the Magat Dam Flood Forecasting and Warning System (FFWSDO) operated by NIA.

Major problems of the existing FFWS and FFWSDO are malfunction of water level gauges, repeater station and warning station, and insufficient flood forecasting and warning as described in Subsection 2.6.5.

In order to cope with the problems, the study under special assistance for project sustainability (SAPS Study) on the flood forecasting and warning system was conducted in 1999 by the Overseas Economic Cooperation Fund (OECF). The improvement plans proposed by the SAPS Study are reviewed and judged in this JICA Study to be recommendable because the same situation exists at present as that during the SAPS Study.

Improvement Plan for Flood Forecasting and Warning System

The proposed improvement plans are presented below, which are based on the review of Cagayan basin part of the SAPS Study.

1) Improvement of FFWS and FFWSDO Facilities: This activity includes rehabilitation of telemetering system and restoration of computer system of FFWS and FFWSDO, provision of telefax communication facility and supply of spare parts and others.
2) Special FFWS and Disaster Management in Tuguegarao: This activity includes establishment of a local hydrological observation station in Tuguegarao River and local communication network among subcenter, RDCC and members, MDCC, evacuation centers, and Barangays.
3) Consultancy and Engineering Services: This activity includes improvement of FFWS/FFWSDO, strengthening of Tuguegarao subcenter and community disaster management capacity building in Tuguegarao. The improvement of FFWS/FFWSDO consists of a) improvement of flood warning information such as preparation of information materials and dissemination flow chart, review of flood warning level and simulation of flood, and b) detailed design/ construction supervision/ operation and maintenance of the FFWS/ FFWSDO facilities. The strengthening of Tuguegarao subcenter includes preparation of strengthening plan and technical guidance for operation of the subcenter. The community disaster management capacity building comprises a) enhancement/ design of community flood disaster mitigation such as detailed design, construction supervision and operation and maintenance of local hydrological station and local FFWS communication network, and b) education and training of disaster management staff.

Implementation Cost of Improvement Plan

The following shows result of the cost estimate for the improvement of the existing flood forecasting and warning system including the disaster management system. The estimate is based on that made by the SAPS Study in 1999 and its update done by PAGASA in 2000.

| Activities | Amount (Million Pesos) |
|---|---|
| 1. Improvement of FFWS and FFWSDO Facilities | 102.5 |
| 2. Special FFWS and Disaster Management in Tuguegarao | 21.4 |
| 3. Consultancy and Engineering Services | 86.5 |
| 4. Base Cost (1.+2.+3.) | 210.4 |
| 5. Project Administration Cost (0.2% of Base Cost) | 0.4 |
| 6. Contingency (15% of Base Cost) | 31.6 |
| 7. Grand Total | 242.4 |

Cost of annual operation and maintenance, which will be made by PAGASA and NIA, is assumed to be 3% of the construction cost. Taxes and duties are not included in the above estimates.

(2) Evacuation Center

The "Calamities and Disaster Preparedness Plan" formulated by NDCC in 1988, provides the details for creation of the operating unit for evacuation service at the regional, provincial, city/municipal and barangay levels.

Problems of Existing Evacuation Center

The existing evacuation system is operated and maintained by RDCC, PDCC, CDCC/MDCC and BDCC in the Cagayan River basin. Major problems on the evacuation center are insufficient supply of drinking water and food, and lack of cooking facilities and comfort rooms in the evacuation centers, which were identified through discussions with OCD officials of Region 2 and interview survey of the City/Municipalities and Barangays concerned made in this JICA Study.

Measures for Improvement and Cost

The evacuation activity is considered to be a local function. LGUs are the main players for the evacuation so that timely evacuation and grasp of the accurate requirement can be attained. Therefore, the problems stated above are recommended to be solved by LGUs. The cost for improvement of the evacuation center is estimated as follows:

| Activities | | Amount (Million Pesos) |
|---|---|---|
| 1. | Construction of deep wells and comfort rooms | 77.1 |
| 2. | Purchase of tents and cooking facility | 61.2 |
| 3. | Preparation and updating of disaster preparedness plan | 13.5 |
| 4. | Education and training of DCC staffs and local people | 4.4/year |

### 7.5.2 Resettlement

(1) Residents' Intention on Resettlement

According to the Questionnaire Survey on Resettlement conducted by the Study Team, half of the residents in the flood prone area show that they agree to move to areas less vulnerable to inundation. Moreover, some 20 % of residents agree to move if enough compensation, livelihood assistance and housing and so on are given. Details are described in Supporting Report.

(2) Formulation of Resettlement Plan

Regarding the formulating of resettlement plan, DPWH has a "Policy Framework for Land Acquisition, Resettlement and Rehabilitation (Nov., 1999)" for a road development project but not for a river improvement project. Environmental Impact Assessment Project Office of DPWH, which is in charge of resettlement procedures, suggests that the policy framework can be applied to resettlement for river improvement projects. Therefore, it is rationale to refer to them in order to formulate a resettlement plan for this project.

The essential components of a resettlement plan are considered to be as follows:

- Selection of necessary acquisition area
- Formulation of the compensation plan
- Selection of relocation area and formulation of the development plan of relocation

Basically, relevant LGUs are responsible for formulating a resettlement plan.

(3) Conditions of Relocation

The following items and respective standards by NHA are as follows.

- Floor area of houses; 25 $m^2$ (NHA, R-2 suggests 30 $m^2$)
- Surface area of lots; 100 $m^2$
- Social infrastructure and utilities to be supplied, including Access road, Drainage system, Sanitary facilities, Water supply system, Power supply system, Community facilities, Schools (Depending on the number of relocated persons, capacity of existing nearby schools)

(4) Necessary Considerations for Resettlement

Regarding basic policy for appropriate resettlement measures, the World Bank's Operational Directive 4.30 on involuntary resettlement should be considered to be satisfied in this resettlement case. In addition to the Operational Directive as well as conditions of relocation described above, the study team is considering the following for better understanding of affected people and for facilitating resettlement procedures.

a) Treatment of Informal Settlers
b) Public consultation and/or Public Involvement
c) Relocation
d) Awareness building of Re-settlers
e) Setting of Compensation Rate
f) Formulation of the Resettlement Action Plan

### 7.5.3 Hazard Map

The hazard map of the Cagayan River basin has been prepared in this JICA Study as shown in Figure 7.5.1 in terms of flood prone area, river bank erosion and soil erosion of the basin. The map will be used to make the people living in the Cagayan River basin, aware of the risks of such hazards and to take actions for preparedness.

Some hazard maps are available in the Cagayan River basin, which are nationwide hazard map of flood susceptibility (DENR), the map of earthquake-induced shallow landslide and tsunami risk (PHILVOLCS), hazard maps on pollution, soil erosion, floods, tsunami and volcanoes (Province of Cagayan), and flood inundation area map for the 1973 and 1980 floods (1987 Master Plan). These maps are incorporated in the hazard map preparation.

In the hazard map, the flood prone area is represented by the flooding area of 1973 flood. The river bank erosion sites are the sites investigated and identified during this JICA Study by the Study Team and DPWH Region 2 as severely eroded banks. The soil erosion area is the area delineated by BSWM, DA in 1995.

### 7.5.4 Cost Estimate

The estimated costs for the proposed non-structural measures mentioned above are summarized below:

a) Evacuation system : Pesos 394 million
b) Resettlement : Pesos 1,185 million

# CHAPTER 8 WATERSHED MANAGEMENT

## 8.1 Basic Concept of Watershed Conservation Plan

### 8.1.1 Functions of Watershed Management

Generally, the watershed means the entire river basin. The watershed includes all the components located therein such as soils, water and forests.

The soils, especially forest soils created by forests in the watershed store rain water, which leads to flood peak cut and low flow increase. The forest soils also absorb energy of raindrops and reduce surface flows, which results in soil erosion reduction. The soils maintain and improve water quality, too. The forests absorb carbon dioxide, supply oxygen, accelerate evapo-transpiration and maintain hydrological cycle in the watershed. The forests also prevent land collapse, wind, fire, sound, and so on.

Reduction of the forest area will result in increase of flood peaks, decrease of low flows, increase of sediment yields, and degradation of ecosystem. Earthquakes and eruptions will induce increase of sediment yields and occurrence of debris flows. The watershed management is required to cope with the above phenomena.

The main objectives of watershed management to be examined in this JICA Study are to mitigate the flood magnitude and to reduce the sediment yield of the Cagayan River basin, and to function as a measure of the flood control on the Cagayan River.

### 8.1.2 Present Issues

Problems encountered in the existing watershed management of the Cagayan River basin are lack of detailed and comprehensive watershed management plan and insufficient activities of watershed conservation in spite of present degradation of the watershed and land collapse in the upper Magat River basin as mentioned in Section 2.7.

In the 1987 Master Plan studied by JICA, a watershed management plan for the Cagayan River basin was not included. JICA, however, carried out another study for the watershed management of the basin, which is "Preparation of Forest Information in Wide Area and Forest Management Planning in the Republic of the Philippines" in 1988 (1988 JICA Study). The 1988 JICA Study provided a forest management plan of the basin, in which prohibited or permissible locations of tree cutting in the forest area and locations of active reforestation in the grass land are recommended in order to prevent natural hazards. However, areas of the tree cutting and reforestation are not specified in the 1988 JICA Study.

### 8.1.3 Basic Concept of Watershed Conservation

This JICA Study has examined and formulated at a preliminary level a watershed conservation plan for the entire Cagayan River basin. Components to be incorporated in the plan are reforestation and sabo works, which are common and effective measures for the watershed conservation.

This JICA Study is limited to formulation of the master plan on the watershed conservation. Therefore, this Study recommends the Government of the Philippines to conduct a feasibility study including further investigations and detailed studies to formulate detailed plans for reforestation and sabo works plan to follow for their immediate implementation after this JICA Study.

The following sections explain the reforestation plan and sabo works plan formulated by this JICA Study for the Cagayan River basin.

## 8.2 Reforestation Plan

### 8.2.1 Area of Reforestation

Area of the required reforestation in the Cagayan River basin has been estimated on an assumption that all land area, of which the slope is over 18%, except for present agricultural land should be covered by the forest or other vegetation listed into the forest category. The slope limit of 18% is basically applied for division of lands of the public domain into forest lands in the Department of Environment and Natural Resources (DENR).

The land area with the slope over 18% was delineated and measured based on the slope map developed by the Bureau of Soils and Water Management (BSWM) of the Department of Agriculture (DA) in 1995, which is the only map presently available. The present forest area and agricultural land area were delineated and estimated by using the Land Use and Forest Type Map and Forest Register prepared in 1995 by Japan Forest Technical Association (JAFTA) with the cooperation of DENR, National Mapping and Resource Information Authority (NAMRIA) and Remote Sensing and Resource Data Analysis Department (RSRDAD). The Land Use and Forest Type Map and Forest Register were derived from the Landsat TM taken in 1992 and 1993 and show the latest forest information of the Cagayan River basin.

The estimated present forest cover consists of areas of old-growth forest, mossy forest, residual forest, sub-marginal forest, pine forest, mangrove forest, reproduction brush, and forest plantations (coconut plantation and other plantation), which are regarded as the forest category according to DENR standard.

The delineated present forest area was overlaid on the land area with the slope over 18% and the area of non-forest within the land steeper that 18% was estimated as seen in Table 8.2.1. The estimate was made for each of 35 forest compartments, which were introduced by JAFTA in 1995 for the forest management.

The area of the past reforestation implemented after the year of 1993 when the used Landsat TM was taken was accumulated based on the collected data for JBIC funded projects, Casecnan watershed management and DENR projects as shown in Table 8.2.1. Detailed data on ADB funded projects and Community Based Forest Management (CBFM) projects are not available, hence reforestation area of these projects are not included in the past reforestation area estimates.

Hence, the area of the required reforestation for the entire Cagayan River basin has been estimated to be 3,188 $km^2$ as shown in Table 8.2.1 and Figure 8.2.1, and as summarized below.

| Sub-basins | Land Area over 18% Slope excluding Agricultural Land ($km^2$) | Present Forest Area in Land over 18% Slope ($km^2$) | Proposed Reforestation Area ($km^2$) |
|---|---|---|---|
| Upper Cagayan River basin | 3,657 | 3,266 | 391 |
| Magat River basin | 3,670 | 2,443 | 1,227 |
| Ilagan River basin | 2,389 | 2,371 | 18 |
| Siffu-Mallig River basin | 1,032 | 694 | 338 |
| Chico River basin | 3,832 | 3,249 | 583 |
| Lower Cagayan River basin | 2,380 | 1,749 | 631 |
| Whole Cagayan River basin | 16,960 | 13,772 | 3,188 |

### 8.2.2 Effect of Reforestation

The forest functions to reduce flood peaks, to increase low flow and to mitigate soil erosion in the watershed. Some results of research and studies on these functions are presented below, which have been made so far in the Philippines and other countries to manifest the effects of the forests.

(1) Effect to Reduce Flood Peaks and Increase Low Flow

A simulation was made by Dr. Fukushima (Japan) in 1987 by applying to a runoff model experimental data on runoff from lands of various vegetation in order to clarify a change of the relationship among evapo-transpiration, direct runoff and baseflow of the watershed under the condition of land cover change from bareland to forest. The simulation result shows the following relationship:

| | Just after Reforestation | 100 years after Reforestation |
|---|---|---|
| Evapo-transpiration | 25% of rainfall | 45% of rainfall |
| Direct Runoff | 50% of rainfall | 25% of rainfall |
| Baseflow | 25% of rainfall | 30% of rainfall |

The direct runoff and baseflow mean runoff during rain and no-rain, respectively. The table shows the effect of the forest reducing the direct runoff and increasing the baseflow.

The above mentioned reduction of the direct runoff of 25% and increase of the baseflow by 5% are used for a trial assessment of the benefit of the reforestation, which is discussed in CHAPTER 10.

(2) Effect to Mitigate Soil Erosion

Some studies have been conducted by development projects or study groups on soil erosion in the Magat watershed in the Cagayan River basin as follows:

1) Magat Watershed Feasibility Study, NIA, 1985,
2) The Economic Impact of Soil Erosion in the Pantabangan and Magat Watersheds, Upland Resource Policy Program Project funded by the Philippine Institute for Development Studies and the International Development Research Center of Canada, 1987,

Both of the above studies estimated soil erosion rate of the interested basins by applying the modified universal soil loss equation and past sediment yield data. However, no detailed or quantitative discussion has been made about the applicability of the equation to the basin and consistency of the estimated rate with the sedimentation record of the Magat reservoir.

In the Magat Watershed Feasibility Study, measurements of the soil erosion and sediment flow have been made in representative catchments of the Magat watershed at Aritao, Dallao and Tapaya. Unfortunately, the data collected during the measurement are insufficient to examine the soil erosion rate for the various land covers.

The following table shows a study result made by Professor T. Kawaguchi in Japan on the relationship between soil erosion and land use:

| Land Use | Waste | Bare | Agriculture | Grass | Forest |
|---|---|---|---|---|---|
| Annual Erosion (mm/year) | $10^{1}$-$10^{2}$ | $10^{0}$-$10^{1}$ | $10^{-1}$-$10^{0}$ | $10^{-2}$-$10^{-1}$ | $10^{-2}$-$10^{-1}$ |

### 8.2.3 Implementation of Reforestation

The Executive Order No.263 (EO 263), entitled "Adopting Community Based Forest Management as the National Strategy to Ensure the Sustainable Development of the Country's Forest Lands Resources and Providing Mechanisms for its Implementation" was issued in 1995. It stipulates that the community based forest management (CBFM) shall be the national strategy to achieve sustainable forestry and social justice. Pursuant to EO 263, the CBFM strategy has been implemented by DENR through cooperation with LGUs to attain the sustainable development and management of the forest. The watershed conservation plan formulated in this JICA Study follows this strategy.

In addition to the CBFM strategy, an active participation of the volunteers such as schoolchildren, students and NGOs to the reforestation activity is recommended in this JICA Study.

### 8.2.4 Cost of Reforestation

The investment cost for the reforestation of 318,800 ha was estimated under the following conditions:

1) Source of unit prices for forest tree plantation and agroforestry is "Guidelines governing the updating of cost estimates and intensification of plantation maintenance and protection activities for DENR-FSP watershed subprojects under JBIC funding, DENR, (2000)".
2) Agroforestry and rehabilitation of infrastructure are included to ensure peoples' livelihood and attain sustainable reforestation activities. Area of the agroforestry is set at 10% of the total reforestation area. The rehabilitation of infrastructure consists of rehabilitation of farm to market roads, inspection/maintenance roads, etc. of which the cost is 2% of the sum of the forest tree plantation cost and agroforestry cost.
3) Participation of volunteers is expected in the plantation establishment, maintenance and protection. 50% of manpower is assumed to be shared by the volunteers in the plantation establishment, maintenance and protection.
4) No land compensation cost is considered since the reforestation is to be implemented by the CBFM procedure.
5) Engineering services and administration costs are included in the unit prices for forest tree plantation and agroforestry.

The estimated investment cost is as follows:

| Work Item | Unit | Work Quantity | Unit Price (Pesos) | Amount (Million Pesos) |
|---|---|---|---|---|
| Forest Tree Plantation | ha | 287,000 | 13,200 | 3,788 |
| Agroforestry | ha | 31,800 | 14,900 | 474 |
| Rehabilitation of infrastructure | LS | • | • | 85 |
| Compensation | LS | • | • | 0 |
| Contingency (15% of the above) | LS | • | • | 653 |
| Total | | • | • | 5,000 |

The annual operation and maintenance cost is Pesos 1,500/ha/year, which was given by PENRO Isabela, DENR.

### 8.2.5 Recommendation of Further Study

The reforestation plan mentioned above has been formulated at a preliminary level on the basis of the limited information and field reconnaissance. The further data collection and analysis, intensive field reconnaissance and detailed study are recommended for the formulation of detailed reforestation plan and immediate implementation of the plan.

Experimental research is also recommended in the Cagayan River basin to investigate land use, runoff and sediment yield so that valuable information is obtained for future watershed management including the formulation of the detailed reforestation plan.

## 8.3 Sabo Works Plan

### 8.3.1 Sediment Yield

The hydrological study of the Reviewed Master Plan confirmed the applicability of the basin average sediment yield of 1.5 mm/year for the entire Cagayan River basin, which has been derived in the 1987 Master Plan.

In order to assume the sediment yield for each sub-basin of the Cagayan River basin, Murano's equation was introduced, since no other equation is available due to insufficient sediment data of the basin. The sub-basin is the same as that for the flood analysis. The Murano's equation was developed based on the sediment deposit data of the 103 existing sabo dams in Japan, and factors of their catchment areas, annual rainfalls, elevations and undulations are incorporated in the equation.

The Murano's equation derives around 31 million $m^3$ of annual sediment yield for the entire Cagayan River basin, while 41 million $m^3$ of the annual sediment is computed based on the denudation rate of 1.5 mm/year. Although these values are different, the Murano's equation was applied for the assessment of sediment balance of the basin, because the available data are limited to discuss the difference of the sediment yield estimations. The estimate result of the sediment yield by Murano is summarized as follows:

| Sub-basins | Catchment Area ($km^2$) | Sediment Yield by Murano (MCM/year) (mm/year) | |
|---|---|---|---|
| Upper Cagayan River basin | 6,633 | 6.8 | 1.0 |
| Magat River basin | 5,113 | 6.4 | 1.3 |
| Ilagan River basin | 3,132 | 2.4 | 0.8 |
| Siffu-Mallig River basin | 2,015 | 0.9 | 0.4 |
| Chico River basin | 4,551 | 11.6 | 2.5 |
| Lower Cagayan River basin | 5,837 | 2.7 | 0.5 |
| Whole Cagayan River basin | 27,281 | 30.8 | 1.1 |
| Whole Cagayan basin except Magat Dam basin | 23,138 | 24.4 | 1.1 |

In the Magat River basin, the record of the Magat reservoir sedimentation is available as shown below:

| Year of Survey | Accumulated Sediment Volume (MCM) | Average Annual Sediment Rate (MCM/year) (mm/year) | |
|---|---|---|---|
| 1984 | 22.0 | 7.3 (1982-1984) | 1.8 |
| 1988-1989 | 49.0 | 6.7 (1982-1989) | 1.6 |
| 1995 | 179.0 | 12.8 (1982-1995) | 3.1 |
| 1998 | 181.0 | 10.6 (1982-1998) | 2.6 |
| 1999 | 188.0 | 10.4 (1982-1999) | 2.5 |

Source: 1999 Survey Results – Magat Reservoir and Tributary Rivers Sediment Range System, Dam and Reservoir Division, Magat River Integrated Irrigation System, December 2000

The river deposit accumulated after the earthquake which occurred in July 1990 at the upstream of the Magat reservoir was investigated and the deposit volume was estimated to be 30 million $m^3$ based on interview surveys of the deposit depth. The total sediment to be transported from the Magat basin is regarded as the sum of the sediment volume in the reservoir and the river deposit.

### 8.3.2 Sediment Balance and Target Area of Sabo Works

According to the estimate results by the Murano's equation, the high sediment yield areas are the Upper Cagayan, Magat and Chico River basins, of which major parts have sediment yield of more than 1,500 $m^3/km^2/year$. These areas overlap the area of severe erosion delineated in the BSWM erosion map. The annual sediment yield estimated by Murano is 24 million $m^3$ for the whole Cagayan River basin excluding the Magat Dam basin.

On the other hand, the annual sediment transport capacity was reviewed for the lower Cagayan River to be in the range between 5 and 8 million $m^3$ as described in Section 5.6. Comparison of the transport capacity and annual sediment yield mentioned above may lead to a conclusion that more than 10 million $m^3$ of the sediment is deposited in the Cagayan River and tributaries.

However, riverbed of the lower Cagayan River is rather stable as stated in Chapter 7. According to the field investigations made by this JICA Study, no remarkable riverbed fluctuation has been found in the Cagayan River basin except for the Magat River basin. The imbalance of the sediment yield and transport of the Cagayan River may be caused by inaccurate estimate of both of the sediment yield and transport due to insufficient information. Therefore, respecting the result of the investigation, the sabo works plan was not formulated in the Cagayan River basin except for the Magat basin.

The existing Magat Dam faces a reservoir sedimentation problem, which has been accelerated by land collapses in the Magat River basin caused by the earthquake occurred in July 1990. Urgent sabo works are required in the upstream of the Magat reservoir to extend the reservoir life of the Magat Dam.

### 8.3.3 Required Number of Sabo Dams in the Magat River Basin

Sabo dam is applied as the sabo works for storing excess sediment. The excess sediment is the sediment yield deducted by the allowable sediment to be released downstream. The following conditions are considered in estimating the number of the sabo dams required upstream of the Magat reservoir:

1) In estimating the sediment yield, the sediment record of the Magat reservoir was used. Among the sub-basins No. 13 to 19 in the Magat basin as seen in Figure 8.3.1, sub-basins No. 13 and 14 are the most erosive areas, which were fractured by the 1990 earthquake. The increased sediment yield after 1990 by the earthquake is assumed to come from the sub-basins No. 13 and 14. The sediment yield of the remaining sub-basins is the same as that before the earthquake. The former is 12,800 $m^3/km^2$/year and the latter is 1,600 $m^3/km^2$/year
2) It is assumed that the reforestation contributes to reduce the sediment yield by 50%.
3) The construction of a series of sabo dams will reduce the slope of riverbed, which will decrease the sediment transport and consequently mitigate the sediment yield. The effect of the riverbed slope decreasing is applied for estimating the sediment yield reduction.
4) The allowable sediment to be released downstream of the sabo dam is the

same as the designed sediment inflow to the Magat reservoir of 5.5 million $m^3$/year.

5) The sediment volume to be stored by the sabo dam is computed assuming that the slope of sediment deposit will become 50% of the original river gradient. The design life of 20 years is considered in estimating the required number of sabo dams. The height of the sabo dam is 25 m.

Calculation result of the required number of sabo dams is summarized below.

| Sub-basin No. | Catchment Area ($km^2$) | Required No. of Sabo Dam (nos) | Total Storing Volume (Million $m^3$) |
|---|---|---|---|
| 13 | 620 | 7 | 95 |
| 14 | 292 | 10 | 55 |
| 15 | 550 | 3 | 16 |
| 16 | 1,228 | 1 | 29 |
| 17 | 628 | 4 | 19 |
| 18 | 559 | 1 | 15 |
| 19 | 266 | 0 | 0 |

The total number of sabo dams required was estimated to be 26. Figure 8.3.1 shows the required number of the sabo dams for each sub-basin of the Magat River basin.

### 8.3.4 Cost of Sabo Dams

The cost for construction of 26 sabo dams was estimated under the following conditions:

1) The 26 sabo dams have the same bottom width, height and upstream/ downstream slopes of 50 $m^3$, 25 m, 1:0.6/1:0.2, respectively.
2) No land compensation cost is considered since the sites of dam construction will be in remote areas where sites with no agricultural lands or roads in the vicinity can be selected.

The estimated construction cost is as follows:

| Work Item | Unit | Work Quantity | Unit Price (Pesos) | Amount (Million Pesos) |
|---|---|---|---|---|
| 1. Main Works<br>1.1 Preparatory Works (8% of 1.2&1.3) | LS | • | • | 266 |
| 1.2 Excavation | $m^3$ | 59,800 | 180 | 11 |
| 1.3 Concrete | $m^3$ | 845,000 | 3,930 | 3,321 |
| 1.4 Miscellaneous (15% of the above) | LS | • | • | 540 |
| 2. Compensation | LS | • | • | 0 |
| 3. Eng. Services and Admi. (15% of 1) | LS | • | • | 620 |
| 4. Contingency (15% of the above) | LS | • | • | 714 |
| Total | | • | • | 5,472 |

The annual maintenance cost is assumed to be 0.1% of the construction cost.

### 8.3.5 Recommendation of Further Study

The sabo works plan mentioned above has been formulated at a preliminary level on the basis of the limited information and field reconnaissance. Further data collection and analysis, intensive field reconnaissance and detailed study are recommended for the formulation of detailed sabo works plan and immediate implementation of the plan.

The study to excavate the river deposit accumulated in the river course upstream of the Magat reservoir should be made, so that the deposit will not flow into the reservoir.

## 8.4 Supporting Program

Illegal tree cutting and slash and burn activities are major problems in terms of forest conservation. Many efforts have been made by the Government to solve these problems, however these still remained unsolved. The intensive survey on these activities, analysis of causes and effects, and study of efficient countermeasures should be conducted in order to preserve the existing and future watershed. Consideration of residents' livelihood is the most essential.

# CHAPTER 9 LAND USE

## 9.1 Land Use Plan

### 9.1.1 General

Regional Physical Framework Plans (RPFPs) of Region 2 (R-2) and CAR include production land use plan, protection land use plan, settlement plan and infrastructure plan. Referring to these plans, discussed in this chapter are important plans on water resources development, namely basic land use plan, agricultural development plan and irrigation development plan. In addition, spoil bank use plan is required for efficient use of excavated materials in flood control construction works. Resettlement plan assures relocation of affected people by right of way of flood control works. Also, the plan is prepared as one of the non-structural countermeasures against flood. In this Chapter, supporting measures for agricultural development or poverty alleviation are presented to realize proposed benefits in the irrigation development project.

### 9.1.2 Land Use Policy

(1) National Land Use Act (draft bill)

This draft bill prepared in October 2000, institutes a national land use policy, including protection of prime agricultural lands, food security for rice and corn production and sustainable development and management of water resources.

(2) Settlement Policy

For settlement development, rational and sustainable utilization of physical resources is proposed in RPFP of R-2 as presented in Supporting Report. It states "Conversion of prime agricultural lands, into settlement purposes shall be rationalized. Irrigated agricultural lands shall be non-negotiable for conversion into other uses." This proposal seems to recognize the important role of agricultural land.

### 9.1.3 Basic Land Use Plan

Referred in basic land use planning is data on Strategic Agriculture and Fisheries Development Zone (SAFDZ), which is prepared by BSWM, R-2 and CAR in pursuant to Agriculture and Fisheries Modernization Act (AFMA). AFMA is explained in Subsection 2.8.5 (2).

(1) Strategic Agriculture and Fisheries Development Zone (SAFDZ)

With the approval of the Agriculture and Fishery Modernization Act (AFMA) in 1997, all suitable agricultural lands within A & D land are to be identified, set aside and protected from unreasonable conversion. The Network of Protected Areas for Agriculture and Agro-industrial Development (NPAAAD) areas are portions of privately owned lands (A & D land) that are technically defined prime agricultural lands identified by BSWM. The Strategic Agriculture and Fishery Development Zone (SAFDZ) refers to areas within the NPAAAD identified for production, agro-processing and marketing activities to help develop and modernize with the support of the government, the agriculture and fishery sectors in an environmentally and socio-culturally sound manner. The SAFDZs are strategically located and accessible areas which are identified jointly by DA and LGUs to serve as areas that will showcase modern farming (crops and livestock) and fishing technologies. ("Primer on SAFDZ", BSWM)

The Cagayan River Basin is divided to SAFDZ area (32%), future SAFDZ area or remaining NPAAAD area (8%) and Non-SAFDZ area (60%).

A basic land use plan is prepared by the Study Team as shown in Figure 9.1.1, which illustrates the process of conversion in land use from present one to proposed one in consideration of SAFDZ data shown in the middle.

(2) Present Land Use

Present land use is shown in the left side of Figure 9.1.1 and in Table 9.1.1. The present land use is categorized in reference with SAFDZ.

(3) SAFDZ Area

In the middle of Figure 9.1.1, SAFDZ areas are presented in ellipses. Distribution from present land use to SAFDZ can be seen in Table 9.1.1.

(4) Basic Land Use Plan

Following basic approaches are taken in the basic land use planning in this Study.

The plan was prepared, in principle, based on the concept of SAFDZ together with RPFPs of Region 2 (R-2) and CAR. For forest land (1,386,800 ha), pasture land (152,700 ha) and fish pond (13,900 ha), the same areas as in SAFDZ are applied. The built-up areas (221,200 ha) are proposed on the basis of those areas in RPFPs of R-2 and CAR. Agricultural area (676,400 ha) is to be maintained at the same scale in total, taking into consideration of basic land use policy to protect agricultural land. Agro-forestry area is proposed 105,100 ha. Details are presented in Supporting Report.

## 9.2 Agricultural Development Plan

### 9.2.1 Agricultural Development Potential in the Master Plan Area

(1) Land Resources

As in Supporting Report, around 680,000 ha is estimated as possible maximum crop area excluding other competing land use areas such as built-up areas. Land suitable for irrigated paddy field is estimated to be about 528,000 ha in gross based on land slope as well as SAFDZ areas.

(2) Water Resources

In Section 2.4, for the Cagayan River Basin, the average annual rainfall and runoff are estimated 2,600 mm and 1,550 mm (or 43.3 billion $m^3$/year), respectively. Design diversion water requirement of about 7.12 billion $m^3$/year in 2020 is estimated from water balance study results in Table 5.5.2 (5/5, Year 2020).

Certain part of the runoff or larger flood discharge flows directly into sea and cannot be utilized. And in drought years, annual runoff will decrease from the average value but it is considered still sufficient to the demand of each sector's design probability. Quantity of water resource can be said sufficient in long term base as a whole. However, from seasonal and spatial point of view, water shortage may occur in drought year and in certain parts of the basin.

### 9.2.2 Basic Concepts of Agricultural Development

(1) Basic Concepts

The basic concepts for agricultural development in the 1987 Master Plan were aiming at:

a. Improvement of the present poor economic position of the basin through full utilization of the endowed land and water resources for increase of agricultural production, and
b. Uplifting of rural living standard and improvement of present income disparity in the area.

The relevancy of the above basic concepts set in the 1987 Master Plan are found exactly conform to the new policy and strategies of Agriculture and fisheries Modernization Act (AFMA) as well as its plan or AFMP of the regions.

(2) Outline of 1987 Master Plan

Agricultural development plan was presented in 1987 Master Plan as summarized in Subsection 3.1.4 and in Figure 9.2.1. Out of 1,080,000 ha of the possible maximum agricultural area, the flat low land of 476,000 ha was planned to be developed fully in 2005, consisting of 306,000 ha of irrigated paddy field and 170,000 ha of diversified cropland. The upland or hilly land of 604,000 ha was planned to be the permanent cropland of 57,000 ha (29% of full development of 200,000 ha) and the pasture of 210,000 ha (70% of full development of 300,000 ha) by 2005, remaining 337,000 ha of the idle grassland.

(3) Agricultural Development in the Study

In the long term, present paddy field of 472,500 ha is planned to be 528,000 ha. Of the diversified crop field, corn field is planned to be113,800 ha and other crop fields 34,600 ha. The pasture area is planned to be 153,000 ha. Agro-forestry area is planned to be 277,600 ha. In the reviewed Master Plan, the same target areas are adopted except agro-forestry area of 105,100 ha.

### 9.2.3 Agricultural Development Strategy

(1) Increase in Agricultural Production

1) Expansion of Agricultural Area

The development targets of the crop area are proposed in Figure 9.1.1. The agricultural area is proposed to be unchanged in total on a balance of paddy field increase and diversified cropland decrease.

2) Increase of Cropping Intensity or Planted/Harvested Area

At present, cropping intensity has not yet reached developed high level. That of rainfed paddy field is around 127% as in Subsection 2.8.3. Proposed cropping intensity is heightened up to 250% in irrigated paddy field including diversified crop cultivation (ref. to Figure 11.3.1).

3) Improvement of Yield and Production Techniques

The target paddy yield applied in the Reviewed Master Plan is 4.5 and 5.0 ton/ha in the wet and dry seasons on average for the fully irrigated field as described in Supporting Report.

4) Paddy and Corn Production Plan

Table 9.2.1 shows a trial of paddy and corn production plan in the basin. The paddy production will become 2.1 times in 2020 from 1.52 million tons to 3.17 million tons. The corn production will be 1.7 times from 0.51 to 0.85 million tons. As representative of other diversified crop, beans are assumed in the same table. Increase of the bean production is estimated 1.6 times.

5) Reduction of Losses in Harvesting and Post-harvesting Stages

To reduce losses at the harvesting and post-harvesting stages, required facilities are; farm to market road, multi-purpose dryer, mechanical dryer, thresher/sheller, rice mill, corn mill, flour mill, warehouses, etc. Detailed consideration is presented in Supporting Report.

(2) Promotion of Agricultural Income Generation

1) Improvement of Marketing System and Facilities

Agricultural cooperative activities by farmers for buying and selling of agricultural inputs and products will contribute farmers directly to raise income and reduce expenditures.

It is recommended to change the system to process within the production area and send to the demand area by reinforcement of milling capacity in the basin.

2) Promotion of Agri-based Processing and Preservation Industries

As concerning to the above mentioned marketing system improvement, it is essential to promote agri-based processing and preservation industries within the region. Details on rice mill and other facilities are described in Supporting Report.

(3) Increase of Production in Hilly and Forestry Area

1) Promotion of Cattle Raising in Hilly Grass Land Area

It is hopeful to promote cattle raising of beef stock for fattening in the feedlot utilizing byproducts; bran of rice and corn, oil cake of corn, molasses of sugar factory, etc. within the region.

2) Promotion of Agro-forestry (fruits)

The wild grass and shrub areas of more than 18% of sloping will be developed to the agro-forestry with fruit trees such as Mango, Citrus, etc. as well as to promote community forestry to preserve and increase the forestry area.

## 9.3 Irrigation Development Plan

### 9.3.1 Basic Development Concept

(1) Necessity of Irrigation Development

Average rice import rate to national consumption is 12% for recent 5 years from 1995 to 1999. To make the country sufficient in rice, the "Rice Program 2000" implemented by DA planned to make the country 95% sufficient in rice by 2000. So, the Philippines seems to accept 5% import of rice or about 350,000 t of rice at present, which is equivalent to about 220,000 ha of harvested area or more than 110,000 ha of physical area in case of two or less cropping per year or on present condition.

In "Corporate Plan 1993-2002, NIA" and "The Study on Strengthening of NIA's Management System, Draft Final Report, August 2001, JICA", future annual rice supply and demand estimates were evaluated, in which rice deficits were projected in future during each plan period (1993-2002 and 2001-2010, respectively), even though new projects would be taken into the estimates. In reference to these estimates, a prolonged estimate up to 2020 is tried as in Table 9.3.1 and Figure 9.3.1. In the estimate, the average generation of irrigated area is set at 31,000 ha/year or about 1.0%/year of the irrigable area in the nation. The results presented the similar trend as the former cases, namely future deficit continuation. Therefore, the rice supply-demand balance is anticipated to be serious up to 2020.

The Cagayan River Basin is recognized as one of the important granary of the country and has a potential for future irrigation development. As mentioned in Subsection 2.8.1 (2), the irrigable area and existing irrigation service area are 475,000 ha and 218,000 ha. So, remaining area to be irrigated is 257,000 ha.

In the country, some other regions have a large potential for irrigation development. However, some of those areas are not stable due to political confusion and social problem or "peace and order" problem. So, constant supply of grains is disturbed sometimes as happened in 2000, when military actions were taken place and transportation of grain was interfered.

Taking into consideration above mentioned matters as well as food security, promotion of irrigation development in the Cagayan River Basin is strongly recommended.

(2) Constraints and Challenges

NIA mentions that the priorities for the short, medium and long-term irrigation development programs are geared to support food production and enhance socio-economic growth in the rural area. The thrusts in project development include accelerating the completion of on-going project, adequate packaging of future projects and introducing improved project management systems and practices. One of the stresses is put on developing a dynamic NIA and Irrigators' Association (IA) partnership in O&M.

### 9.3.2 Approach to Irrigation Development Plan

(1) Framework Plan

As a framework plan or the ultimate plan for the basin, all the remaining irrigable area of 257,000 ha is its target area for new generation of irrigated area, aiming at 100% of irrigation accomplishment. At the same time, all the existing irrigation systems should be rehabilitated and be fully operational.

(2) Long Term Plan

In formulating long term irrigation development plan, existing NIA program/plan and that in the 1987 Master Plan are taken into consideration. Selected 40 candidate schemes are of national level NIS/NIP and major CIS/CIP, as presented in Table 9.3.2. To decide schemes for long term plan, EIRR calculated by the expert is used. Schemes of less than 15% EIRR are excluded from economical viewpoint as described in Subsection 9.3.6 (2).

(3) Candidate of Reviewed Master Plan

In 1987 Master Plan, 14 irrigation projects were proposed consisting of 9 new/extension projects and 5 rehabilitation/improvement projects. Irrigation components of 2 multipurpose projects were included in the 9 projects. For the Reviewed Master Plan, 15 candidate schemes are selected as a part of package including other sector schemes as described in Subsection 10.8.3 (3). In addition, 13 number of economically high graded schemes are selected. In total, 28 schemes are the candidate schemes as seen in Table 9.3.3.

### 9.3.3 Proposed Irrigation Project in the Long Term Plan

Irrigation schemes proposed for long term plan are listed in Table 9.3.2 and selected schemes are shown in Figure 9.3.2. Main features of these schemes are shown in Supporting Report.

### 9.3.4 Water Management

The optimum water management is a challenge to distribute water as wide as possible within limited given conditions. To understand hydraulic characteristics as well as problematic point or bottleneck, profiles of irrigation canal network, is essentially necessary. The profiles or longitudinal sections should include elevations of canal bottom and right and left bank tops with acceptable accuracy. Weak points found in the hydraulic profiles should be repaired or improved.

Irrigators' Association together with NIA, should control gate operation for even water distribution.

### 9.3.5 Cost Estimate

The project cost is estimated for the proposed cropping pattern of rice-rice-beans, etc. and cropping intensity of 250%. Estimated project cost is shown in Table 9.3.2.

### 9.3.6 Prioritization for Candidate Schemes

(1) Criteria for Prioritization

Projects with economic internal rate of return (EIRR) of 15% or higher have higher priority. EIRR is used as one of main indicators.

More effective scheme for poverty alleviation and equitable development should have higher priority. In general, less developed area has disadvantages in economic aspect, so higher benefit is difficult to be gained. However, such area has potential high benefit from lower without-project level to full developed level. Anyway, low developed area should have higher priority for equitable development in accordance with AFMA. As mentioned in Supporting Report, household income of Cagayan province is lower than that of Isabela province. So, irrigation projects along the lower Cagayan River should be given higher priority Such areas that have poor traffic condition should be improved with higher priority.

From practical point of view, on-going and pipeline projects should receive higher priority, since early benefits can be expected by early implementation of such matured project.

(2) Prioritization

EIRR is calculated in economic evaluation in Subsection 10.8.3. Out of 40 candidate schemes in Table 9.3.2 for the long term plan, EIRR of 2 schemes is less than 15% and 38 schemes are remained in the long term plan as introduced in Table 9.3.3 and in Figure 9.3.2. Those schemes are compared according to the criteria presented in above (1). For the Reviewed Master Plan, 28 candidate irrigation schemes are selected as shown in Table 9.3.3.

## 9.4 Spoil Bank Plan

### 9.4.1 Basic Concept

The spoil bank area should be used effectively. In selection of the spoil bank area, paddy field is excluded in principle not to change required water level, except for swampy paddy field of poor drainage condition. Old river course will be basically remained as it is, since it is usable as natural fishing area and flood retarding area. One of the uses is for area of resettlement plan. Original and proposed land uses of the spoil bank area are as shown below.

| | | |
|---|---|---|
| Hilly area | → | Built-up area, upland crop field |
| Corn field | → | Corn or other upland crop field (better condition) |
| Swampy paddy field | → | Normal paddy field |
| Swamp | → | Paddy field |

### 9.4.2 Basic Design

Basic design and its cost estimate are carried out for reaches along the lower Cagayan River from Alcala to Enrile, where a large amount of excavation is proposed for three cut off channels (COCs). Excavated material is to be used for closing dike and flood dike embankment. Spoil bank will be required only for Tuguegarao COC. Estimated earth volume for the spoil bank is about 10 million $m^3$ or roughly equivalent to 500 ha with 2 m high. Within the probable and suitable spoil bank areas, swampy paddy field of Solana depression in back swamp is recommendable for Tuguegarao COC, because drainage improvement is desired by the people in the area.

### 9.4.3 Cost Estimate

It is considered that unit cost of excavation include hauling cost to spoil bank in the cost estimate of flood control works. Compaction cost is not necessary in case of drainage improvement in swampy paddy field. Required cost is road construction and rehabilitation to connect existing road to the spoil bank, together with land acquisition cost for new road. The estimated cost is about 200 million pesos.

## 9.5 Resettlement Plan

### 9.5.1 Basic Concept

Obtained information on the resettlement planning is presented in Subsection 7.4.2.

Proposed resettlement area is hilly area near the flood plain, to avoid flood. In the plain, natural levee may be the resettlement area with heightening of the land, if necessary. One of ideas on the proposed area for the resettlement is considered to be use of spoil bank area for excavated materials.

### 9.5.2 Basic Design

Each municipality concerned must prepare resettlement plan according to the development plan performed by Local Government Unit (LGU). As a reference for that, typical resettlement plan layout is prepared as illustrated in Figure 9.5.1.

## 9.6 Supporting Measures

### 9.6.1 Basic Concept

(1) Agricultural Supporting Program

In general, supporting programs are necessary for the purpose of improvement of inequitable income distribution to mitigate poverty in the rural area. Mainly performed by DA, the programs include, but not limited to, intensification and activation of irrigators' association (IA), finance and marketing support and so on. In case of Communal Irrigation System (CIP), such supports are implemented as usual activities. In case of NIP also, such supporting programs should be accompanied with the hard works. Thus, effective and efficient irrigation farming can be attained more easily.

In case of NIP also, such supporting programs should be accompanied with the hard works. Thus, effective and efficient irrigation farming can be attained more easily.

(2) Strengthening of Agricultural Support Services for Small Scale Farmers

Details are mentioned in Supporting Report on the following items.

1) Promotion of Agrarian Reform
2) Financial Support Services
3) Promotion of Farmers' Organization
4) Community-based Agricultural Infrastructure Improvement

(3) Rural Development Center

It is quite important to reduce production cost of main crops, including cost for post-harvest, marketing, etc. For the purpose, the Study Team proposes to install an integrated multi-sectoral center as a core space covering certain scale of area. More detailed information are seen in Supporting Report.

(4) Effect of Rice Milling

It is reported that not small amount of paddy produced in the Cagayan River basin is sent to the milling area of Nueva Ecija, Bulacan and Pangasinan. The Study Team proposes to mill rice in the basin as much as possible. Effect of rice milling in the basin includes transportation cost saving, use of by-products such as bran, husk, etc., employment generation, and so on. Particularly in northern part of Cagayan Province, milled rice may be delivered to Manila less costly by sea route.

(5) Improvement of Transportation System

As mentioned in Subsection 2.8.2 (1), transportation system from the Cagayan River basin to Metro Manila or crop demand area is insufficient. In addition to present main land route through Dalton Pass, activation of the sea route via Irene Port, Santa Ana or Aparri is considered necessary for development of the Lower Cagayan River area and northern coastal area.

### 9.6.2 Basic Design

(1) Crop Production in the Plain

1) Rice mill

A study on rice mill is carried out in Supporting Report, which suggest rice mill with nominal capacity of 5 t/hr can cover around 1,000 ha of new irrigation area, on condition that the rice mill receive net increase of the rice production.

2) Warehouse and Other Facilities

Other facilities are mentioned in Supporting Report, including warehouse, equipment, machinery and vehicle, rice thresher, corn sheller, mechanical dryer, hand tractor, tractor, transplanter, combine-harvester, car and truck, boats, power and water supply system, recycling system and solar energy use, automatic meteo-hydrological observation station, building and housing, etc.

(2) Livestock in the hilly area

Livestock industry should be closely combined with corn cultivation, formulating a cycle system. Corn fields supply feed and livestock area can return waste as organic fertilizer. This system is proposed to be supported by another type of rural development center.

(3) Agro-Forestry and Diversified Crop in the Mountainous Area

For agro-forestry and diversified crop cultivation, recommended is upland development experimental center with test field and spray irrigation systems including sprinkler and drip irrigation system. The proposed location should be decided after analysis on SAFDZ on the provincial and more detailed SAFDZ map. Proposed agro-forestry area in 2020 is 105,100 ha.

### 9.6.3 Cost Estimate

(1) Regular Supporting Measures

Cost for commonly required supporting measures is included in the respective irrigation project cost as administration and supporting program cost, which is estimated 8% of the summed cost for direct construction, compensation and O & M facilities.

(2) Cost for Rural Development Center

Total cost is estimated 189 million pesos as in Supporting Report.

(3) Cost for Upland Crop Experimental Center

3 centers: 120 million pesos

# CHAPTER 10 REVIEWED MASTER PLAN

## 10.1 Brief of 1987 Master Plan and Other Projects

This section presents brief explanations of the existing major plans, projects and programs, which are closely related to the development of the Cagayan River basin.

### 10.1.1 Proposed Projects and Programs in 1987 Master Plan

The 1987 Master Plan was formulated for water resources development of the Cagayan River basin consisting of the major schemes under the four sectors; 1) multipurpose projects, 2) flood control schemes, 3) agricultural development schemes and 4) hydropower development schemes.

The multipurpose projects consisted of i) Mallig project with Mallig No.2 dam, ii) Siffu project with Siffu No.1 dam, iii) Matuno project with Matuno No.1 dam, and iv) Alimit project with Alimit No.1 dam and Magat dam O&M.

The flood control schemes included i) Tuguegarao dike, ii) Narrow improvement (widening of constricted sections: NLL), iii) Bank protection, iv) Cabagan dike, and v) Narrow improvement (widening of constricted sections: NLR).

The agricultural development schemes comprised irrigation development schemes, irrigation rehabilitation schemes and others. The irrigation development schemes consisted of i) Dabubu irrigation scheme, ii) Lulutan irrigation scheme, iii) Gappal irrigation scheme, iv) Ilagan irrigation scheme, v) Tuguegarao irrigation scheme, vi) Alcala~Amulung irrigation scheme and vii) Zinundungan irrigation scheme. The irrigation rehabilitation schemes consisted of i) Pinacanauan irrigation scheme, ii) Solana irrigation scheme, iii) Baggao irrigation scheme, iv) Dummon irrigation scheme and v) Tumauini irrigation scheme. The others were i) Diversified crops development, ii) Permanent crops development, iii) Pasture land development, and iv) Magat O&M.

The hydropower development schemes were i) Ibulao scheme, ii) Tanudan scheme and iii) Diduyon scheme.

The outline of the 1987 Master Plan is presented in CHAPTER 3 of this Report.

### 10.1.2 Recommendations by SAPI Study

The SAPI (Special Assistance for Project Implementation) study was carried out in May to August 1999 to recommend the institutional capability building in river sector in the Philippines. Eight on-going river related projects in the Philippines were selected to clarify problems being encountered, examine causes of the problems and recommend action plans to solve the problems. Among the problems being encountered, delay of the construction schedule is the most important and critical problem. In line with the conceivable scenarios such as 1) preparation of laws and regulations, 2) reorganization of DPWH and 3) human resources development to cope with the problem and to attain institutional capability building in the river sector, the short term and long term action plans were proposed in the SAPI study. The detail is presented in Subsection 2.6.6.

### 10.1.3 Other Projects and Programs

(1) Existing Flood Control Projects and Plans by DPWH

DPWH Region 2 Office has the 61 ongoing flood control projects and 49 proposed projects. The Region 2 Office also has a medium-term infrastructure program for the period from 1999 to 2004. The detail of the DPWH flood control projects and plans is described in Subsection 2.6.4.

(2) Existing Flood Control Projects and Plans by LGUs

The projects implemented by the LGUs are limited to a few small-scale riverbank protection works due to constraints of finance and technical staff. The detail of the LGUs' flood control projects and plans is described in Subsection 2.6.4.

(3) Preparation of Forest Information in Wide Area and Forest Management Planning in the Republic of the Philippines, JICA, June 1988

The study was conducted by JICA from August 1985 to June 1988 to develop the management plan of the forest resources in the whole Cagayan River basin. The proposed forest management plan for the entire Cagayan River basin presents the forest management criteria for each of the divided 306 management units. The forest management plan for the model area provides the technical procedures and guidelines for effective implementation of the forest management in the model area. The detail is presented in Subsection 2.7.3.

(4) Cagayan Economic Zone Authority (CEZA)

The CEZA is the agency mandated to supervise and manage the development of the "Cagayan Special Economic Zone and Freeport (CSEZFP)". The CSEZFP is located at the northeastern part of Region 2. The projects of CSEZFP include the major schemes such as on-site development (rehabilitation of Port Irene, Sta. Ana Regional Agro-Industrial Growth Center (SARAIGC), development of an airport, etc.) and off-site development (access highway, construction of 200MW power generation plant, etc.). The CSEZFP projects are expected to stimulate local industry sector especially the agro-industry. The detail is given in Subsection 2.2.4.

(5) Agro-Fishery Modernization Act (AFMA)

The AFMA is established to modernize the agriculture and fisheries sectors. It is led by both the Department of Agriculture (DA) and the Department of Agrarian Reform (DAR). The AFMA projects are expected to develop the primary sector, particularly agriculture, livestock and fishery sub-sectors. It also supports the development of agro-based industries in the region and increases in the demand for services. The detail of the AFMA is described in Subsection 2.8.5.

## 10.2 Basic Strategy of Review Works

### 10.2.1 Target Year

The target year for the Reviewed Master Plan was set at the year 2020. Although it was proposed to be 2015 in the inception report, the Steering Committee suggested extending it to 2020, and the Advisory Committee of Japan and the Technical Working Group of the Philippines as well as JICA agreed to extend the target year.

### 10.2.2 Basic Concept of Cagayan River Basin Development

(1) Present Socio-Economic Situation of the Region (Refer to Figure 10.2.1)

1) Per Capita GRDP in Region 2

Per Capita GRDP in Region 2 was Pesos 20,200 in 12th position or 4th lowest among 15 Regions, which is equivalent to 55.3% of the national average of Pesos 36,500. This implies that Region 2 is one of under-developed or depressed regions in the Country.

2) Low Income/High Poverty Incidence

The regional annual average family income in Region 2 was Pesos 86,822 which was far less than the national average of Pesos 123,168 in 1997. The poverty incidence in Region 2 was 31.6% in 1997 which ranked 4th lowest among the 15 Regions in the Country. This figure shows a rather good situation compared with others, however, as the Cagayan Provincial

Government has programmed, the poverty incidence should be reduced further.

3) No Political Disturbance

Water Resources Development Master Plan was formulated in 1987 including water supply, irrigation and hydropower development, as well as flood control schemes. At that time, there were some political disturbances in the Region. Therefore, the development projects proposed in the 1987 Master Plan were little implemented. At present, there is no political disturbance in the objective area and mutual agreement on the project implementation has been confirmed through the consultation meeting among the NG and LGUs concerned. This implies that it is now a good time to implement the Master Plan Projects.

(2) Background/Causes of Under-development of Region 2

1) Natural Calamity

a) Floods have occurred frequently in the Cagayan river basin, especially in the lower Cagayan. Recorded maximum flood in the Cagayan basin was in 1973, which inundated an area of 1,860 $km^2$ equivalent to 39.2% of total irrigable area in the basin. The inundated area in 1980 flood was 1,740 $km^2$. Flood inundation is one of the major constraints that need to be eradicated or drastically reduced to sustain the regional economic development.

b) Other natural calamities, which have affected the area, are earthquake, deforestation, erosion and sedimentation especially in the upstream area.

2) Low Investment/Budgetary Constraint

a) The Workshop so far conducted identified that the most serious problem encountered in the regional development is low investment and financial constraints.

b) The conclusion of the Workshop was "Insufficient fund ⇒ No comprehensive development Master Plan ⇒ No chance to look for the finance ⇒ No Feasibility Study ⇒ No Project Implementation".

c) No remarkable water resources development projects have been implemented in the Cagayan River basin since Magat Dam and Irrigation Project.

3) Little Understanding of Development Needs

a) The Workshops also brought up the question of whether both National Governments and LGUs have little understood or have ignored the need for development in the Cagayan Valley.

b) One of the very serious constraints for development is that the Cagayan Valley is in an isolated area with difficult land transportation routes to Manila and Central Luzon crossing the mountainous area on the southern edge of the basin.

(3) Need to Socio-economic Development (National Level)

1) Food Security

a) The Philippines rice production is insufficient to sustain the self-sufficiency. DA has forecast a shortage of rice production even in 2010 by 5% of the total demand.

b) The rice supply relies to some extent on import from foreign countries. The more intensive irrigation for rice production is needed to reach self-sufficiency in the country.

2) Equitable/Balanced Development

a) The Government has a basic policy to achieve a balanced/equitable development in the country in order to prevent a disparity in economic development among the regions.

b) The under-developed areas, like Region 2, should be given higher priority for development assisted by necessary investment.

3) Upgrading Living Standard and Income Generation

a) Medium-Term Development Program (MTDP) of the Cagayan Province stated that the target for development of the Cagayan Province is to achieve international competitiveness for the agricultural-industrial sector.

b) Accordingly, the Province geared itself to upgrading the living standard and income generation, thus reducing poverty incidence.

(4) Development Potentials

1) Land Resources

a) The Cagayan River is the largest river in the Philippines having a land area of 27,281 $km^2$.

b) Total irrigable areas in the country add up to 3.1 million ha, among which developed area/existing irrigation system covers 1.3 million ha, about 43.2% of the total.

c) Irrigable area in Region 2 covers 475,000 ha, out of which existing irrigation system covers 218,000 ha (about 45.9% of the total). Remaining areas for irrigation development in Region 2 are 257,000 ha, which is the largest in the country as the remaining potential for further development. These areas are fertile and good for agricultural cultivation.

2) Water Resources

a) The Cagayan River has an abundance of surface water. Average runoff at the river mouth is 1,372 $m^3/s$ or 43.2 billion $m^3$/year. Current water consumption is very limited and water resources are sufficient in total volume to supply domestic, industrial, and irrigation purposes, although there would be some water shortage seasonally and locally in the target year 2020.

b) Water resources developments implemented so far are limited to Magat Dam and Irrigation Project and Casecnan Diversion Project (Diverting Cagayan water to Pampanga area) only.

c) There is still plenty of potential for water resources development in the future.

3) Others

a) Other development resources conceivable would be tourism/ recreation, fisheries, etc.

(5) Basic Development Concept

1) Target Year of 2020

Target year for Master Plan was set as the year 2020.

2) Per Capita GRDP to reach National Average Level

The Per Capita GRDP in Region 2 was the 4th lowest among the 15 Regions in the country in 1997. The target year 2020 was set to reach the national average level except National Capital Region with the mutual consent of the Steering Committee Meeting. This target is simply interpreted as doubling the family income by the target year.

3) Reduction of Poverty Incidence

Poverty incidence should be reduced to at least 20% in the target year 2020.

4) Investment for Water Resources Development of around 30 billion Pesos up to the year 2020

In order to realize this target of Per Capita GRDP, the required investment up to the year 2020 is estimated as shown below.

| | | |
|---|---|---|
| Current Projects | | 508.9 billion Pesos |
| Special Projects | | |
| | AFMA | 16.3 |
| | CEZA | 35.2 |
| | Water Resources Projects | 30.3 |
| | Other Capital Formation | 327.4 |
| Total | | 918.2 |

Investment for water resources development includes those for municipal/ industrial water supply, irrigation, hydropower generation, flood control, watershed management, etc.

The Study Team assumed the allocation of water resources development fund of 30.3 billion Pesos to be as follows:

- Flood control — About 20.0 billion Pesos
- Irrigation — About 10.0 billion Pesos
- Hydropower, watershed management and others from other funding source for current projects, private sector's investment, etc.

Of the above investment, about 30-40% will be foreign currency and 60-70% local currency portion. The above investment requirements are tentative for giving a basic concept and are subject to change after detailed calculation.

(6) Relationship between Socio-economic Development and River Basin Development

In reviewing the 1987 Master Plan, attention has been given to the consistency between the Cagayan River basin development and socio-economic development in the basin. Main points to be considered to achieve the consistency are targets, direct measures, implementation and maintenance, and supporting measures of the projects/ activities of the river basin and socio-economic development. The general idea of the relationship between the socio-economic development and river basin development is illustrated in Figure 10.2.2.

The river basin development includes watershed management, water resources management including water resources development, water usage, river water quality control, and river environment conservation. Among them, the core projects are flood control, watershed management and land use.

The river basin development plan of the 1987 Master Plan is reviewed mainly for flood control, watershed management and land use within the framework of socio-economic development in Region 2 proposed by this JICA Study for the target year of 2020. The socio-economic framework has a goal of increasing per capita GRDP in Region 2 to the national average excluding National Capital Region (NCR) by the year 2020.

The review works also include those for the implementing structures and supporting programs. The implementing structures cover multi-sectoral organization of the National Government, LGUs, Communities and NGOs. The supporting programs consist of funding system, institutional and organizational improvement, capacity building and awareness education.

### 10.2.3 Work Flow of Review Works

The review works of the 1987 Master Plan have been carried out conforming to the following procedure:

1) setting the socio-economic framework up to the target year,
2) reviewing conceivable flood control long-term plan, watershed conservation plan and land use plan,
3) choosing candidate projects for the Reviewed Master Plan from the projects in the flood control long-term plan, watershed conservation plan and land use plan, and integrating the projects selected from the candidate projects, which will be implemented in the Reviewed Master Plan up to the target year,
4) assessing economic, social and environmental viability of the Reviewed Master Plan, and,
5) selecting priority projects from the projects in the Reviewed Master Plan for the feasibility study.

The socio-economic framework of Region 2 has been drawn up on the basis of NEDA's growth scenario, which is discussed in detail in CHAPTER 4. The flood control long-term plan, watershed conservation plan and land use plan have been reviewed, respectively, on the basis of the present situation in the basin. The reviewed plans show the expected goals of the Cagayan River, its watershed and land use of the basin, respectively, and the projects to achieve the goals. The priority of the candidate projects taken from the reviewed plans has been studied in view of urgency, equitable development, economic effect and environmental aspects. The priority projects are then selected and integrated to formulate the Reviewed Master Plan.

The implementing structure has been reviewed for the flood controls, watershed management, and land use with the target year as 2020. The projects to be incorporated in the Reviewed Master Plan have been assessed from the economic, social and environmental viewpoints. The priority projects are selected from the projects in the Reviewed Master Plan, which are to be examined in the feasibility study.

### 10.2.4 Structural Measures and Non-structural Measures

The conceivable measures for the flood control plan are structural measures and non-structural measures. The structural measures mitigate the hazards, while the non-structural measures reduce the vulnerability. Multipurpose dams, widening of bottlenecks in the narrows, embankment, riverbank protection and watershed management are the structural measures. Disaster management system, flood forecasting and warning system and resettlement are the non-structural measures.

The watershed conservation and land use plans also consist of structural and non-structural measures. As for the watershed conservation plan, hard measures such as reforestation and sabo works are the structural measures, while watershed management system such as forest maintenance and protection system is non-structural measures. In the land use plan, the irrigation system is the structural measures and improvement of production techniques, strengthening of agricultural support services, etc. are non-structural measures.

The supporting programs such as funding system, institutional and organizational improvement, capacity building and awareness education are also included in the flood control, watershed conservation and land use plan.

### 10.2.5 Priority Study of Candidate Projects and Programs

A priority study has been made for the candidate projects and programs in the flood control, watershed conservation and land use plans from the viewpoints of urgency, equitable development of the basin, economic effect and environmental aspect. Among these viewpoints, the key indicator for priority is the economic effect. The equitable development of the basin aims to improve the economic activity of the low developing areas resulting in alleviation of poverty. The programs are a requisite for the project implementation.

## 10.3 Hydrological Condition

### 10.3.1 Review of Rainfall Condition

Characteristics of rainfall recorded after the 1987 Master Plan show similar tendency with the rainfall data used in the 1987 Master Plan in terms of rainfall amount, intensity and hourly distribution, which have been derived from the analysis of double mass curves, intensity curves and hourly rainfall distribution curves.

### 10.3.2 Review of Hydrological Condition

The probable flood peak discharge obtained in this JICA Study showed the same results or slightly lower than that of the 1987 Master Plan.

Considering the very limited number of rainfall data available for this JICA Study, it cannot be judged whether the probable flood peak discharge obtained in this JICA Study has higher accuracy than that obtained in the 1987 Master Plan Study or not. Therefore, taking a conservative approach, no changes are made to the probable flood flow obtained during the 1987 Master Plan and all the calculated floods in the 1987 Master Plan are adopted in the JICA Study as well.

### 10.3.3 Review of Sediment Condition

The validity of the sediment yield presented in the 1987 Master Plan, i.e. 1.5 mm/year, is examined in Subsection 5.6.4. Comparison of sediment load between 1987 Master Plan and this JICA Study at three gauging stations showed similar results. The estimated sediment runoff from the whole Cagayan basin in the 1987 Master Plan, 1.5 mm/year, remains to be valid.

Moreover, annual sediment transport under the present river condition was computed and noted that there is no significant change in the annual sediment transport. The ratio of wash load to the total sediment load indicates a high value in the lower reach of the Cagayan Mainstream, while it is small in upper reach and in the tributaries. The ratio of wash load to the annual runoff volume of water is 0.05% at the most, and that of the total sediment load to the annual water runoff ranges 0.05 to 0.07%.

### 10.3.4 Riverbed Fluctuation

The riverbed fluctuation analysis was carried out for evaluating the stability of present river stretch and for predicting the influence of narrow improvement (channel widening) and construction of cut-off channels on the variation of average riverbed of the Lower Cagayan River stretch.

Simulation of the riverbed fluctuation for each of the following 6 cases has been conducted:

Case-0 : Natural Condition (no changes);

Case-1 : Widening the river channel of Tupang site to 500 m;

Case-2 : Widening the river channels of Tupang and Nassiping sites to 500 m;

Case-3 : Widening the river channels of Tupang, Nassiping and Magapit sites to 500 m;

Case-4 : Widening the river channels of Tupang, Nassiping and Magapit sites to 700 m; and

Case-5 : Construction of three cut-off channels (Gabut, San Isidro and Tuguegarao) in the stretch between Alcala and Tuguegarao.

Results of the above three simulations are discussed in CHAPTER 5 in detail. It is concluded that 1) the present river stretch is stable and 2) no negative effect will be introduced by above improvement cases.

## 10.4 Flood Control Plan

### 10.4.1 Flood Control Long Term Plan

(1) Flood Control Structural Measures in Reviewed Long-Term Plan

The identified structural measures in the reviewed long-term plan are summarized below.

1) Dike embankment
   - In the main Cagayan River including Alcala-Buntun Dike, Tuguegarao Dike, and Enrile Dike as shown in Figure 7.4.5, and Lower Reach Dike
   - In the major tributaries, the Siffu, Ilagan, and Magat Rivers
2) Cut-off channel works
   - In the main Cagayan River at Gabut, San Isidro and Tuguegarao
   - In the Magat, Siffu and Mallig Rivers
3) Bank protection at 73 sites as presented in Figure 2.6.1
4) Flood control dams
   - Cagayan No.1 dam
   - Ilagan No.1 dam

Outline of the reviewed long-term plan is enumerated in Table 10.4.1.

(2) Non-structural Measures

Although the 1987 Master Plan stressed the importance of the non-structural measures in the comprehensive flood control plan, it had focused on the structural measures expecting that flood control effects would appear immediately. Recognizing that flood damage mitigation is attained by the combination of structural measures, non-structural measures and supporting measures, the non-structural measures are incorporated in the Reviewed Master Plan. The proposed non-structural measures are an evacuation system consisting of a flood forecasting and warning system (FFWS) and an evacuation center, and resettlement.

For the FFWS, improvement of the existing FFWS facilities and strengthening of PAGASA subcenter and local disaster management capacity in Tuguegarao are recommended.

Improvement of the existing evacuation center includes strengthening of the existing evacuation center facilities, strengthening of capability of DCC staffs and strengthening of capability of the local people against flood disasters.

For the resettlement plan for flood control projects in the revised long-term plan, the same concept is applicable as in Subsection 7.5.2 and Section 9.5. Particular care should be exercised with ancestral people in the mountainous area.

Since detailed design is not conducted for flood control measures in the Reviewed Long-term Plan, required resettlement scale is not known. Therefore, the resettlement cost is estimated based on that for the Reviewed Master Plan. The resettlement cost of 1.2 billion Pesos is arrived at.

(3) Project Cost

The estimated project cost excluding cost for resettlement is finally Pesos 30.5 billion consisting of Pesos 10.3 billion for the scheme in the middle lower Cagayan, Pesos 4.4 billion for bank protection works scheme basin wide and Pesos 15.8 billion for the other schemes in the lowermost, middle and upper Cagayan. The cost for resettlement is estimated in the later Section on the Resettlement Plan.

### 10.4.2 Urgent Works of Bank Protection for the Lower Cagayan River

In order to prevent damage, the riverbank protection works are to be urgently implemented at 43 heavily eroded sites in the whole Cagayan River consisting of 21 sites in the lower Cagayan and 22 sites in the middle Cagayan and major tributaries. The feasibility study for the 21 sites in the lower Cagayan was made by the JICA Study Team and for the 22 sites in the middle Cagayan and tributaries, by DPWH Region 2 office, respectively. The result for the 21 sites in the lower Cagayan is explained below.

The 21 sites for the bank protection works in the lower Cagayan are shown in Figure 10.4.1. The preliminary design of the protection works is made based on the following criteria.

Protection method with high flexibility is adopted considering low construction cost, easier maintenance, effective utilization of local materials, etc. It should be noted that this design is not for a permanent structure that can resist any flood permanently, but rather temporary structures, that need good maintenance and repair. Four (4) methods are applied depending on site conditions, as shown in Figure 10.4.2.

Based on the above criteria, preliminary design of bank protection works were done with due consideration of site and land use conditions, availability of local materials, workability, easier maintenance, sustainability, construction cost, biotope, etc. The total construction cost is estimated at Pesos 0.73 billion. Further details are explained in ANNEX VI.

## 10.5 Watershed Conservation Plan

### 10.5.1 General

Major problems on the present watershed management in the Cagayan River basin are reduction of forest area and soil erosion in the basin, especially in the Magat River basin. In the 1987 Master Plan, the watershed management plan for the Cagayan River basin was not included.

In order to solve the problems, reforestation and sabo works have been examined in this JICA Study and the watershed conservation plan including reforestation plan and sabo works plan have been formulated as presented below.

### 10.5.2 Reforestation Plan

Required reforestation area has been estimated to be 3,188 km$^2$ in the whole Cagayan River basin on the assumption that all land with slope over 18%, except for present agricultural land, should be covered by forest or other vegetation as discussed in detail in Section 8.2. The proposed reforestation areas for each sub-basin are tabulated below.

| Sub-basins | Land Area over 18% | Present Forest Area | Proposed |
|---|---|---|---|

| | Slope except Present Agricultural Land ($km^2$) | in Land over 18% Slope ($km^2$) | Reforestation Area ($km^2$) |
|---|---|---|---|
| Upper Cagayan River basin | 3,657 | 3,266 | 391 |
| Magat River basin | 3,670 | 2,443 | 1,227 |
| Ilagan River basin | 2,389 | 2,371 | 18 |
| Siffu-Mallig River basin | 1,032 | 694 | 338 |
| Chico River basin | 3,832 | 3,249 | 583 |
| Lower Cagayan River basin | 2,380 | 1,749 | 631 |
| Whole Cagayan River basin | 16,960 | 13,772 | 3,188 |

Cost of the reforestation has been estimated to be Pesos 5,000 million. The CBFM and participation of the volunteers are proposed in the reforestation plan.

According to the hazard map shown in Figure 7.5.1, severely eroded area is located in the Upper Cagayan, Magat, Siffu-Mallig and Chico River basins. Priority areas for the reforestation should be these basins.

### 10.5.3 Sabo Works Plan

No remarkable riverbed fluctuation has been found, which means that sediment yield and transport are balanced, in the Cagayan River basin except for the Magat River basin. The existing Magat Dam faces a reservoir sedimentation problem, that has been accelerated by land collapses in the Magat River basin caused by an earthquake, that occurred in July 1990. Urgent sabo works are required in the upstream of the Magat reservoir to extend the reservoir life of the Magat Dam.

The sabo dams are applied for storing the sediment in the Magat basin. The required number of the sabo dams is estimated to be 26, which is based on the sediment record of the Magat reservoir. Construction cost of the sabo dams is Pesos 5,472 million.

## 10.6 Land Use Plan

### 10.6.1 General

For irrigation development, the basic concept of the 1987 Master Plan is followed as a useful one. However, the total number of irrigation schemes becomes 40 from 14, because new projects have been proposed recently by NIA R-2 and some of the service areas are divided into smaller projects.

Such changes in the status of irrigation development plan are considered in this review. In addition, some projects are revised or newly proposed through discussion between the NIA R-2 engineers and the Study Team.

### 10.6.2 Agricultural Development Plan

As mentioned in Subsection 9.2.3, basic concepts in the 1987 Master Plan conform to the policies of AFMA and AFMP of the regions.

Proposed agricultural development plan is discussed in Subsection 9.2.3 (1) and is seen in Tables 10.6.1, 10.6.2 and Figure 9.1.1. It is summarized as follows.

(1) Agricultural Area

In the reviewed Master Plan, agricultural area will be maintained as the same area as a whole. The paddy field will be 528,000 ha or reach to full development level in terms of the gross physical area in 2020, though not all the area will be irrigated. The diversified crop area (corn and others) will be reduced to 162,000 ha. The corn fields will decrease from 137,300 ha to 120,800 ha, because corn fields near the river channel will be converted to paddy fields after completion of flood control measures concerned. Field area for other diversified crops such as vegetables, beans and tobacco will decrease to 41,200 ha. The fruit trees will cover 27,300 ha.

(2) Grassland

The pasture land will be extended from 103,500 ha to 152,300 ha. The wild grass and brush areas will decrease to 131,000 ha

(3) Fishery and Agro-Forestry

The fishpond area will increase from 11,900 to 13,900 ha.

Agro-forestry is a recommendable measure to protect forest deterioration from excessive slash-and-burn agriculture. The area of agro-forestry is proposed to be 105,100 ha.

### 10.6.3 Irrigation Development Plan

(1) Change in Irrigation Status

Within some NIP areas, several CISs have already been completed and some CIPs are newly proposed covering a part of the area.

Though two NIPs are on-going now, none of the NIP were fully completed during the period from the 1987 MP to date (Table 10.6.3).

(2) Candidate Scheme for Reviewed Master Plan

Information and discussion on 40 candidate irrigation schemes in the long term plan (Table9.3.2 and Figure 9.3.2) as well as criteria for prioritization are described in Subsection 9.3.6. Three factors are considered for the prioritization, namely poverty alleviation and equitable development, preparedness in procedure, and EIRR. Thirty eight (38) irrigation schemes are selected for the long term plan, out of which 28 schemes are regarded as candidate schemes in the Reviewed Master Plan. The schemes are prioritized as shown in Table 10.6.4.

(3) Reviewed Master Plan

Irrigation component to be implemented in the Reviewed Master Plan is divided into two parts by funding source, namely that by new funds (NF) and by NIA regular fund (RF). Selected 24 irrigation schemes, out of which 15 schemes by NF and 9 by RF are presented in Table 10.6.5. In the selection, implementation schedule of related flood control, procedure preparedness and EIRR are considered.

(4) Priority Project for Next Stage

Priority project for pre-feasibility study is selected in Table 10.6.5 in consideration of preparedness, equitable development and poverty alleviation, and combination and timing with implementation of related flood control project. The most prioritized project is selected to be the Alcala Amulung West Pump Irrigation Project.

(5) Supporting Program

As mentioned in Section 9.6, supporting program should be accompanied by each irrigation project for smooth and effective O&M. On-going supporting programs improve the farming, but the budget is too small to meet total requirements. The programs include strengthening of farmers' cooperative and irrigators' associations (IA), reasonable, flexible and small finance, marketing improvement, post harvest facilities, and so on.

A proposed supporting measure related to the irrigation project is installation of rural development center, including rice mill. The center can be combined with resettlement area, if possible. Details are described in Supporting Report.

## 10.7 Reviewed Master Plan Integrating Sectoral Schemes

### 10.7.1 Procedure of Integration

Integration of the sectoral schemes, which are the candidate projects selected from the reviewed flood control, watershed conservation and land use plans, was carried out to formulate the Reviewed Master Plan in the following manner:

1) The candidate projects were selected from the flood control long-term plan and land use plan. Five multipurpose dams discussed in CHAPTER 6 were also included in the candidates.
2) Project packages were constructed combining some of the candidate projects of flood control and land use plans with the multipurpose dams.
3) Priority study among the project packages was conducted in view of urgency, equitable development, economic effect and environmental aspect.
4) The projects for the Reviewed Master Plan were selected from the highest priority package.
5) Highly economical irrigation projects were added to the selected projects for the Reviewed Master Plan mentioned above.

Projects of the watershed conservation plan were not included in the project packages because of the limited strategic investment amount of about Pesos 30 billion for the Reviewed Master Plan. The watershed conservation projects are, therefore, recommended to be implemented with separate budgets.

Some irrigation projects, most of them are rehabilitation projects, are recommended to be implemented by NIA regular funds up to the year of 2020.

### 10.7.2 Packaging of the Projects

(1) Multipurpose Dams

Five multipurpose dams proposed in the 1987 Master Plan have the following economic investment costs, economic benefits and EIRRs:

(unit for cost and benefit: million Pesos)

| Description | Siffu No.1 Dam | Mallig No.2 Dam | Alimit No.1 Dam /Magat Dam O&M | Matuno No.1 Dam |
|---|---|---|---|---|
| Investment cost | 2,696 | 9,474 | 4,989 | 14,794 |
| Benefit, flood | 61 | 48 | 97 | - |
| Benefit, irrigation | 693 | 1,850 | 332 | 1,174 |
| Benefit, hydropower | 189 | - | 382 | 3,254 |
| EIRR (future cond.) | 28.3% | 16.6% | 20.7% | 36.8% |

Among the above multipurpose dams, Siffu No.1 Dam and Alimit No.1 Dam/Magat Dam O&M were selected for the packaging from the viewpoints of high economic viability.

Matuno No.1 Dam has the highest EIRR of 36.8% among five dams owing to high hydropower generation benefits. However, the Matuno No.1 Dam was not selected for the packaging considering that the country’s privatization policy in power generation sector does not meet the implementation of power-oriented projects by public investment and the present sufficient installed capacity in the whole country does not lead to urgent implementation of the project. The

Matuno No.1 Dam project is recommended to be implemented by non-public investment.

(2) Packages with a Multipurpose Dam

In order to select the projects for the Reviewed Master Plan among the candidate projects of the flood control plan and land use plan, project packages were constructed in combination with a multipurpose dam.

The following are the constructed packages of the projects:

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|
| Packages | Dam | AB | TE | FS | FA | IL | IS | IA | BP |
| Package 1 | Siffu | • | • | • | - | • | • | - | • |
| Package 2 | - | • | • | • | - | • | • | - | • |
| Package 3 | Siffu | • | • | - | - | • | - | - | • |
| Package 4 | - | • | • | - | - | • | - | - | • |
| Package 5 | Alimit | • | • | - | • | • | - | • | • |
| Package 6 | - | • | • | - | • | • | - | • | • |
| Package 7 | Alimit | • | • | - | - | • | - | - | • |

Notes; Dam: Siffu No.1 Dam or Alimit No.1 Dam/ Magat Dam O&M

AB : Alcala-Buntun dike and, Gabut and San Isidro cutoff channels

TE : Tuguegarao dike/ cutoff channel and Enrile dike

FS : Flood control projects relating to Siffu No.1 Dam except AB and TE (Dikes between river mouth and Magapit, Dikes between Enrile and Siffu No.1 Dam)

FA : Flood control projects relating to Alimit No.1/Magat Dam except AB and TE (Dikes between river mouth and Magapit, Dikes between Enrile and Magat Dam)

IL : 4 Irrigation projects between Alcala and Tuguegarao (Alcala-Amulung West Pump Irrigation Project (PIP), Solana Pump Irrigation System (PIS), Enrile PIP, Iguig-Alcala-Amulung PIS)

IS : 11 Irrigation projects relating to Siffu No.1 Dam except the above IL (Mamil PIP, Santa Isabel PIP, Zinundungan Irrigation Extension Project, Lallo West PIP, Nassiping PIP, Magapit PIS, Pinacanauan River Irrigation System, San Pablo-Cabagan Irrigation System, Santa Maria Communal PIS, Delfin Albano PIP, Tumauini Multipurpose Project)

IA : 15 Irrigation projects relating to Alimit No.1/Magat Dam except the above IL (Damao PIP, Lapogan PIP, Lulutan PIP, Gamu PIP as well as the above IS)

BP : bank protection of 73 sites and flood control non-structural measures such as improvement of flood forecasting and warning system and evacuation center

### 10.7.3 Selection of the Project Package

(1) Economic Effect of Packages

The economic internal rates of return (EIRRs) in present and future conditions are tabulated for each project package as follows:

| Packages | EIRR(%) (present conditions) | EIRR(%) (future conditions) |
|---|---|---|
| Package 1 | 12.6 | 19.7 |
| Package 2 | 11.7 | 18.9 |
| Package 3 | 10.6 | 17.3 |
| Package 4 | 8.7 | 15.3 |
| Package 5 | 12.0 | 19.5 |

| | | |
|---|---|---|
| Package 6 | 11.9 | 19.3 |
| Package 7 | 9.5 | 16.6 |

The above table shows the highest EIRR for Package 1. Although Packages 5 and 6 have similar EIRRs to that of Package 1, Package 1 is regarded as one of the packages with highest economic effect.

(2) Urgency, Contribution to Equitable Development and Environmental Aspect of Packages

Siffu No.1 Multipurpose Dam is expected to supply water to a part of the irrigation command area of the existing Magat Dam, where the Magat dam cannot supply water due to insufficient supply capacity. The area of water supply by the Siffu No.1 Dam will reach 30% of the total command area of the Magat Dam. The supply of the irrigation water from the Siffu No.1 Dam will lead to an increase in agricultural production to a level of the Magat command area. The increase will then contribute to an equitable development of the Cagayan basin.

On the other hand, Alimit No.1 Multipurpose Dam has been planned to supplement water to the Magat Dam, in which a flood control space is to be provided. NIA, which operates and manages the Magat Dam, is in the process of privatization at present. The realization of the Alimit No.1 Dam and provision of the flood control space to the Magat Dam should be studied and implemented in the privatization process with non-public investments. Therefore, the Alimit No.1 Dam was not selected for the Reviewed Master Plan to be implemented by public investments.

There is no serious issue on the natural and social environment for all the Packages.

(3) Selection of Highest Priority Package

Judging from the assessments mentioned above for the project packages in view of economic effect, urgency, equitable development and environment, the Package 1 was selected. The Package 1 consists of the following projects:

1) Siffu No.1 dam,
2) Alcala-Buntun dike and, Gabut and San Isidro cutoff channels,
3) Tuguegarao dike and cutoff channel, and Enrile dike
4) Other flood control projects relating to Siffu No.1 dam including dikes between river mouth and Magapit, and dikes between Enrile and confluence of Siffu River with the Cagayan River, and bank protection,
5) Flood control non-structural measures,
6) 4 irrigation projects between Alcala and Tuguegarao, i.e.,

Alcala-Amulung West Pump Irrigation Project (PIP), Solana Pump Irrigation System (PIS), Enrile PIP, and Iguig-Alcala-Amulung PIS,

7) 11 other irrigation projects relating to Siffu No.1 dam, i.e., Mamil PIP, Santa Isabel PIP, Zinundungan Irrigation Extension Project, Lallo West PIP, Nassiping PIP, Magapit PIS, Pinacanauan River Irrigation System, San Pablo-Cabagan Irrigation System, Santa Maria Communal PIS, Delfin Albano PIP, Tumauini Multipurpose Project.

### 10.7.4 Selection of the Projects for Reviewed Master Plan

(1) Investment on the Water Resources Development

The target year of the Reviewed Master Plan is the year 2020. The target of the Reviewed Master Plan is that the per capita GRDP reaches the national average except NCR (Pesos 56,100). Total required investment consists of current projects of Pesos 509 billion and special projects of Pesos 409 billion including water resources development projects. The required investment to water resources development is around Pesos 30 billion.

(2) Selection of the Projects

The projects to be incorporated in the Reviewed Master Plan were selected from the projects of the Package 1 in view of the following under the condition that the total project cost should be about Pesos 30 billion:

1) Siffu No.1 Dam is selected from the viewpoint of its high EIRR of 28.3%. The construction cost is Pesos 3.2 billion.
2) Flood control projects in the Lower Cagayan River are selected from the technical viewpoint that downstream reach should be improved prior to improvement of the upstream. Implementation of the projects in the Lower Cagayan enables irrigation development in the flood prone area, which is less developed compared to middle or upper Cagayan River basin. The projects include Gabut, San Isidro and Tuguegarao cutoff channels, and Alcala-Buntun, Tuguegarao, Enrile and Lower Cagayan dikes. The construction cost amounts to Pesos 13.1 billion. Dike construction between Enrile and the confluence of Siffu River with the Cagayan River is recommended for after the year 2020.
3) Bank protection at 73 sites and improvement of FFWS/evacuation center are included. Spoil bank plan and resettlement plan are also incorporated in the Reviewed Master Plan. The cost is Pesos 6.0 billion.
4) Out of 15 irrigation schemes of IL and IS in the Package 1, two schemes

(Mamil and Santa Isabel PIPs) are excluded from the Reviewed Master Plan, because these schemes needs, before implementation, flood control measures, but they are not scheduled to be implemented within the plan up to 2020. Magapit PIS and Iguig-Alcala-Amulung PIS are two parts of former Cagayan Integrated Agricultural Development Project (CIADP). In the Reviewed Master Plan, rehabilitation of CIADP is regarded as one scheme, so the number of schemes reduced by one. 12 schemes from Package 1 are listed on the Revised Master Plan. In addition, 13 other schemes are included in the plan as shown in Tables 9.3.3 and 9.3.4. These schemes are selected based on the criteria below. Firstly, such schemes as seen on the list of NIA 10-year Irrigation Development Program are in principle given higher priority. Those schemes that have higher economic viability are also given higher priority. From equitable development viewpoint, basin-wide distribution is considered, since schemes in the low developed area or Cagayan Province are already included in the Package 1. The total investment cost is Pesos 8.7 billion for the new funding projects and Pesos 9.5 billion by NIA regular fund.

Implementation of the watershed conservation projects consisting of reforestation and sabo works is recommended by other funding sources.

(3) Selected Projects for Reviewed Master Plan

The projects selected for the Reviewed Master Plan are summarized as follows:

1) Multipurpose dam project: Siffu No.1 Dam,
2) Flood control schemes:
    a) Dike embankment including revetment, sluice and riverbank tree zone
        - in the main Cagayan River from River mouth to Tuguegarao
    b) Cut-off channel works
        - Gabut, San Isidro and Tuguegarao
    c) Bank protection works
        - 21 Sites from river mouth to Cabagan in the main Cagayan
        - 52 sites upstream from Tumauini in the main Cagayan, Siffu, Mallig, Ilagan, and Magat Rivers
    d) Evacuation system including FFWS and evacuation center
    e) Resettlement
    f) Strengthening of institution and organization
3) Watershed management schemes

a) Reforestation plan (Reforestation area 3,188 $km^2$)

b) Sabo works plan (26 sabo dams)

4) Agricultural development schemes

Structural measures:

a) New irrigation / extension schemes (17 schemes with total 54,985 ha)

b) Irrigation rehabilitation / improvement schemes (7 schemes with total 22,506 ha)

c) Diversified crops development (148,400 ha)

d) Permanent crops development (105,100 ha)

e) Pasture land development (152,700 ha)

f) Magat O&M improvement

Supporting measures:

a) Continuation and enhancement of on-going agricultural support services

b) Strengthening of support system for irrigation system

c) Enhancement of marketing and transportation system

d) Establishment of upland development experimental center

5) Hydropower Development Schemes

a) Ibulao scheme (run-of-river type)

b) Tanudan scheme (Run-of-river type)

c) Diduyon scheme with Diduyon dam

d) Matuno No.1 Dam Project (multipurpose)

Total project cost is estimated to be Pesos 31.5 billion. The selected projects are tabulated in Table 10.7.1 and 10.7.2. Location of the selected projects in the Reviewed Master Plan is shown in Figure 10.7.1.

(4) Recommendation of Project Implementation by Other Funds

Outside the investment amount of Pesos 31.5 billion, it is recommended to implement the following projects.

1) Irrigation projects proposed in the long-term plan other than those included in the Reviewed Master Plan are to be implemented by the NIA regular funds,

2) The watershed management projects are to be implemented by the DENR with its regular fund and / or private sector investment,

3) The Alimit No.1 dam and the modification of the Magat Dam operation are to be implemented in order to provide additional flood control space to the Magat dam

4) Hydropower projects of Ibulao, Tanudan and Diduyon schemes are to be implemented by looking for private sector investment.

5) The Matuno multipurpose dam project, which is the most prospective dam scheme in terms of EIRR, is to be implemented by private investment.

## 10.8 Project Evaluation

### 10.8.1 Natural and Physical Environmental Assessment

In the 1987 M/P survey, three project components, i.e. 1) dam construction, 2) river improvement and 3) agricultural development, were proposed and examined for environmental impact assessment. In this study, the components of watershed management including reforestation and sabo dams, and resettlement under non-structural measures are added to be considered with the environmental effects. The table below shows the five impact factors to be examined and to be mitigated in EIA procedures. It also itemizes the basic impacts caused by these five factors.

**Impact Factors and Basic Impacts of Project Components in This Study**

| Impact Factors | Basic Impacts |
|---|---|
| (1) Dam Construction [1]<br>(2) River improvement work<br>- Bank protection<br>- Dike system (Levees)<br>- Cut-off channel<br>(3) Agricultural Development work<br>- Diversion weir<br>- Pump station<br>- Irrigation and drainage channel<br>(4) Watershed Management work [2]<br>- Reforestation<br>- Sabo Dam Construction<br>(5) Resettlement | • Covering a certain area by dams weir and by consequent dammed up water<br>• Disturbing longitudinal connectivity by dams<br>• Disturbing lateral connectivity between river channel and surrounding areas by bank protection works, levees and agricultural structures such as diversion weirs and pump stations.<br>• Decreasing the roughness of the river channel by bank protection works and consequent reduced diversity of habitat in the river channel.<br>• Making the gradient of river bed steeper by cut-off channels<br>• Reducing flood risks and consequent drying effects over the marginal areas of the river<br>• Turbidity caused by construction works of dams and river improvement works.<br>• Producing lentic water bodies of former river channel separated from existing river channel due to the construction of cut-off channel.<br>• Land acquisition and consequent relocation during resettlement procedures for safer area or caused by flood control structures |

Note: 1) One dam (Siffu No.1) is incorporated in the reviewed M/P and the other 4 dams are incorporated in the Long-term Plan.
2) Incorporated in the reviewed M/P but recommended to be implemented with separate budgets.

The following are further descriptions of the impacts on the respective environmental elements that are examined in the 1987 M/P Study, focusing on the relationships between causes and consequent impacts, and necessary mitigation measures:

(1) Terrestrial Flora and Fauna

a. The Impact on Flora and Fauna

Dam construction may cause the submergence of upper part of dam site, which will make all the plants growing over the area to be extinct. It is necessary, therefore, to make a detailed inventory of plants from an ecological and economical point of view at the stage of F/S of the planned dam construction.

Regarding the river improvement work, it would also cause a “drying up effect” because the flood prone area would be protected by river improvement works and consequently would become drier than under the present condition. This, in turn, may create a disadvantageous environment for the flora and fauna that prefer to grow in a humid area. As for the agricultural development, no serious adverse effect would occur on them. Watershed management work including reforestation and resettlement would not cause any serious adverse effects. Instead, reforestation would enhance biodiversity in and around the reforested area.

b. The Impact on Rare, Endangered Species

The results of inventory based on existing data and on-site survey conducted in the course of this study revealed that there are many rare or endangered species. Most of them are registered on the Red List (IUCN) or CITES. In this F/S of the flood control project, therefore, the impacts on rare and/or endangered species are to be studied and evaluated.

(2) Protected Area

There are 18 protected areas designated in the Cagayan River basin (Refer to 2.11.1. (3) Protected area).

Siffu No.1 dam, which is incorporated in the reviewed M/P, is not located in or around any protected area. The construction of the dam, therefore, will not ruin or deteriorate the natural environment in the protected area. However, Mallig No.2 dam, which is incorporated in the Long-term Plan, is planned above the Chico River Forest Reserve. Therefore, it is necessary to undertake the EIA study at the stage of F/S.

Judging from the geographical locations of the project components and each protected area, the river improvement works or agricultural development will not cause adverse effects to any of the protected areas because planned projects are not located in or around the protected areas. As for resettlement, it is necessary to refrain from developing resettlement sites in the protected areas.

(3) Aquatic Ecology

Considering the fundamental nature of aquatic fauna, an adverse effect may occur on migratory species if a dam or weir is constructed at a certain point of the Cagayan River system. According to the Study conducted by Cagayan State University, diminishing the number of Ludong in the river system is partly due to the construction of Magat Dam. Other than Ludong, there inhabit some 10 migratory species of nekton in the Cagayan river system. Therefore, it is necessary to clarify the life history of migratory fishes at the F/S stage of the respective dam construction. In order to minimize the adverse effects of dam construction, a bio-path, which is constructed around a dam, and through which fishes can migrate beyond a dam weir, is considered to be the most practical and effective.

Regarding the river improvement work, lateral connectivity might be disturbed by such structures as levee and other bank protection structures. Therefore, it may impact on several kinds of catfish, especially on their spawning activity. With regard to agricultural development, the connectivity of habitat is also the main issue for the construction of diversion weir or drainage channels. In addition, inadequate or over use of agricultural chemicals may cause unintentional removal of aquatic species.

(4) Water Quality

During the construction period, construction works of dam, levee, cut-off channel or land preparation works accompanied by agricultural development works may cause some turbidity of river water in the vicinity and downstream of the construction work site. This turbidity does not mean any chemical contamination and does not last for a long time. Instead, it settles as river flow moves downstream because suspended particles in river water generated by construction works, precipitated and deposited on the riverbed.

Regarding impacts during operation periods, construction of dams or river improvement structures does not cause any water contamination or turbidity. As for the agriculture during the operation period, agricultural chemicals such as, pesticides, herbicides or fertilizers may cause adverse effects on water quality in terms of contamination or eutrophication of the Cagayan river water. Therefore, to minimize the contamination or eutrophication pressure on the Cagayan river water, it is quite important to give appropriate information or education on the proper usage of agricultural chemicals to local farmers.

### 10.8.2 Socio-environmental Assessment

The relationship between the impact activities/factors and basic impacts on social environment has already been summarized in the Table listed in Subsection 10.8.1. The following are further descriptions of the impacts on the respective environmental elements that are examined in the 1987 M/P Study, focusing on the relationships between causes and consequent impacts, and necessary mitigation measures:

(1) Navigation

Based on on-site survey and interview survey of this study, it was revealed that at least 18 routes for navigation, including car ferry, currently exists along the lower reach of the Cagayan River (Refer to 2.11.2 (2) Navigation). The navigation routes are important in terms of trip, transportation and commute under such conditions due to insufficient road network or lack of bridges.

In general, this kind of work could increase the run-off velocity and accordingly lowering the water level of the river. It means to reduce the depth of river water, which would result from the smaller roughness and steeper gradient of the riverbed. This effect occurs not only during the flooding period but also between the flooding periods. Implementation of the work, therefore, might cause an adverse effect on navigation activities in terms of safety or possibility of navigation itself due to insufficient depth of water in the river. The effect might occur, in particular, over the reach between Alcala and Tuguegarao where cut-off channel(s) is planned.

Considering the importance of navigation routes and possible effects described above, detailed hydrological analyses and design of the location, size and structures of cut-off channels should be done to make these effects negligible for navigation system.

(2) Historical and Cultural Heritage

There are many historical and cultural heritages in the Cagayan Valley. Of all the historical and cultural heritage and natural tourist spots, there are five churches and one cathedral, i.e. Iguig Calvary Hills and the Parish of St. James the Greater, St. Peter’s Cathedral, Alcala’s St. Philomene Church, St. Hyacinth (San Jacinto) Ermita Church, St. Pablo Church, Parish Church of St. Mathias, located along the lower reach of Cagayan river. The rest are located away from the river or in the upper part of the Cagayan river basin. As for natural tourist spots, most of them are located away from the Cagayan river channel except for the three caves in Peñablanca, including Callao Caves Tourism Zone.

It is considered that there is no major adverse effects on the heritages, because all the historical and cultural heritage sites are located outside the planned construction works of levee, cut-off channels or agricultural development. As for natural tourist spots, likewise, major adverse effects are not considered to occur since their locations are apart enough from the planned sites.

(3) Minority Tribes

There is no update on the distribution of respective cultural minorities to renew the Table 2.12, ANNEX EN, of the 1987 M/P Report prepared by JICA. The new official source, Philippine Year Book of the NEDA does not touch on this issue. With regard to location, population and settlement areas, there is no information to renew the succeeding Table 2.13 either. NCIP, Region 2 has no data available to update these items.

According to the statistics of NCIP, Central Office, the population of indigenous people is shown in Tables 2.7.1 and 2.7.2 (ANNEX V, Supporting Report). In Region 2, some 40% of all the people are considered to be indigenous in its origin. In CAR, on the other hand, almost all the people can be considered as indigenous. Most of the indigenous people have been supposedly assimilated with the non-indigenous people, and are currently living in the same way as them. It is considered therefore, that no serious impacts would be generated by implementation of M/P.

In spite of the fact that the indigenous people have been assimilated with non-indigenous people, i.e. Ilocano, it is essential that a detailed survey related to indigenous people dwelling over the reservoir of the planned dam, Siffu No.1, is to be conducted at the stage of F/S.

(4) Public Health and Sanitation

The reviewed M/P has one dam construction project, two cut-off channels and will produces lentic water bodies separated from existing river channel due to the construction of cut-off channel. These water bodies may effect adversely on environmental sanitation because they could act as an origin of such water-related diseases as malaria and dengue fever through a vector of mosquito with no proper measures to prevent from spreading out. In other words, provided with preventive measures, these water-related diseases can be minimized to occur or spread out.

The projects involved in the reviewed M/P have such positive aspects as reduction of the flooding and improvement in the drainage status. This, in turn, would contribute to alleviate the water-related diseases.

### 10.8.3 Economic Evaluation

In project evaluation, two quantitative analyses, i.e., (1) financial evaluation, and (2) economic evaluation, are discussed in general, in addition to evaluations through technical, social and environmental aspects. The financial evaluation is to examine a proposed project from the financial point of view, involving tests of earning capacity and financial efficiency. The economic evaluation is to examine the proposed project from the economic point of view, testing the viability of social investment in the national economy.

In order to examine earning capacity of a project, the financial evaluation is examined on the basis of market values of project costs and incomes from the proposed project. The revenue accrues from beneficiaries as compensation of services that the proposed project offers to them. Based on these cost and revenue, the projects are examined in terms of financial efficiency and evaluated taking into account of financial circumstances. However, in the case that the proposed project does not accrue any revenue directly from beneficiaries, the financial evaluation cannot be conducted generally. Flood control scheme exactly corresponds to this case. Thus, the financial evaluation is not conducted in this section.

(1) Criteria and Assumptions of Economic Evaluation

a) Structure of Project Benefit

Economic evaluation of the proposed projects based on economic benefit and cost is a guideline of assessing their economic viability. The project benefit is obtained as an economic difference between with-project and without-project conditions. In a flood control project, for instance, its economic benefit is given as the effect of reduction in annual mean flood damage to public and private assets and production activities in and around the flood area. For estimation of the benefit, thus, it is the first step to identify and quantify potential flood damages in the flood prone area under without-project condition. The structure of these flood control benefits is tabulated in Table 10.8.1.

Since the target year is set as 2020, the socio-economic conditions in the study area will be enhanced under the national and regional economic development activities consecutively till the target year. Thus, two sets of economic evaluation are conducted under both present and future enhanced conditions. Under present conditions, the project benefit is estimated under present socio-economic conditions in the project areas. Under future conditions, the benefit is assumed to grow at the same rate as the regional economy grows, i.e., GRDP growth of the region. In this study, thus, the projects are evaluated under two socio-economic conditions, that is, under present conditions and under future conditions. All the projects are evaluated mainly under future conditions, expecting the future development as projected in CHAPTER 4 in this study.

b) Criteria and Assumptions

Economic evaluation is carried out to ascertain the economic viability. In the project evaluation, in general, Economic Internal Rate of Return (EIRR) is utilized as a tool of assessing economic viability to judge whether the proposed projects are worth investing in. Besides EIRR, Net Present Value (NPV) and Benefit-Cost ratio (B/C) are presented as supplementary indices, for which costs and benefits are discounted at 15% per annum in the Philippines.

Economic cost differs from financial cost in the sense of value judgment since the former is valued at real resource cost and the latter is resource cost valued at market prices. Thus, to estimate the economic costs of the proposed project, the financial costs that were estimated by cost estimators have to be converted by using conceivable adjustment.

In estimating the economic cost and benefit, the economic values are estimated applying the following criteria and assumptions.

| No. | Item | Set-up Conditions and Assumptions |
|---|---|---|
| 1. | Base Year | Beginning of the year 2002 |
| 2. | Construction Period | In 2001, the preparatory works such as engineering services and land acquisition are conducted. The construction works are completed in five years. |
| 3. | Disbursement Schedule | Disbursed in accordance with construction schedule |
| 4. | Economic Life | 50 years after the completion of the projects |
| 5. | Evaluation Period | 56 years of 6 year for the construction period and 50 years after the completion of the construction works |
| 6. | Timing of Accruing Benefits | The matured benefits will appear after the completion of the respective projects. During construction period, the partial benefits will appear in proportion to the progress of the construction works for flood control scheme. In irrigation projects, the matured benefit will appear after five years from inauguration of the projects. |
| 7. | Price Level | Costs and benefits of the projects were set down at the year 2000. |
| 8. | Prevailing Exchange Rate | 45.00 Pesos per US$1.00 and ¥125 per US$1.00 |
| 9. | Opportunity Cost of Capital | 15% per annum |
| 10. | Growth till Target Year 2020 | Based on the projection in Section 4.3, CHAPTER 4 |

In estimating the economic benefit, the following criteria and assumptions are applied to convert the financial market values of project benefits and costs to the economic ones.

Market values are usually distorted by transfer payments such as taxes and subsidies. These payments are eventually transferred to the government, which acts on behalf of society. For this reason, they should not be treated as economic cost. These have to be eliminated from the market values of cost and benefit as a whole. In the Philippines, the taxes related to construction works are income tax, customs duties, local taxes, etc.

Although all the costs have to be measured as economic costs, i.e., the real costs or "opportunity costs", it is clearly impracticable to trace procurement routes and financial sources for all the project inputs, particularly at reviewing the master plan stage. Thus, taking this situation into consideration, the economic costs are assumed to be approximately 85% of the financial costs in the review stage of the master plan. 85% is set as a standard conversion factor, which is discussed in the feasibility study.

Lands expropriated for embankment, cut-off channel, etc. are to be purchased on the basis of financial market value. In economic evaluation, however, land is generally evaluated on the basis of its productivity for crop cultivation, or on the balance of supply and demand in the market for non-productive land such as town area.

c) Review Procedure of Evaluation Based on 1987 Master Plan

The master plan study was reported in 1987, 14 years ago. Socio-economic conditions in the study area have considerably changed since the time of the master plan formulation. In this review study, thus, the economic benefit and cost of the proposed projects were re-evaluated applying price deflators to the benefit and cost corresponding to the projects in the master plan. The deflators for cost components were derived from consumer price index (CPI) and wholesale price index (WPI). The deflator for benefit components was calculated on the basis of CPI, population increase and economic growth in the study area. Although the master plan was reported in 1987, the prices of the 1985 level were used for estimation of costs and benefits. Accordingly, the price deflators between 1985 and 2000 were set as 3.0 for cost components and 3.4 for benefit components for all schemes except agricultural projects.

In terms of benefits of agricultural projects only, however, the price deflator was set as around 3.0 reflecting economic prices of rice and corn in the world market. In the 1987 Master Plan, the economic prices of rice and corn were 3,800 Pesos/ton and 2,700 Pesos/ton, respectively. On the other hand, these prices in 2000 were estimated at 10,300 Pesos/ton and 8,100 Pesos/ton in economic terms respectively, referring to the world market values in the World Bank Report. Based on these data and the local market prices of vegetables, the price deflators were calculated as 2.7 for rice, 3.0 for corn and 3.4 for vegetables for the 2000 value against the 1987 value in the master plan.

(2) Economic Evaluation of Sectoral Schemes

1) Multipurpose Scheme and Flood Control Plan

a) Alternative Projects of Flood Control in Lower Cagayan River

The alternatives in the Lower Cagayan River are discussed in CHAPTER 7. The evaluation study supports to select the most effective alternative scheme among the alternatives from the economic point of view. For evaluation purposes of the flood control projects, irrigation projects are indispensable to examine viability of flood control projects especially in the rural sites. Thus, irrigation projects in the respective reaches are combined with the flood control schemes. The alternative plans of flood control schemes are (i) four alternatives in reach from Alcala to Buntun Bridge and (ii) three alternatives in reach from Buntun Bridge to Upstream of Tuguegarao. The details of the alternative schemes are discussed in Subsection 7.2.3 and 7.2.4.

b) Economic Costs

The financial construction costs of the projects were estimated in the respective sections on the basis of financial market prices. The economic costs of the respective projects are obtained after going thorough the conversion procedure of the financial costs. Their results are summarized as follows:

(Unit: Million Pesos)

| Alternatives | Financial Cost | | Economic Cost | | |
|---|---|---|---|---|---|
| | Flood Control | Irrigation | Flood Control | Irrigation | Total |
| i) Alternatives in Reach from Alcala to Buntun Bridge | | | | | |
| Case 1 | 5,143 | 2,458 | 4,573 | 2,090 | 6,663 |
| Case 2 | 3,127 | 1,759 | 2,673 | 1,495 | 4,168 |
| Case 3 | 2,608 | 1,638 | 2,230 | 1,393 | 3,623 |
| Case 4 | 1,416 | 1,311 | 1,206 | 1,114 | 2,320 |
| ii) Alternatives in Reach from Buntun Bridge to Upstream of Tuguegarao | | | | | |
| Case 1 | 1,969 | 560 | 1,740 | 476 | 2,216 |
| Case 2 | 15,968 | 560 | 13,133 | 476 | 13,609 |
| Case 3 | 4,974 | 560 | 4,032 | 476 | 4,508 |

Operation and maintenance (O&M) cost was assumed at 0.5% of the total direct construction cost for flood control schemes. In irrigation projects, the O&M cost is estimated on consumption of electricity for pumps and other costs individually.

c) Economic Benefits

Flood control benefit is defined as flood damage reduction by the proposed works. These analyses were completed in the 1987 Master Plan. In this review study, thus, the benefits of the alternative projects were estimated basically applying the figures calculated in the 1987 Master Plan. The benefit figures in the master plan are converted using the price index of 3.4, as mentioned in (1)-b) in this section.

Yet, the benefits of the alternatives, for some of which the project formation was modified from the master plan, are estimated separately, referring to the benefits in the 1987 Master Plan. In particular, the benefits of the irrigation projects in the alternatives in i) above are estimated individually, on the basis of the revised schemes. These schemes were reorganized taking account of situation changes from the master plan stage under discussion between the agricultural expert and National Irrigation Administration (NIA).

In the reach from Buntun Bridge to Upstream of Tuguegarao, particularly Cases 2 and 3, the benefits from the flood control projects were considered to accrue from the potential value of urban central zone in Tuguegarao City, in addition of the benefits estimated in the 1987 Master Plan, because, the central area of the city could be extended to south-eastern parts where the new lands are created by the alternative projects. The potential values of new central zones are estimated referring to the market value of land, which is considered justified on the balance of supply and demand in the market. The values applied for the studies were as follows: 4,000 Pesos/$m^2$ for the core central zone (within a 500 m radius from the center); 2,000 Pesos/$m^2$ for the second central zone; and 1,000 Pesos/$m^2$ for the third central zone. These benefit amounts were converted from financial market value to economic value by means of the conversion factor, 0.85, as mentioned in (1)-b) in this section.

The annual average benefits derived from the respective schemes were calculated in the table below.

(Unit: Million Pesos at Economic Terms)

| Alternative | Under Present Conditions After Completion | Under Future Conditions In 2010 | In 2020 |
|---|---|---|---|
| i) Alternatives in Reach from Alcala to Buntun Bridge | | | |
| Case 1 | 974 | 1,960 | 3,853 |
| Case 2 | 663 | 1,204 | 2,365 |
| Case 3 | 573 | 1,043 | 2,047 |
| Case 4 | 409 | 689 | 1,352 |
| ii) Alternatives in Reach from Buntun Bridge to Upstream of Tuguegarao | | | |
| Case 1 | 226 | 457 | 877 |
| Case 2 | 588 | 1,135 | 2,013 |
| Case 3 | 837 | 1,616 | 2,866 |

For the sake of installation of flood control facilities, the undertaker of the projects has to expropriate some areas for cut-off channels, dykes and irrigation canals. These sites include some agricultural lands for cropping partially. Therefore, crop production cannot be carried on after the construction works begin. This production activity has to be considered as negative benefit of the projects. These negative benefits were estimated on the assumption that all expropriated croplands were used for paddy harvest.

d) Economic Evaluation

Economic efficiency of all alternatives is examined by means of evaluation indices. EIRRs were calculated as shown in the table below.

| Alternative | EIRR (Present Conditions) (%) | EIRR (Future Conditions) (%) |
|---|---|---|
| i) Alternatives in Reach from Alcala to Buntun Bridge | | |
| Case 1 | 10.0 | 19.6 |
| Case 2 | 9.4 | 19.2 |
| Case 3 | 9.4 | 19.1 |
| Case 4 | 9.1 | 19.0 |
| ii) Alternatives in Reach from Buntun Bridge to Upstream of Tuguegarao | | |
| Case 1 | 15.3 | 26.0 |
| Case 2 | 4.1 | 10.5 |
| Case 3 | 16.4 | 27.6 |

Among the alternative schemes under future conditions, the most effective ones were Case 1 for the reach from Alcala to Buntun Bridge and Case 3 for the reach from Buntun Bridge to Upstream of Tuguegarao. For the alternative i) and ii), Case 1 and Case 3 were selected from the economic view point, because they recorded the highest EIRRs among the alternatives.

e) Economic Viability of Master Plan Schemes

The alternatives of master plan schemes are formulated on the basis of the preliminary design results. The respective schemes were formulated into five alternative schemes in Section 7.4 in CHAPTER 7.

In the same manner, the economic costs and benefits were compiled applying the respective ones estimated in the previous sections. The economic efficiency of the five alternatives was examined through EIRRs calculated in the table.

| Alternative | EIRR (Present Conditions) (%) | EIRR (Future Conditions) (%) |
|---|---|---|
| Alternative 1 | 12.5 | 22.5 |
| Alternative 2 | 10.5 | 19.4 |
| Alternative 3 | 9.6 | 18.2 |
| Alternative 4 | 9.0 | 16.9 |
| Alternative 5 | 2.9 | 8.4 |

All alternatives under future condition except Alternative 5 seem to be viable from the economic point of view because their EIRRs are higher than 15%, the social discount rate in the Philippines. Among them, Alternative 1 has the highest economic efficiency, EIRR of which is 22.5%.

In the review of the 1987 Master Plan, the entire combined project of all the flood control schemes has to be examined from the economic point of view. The projects are composed of the following four categories.

a) Widening of the bottlenecks in the narrows
b) Embankment (dike) to protect residential areas and agricultural lands
c) Bank protection works to stabilize the low water channels
d) Multipurpose dam schemes to supply irrigation water, to reduce flood peaks and to generate hydropower electricity.

The economic efficiency of the former three types was examined in the previous sections. The multipurpose dam schemes were already examined in Table 10.8.2. Then, the overall economic efficiency of all these flood control projects mentioned in the above item a) to d) was calculated at 15.6% under present conditions and 23.4% under future conditions. Consequently, the overall flood control projects is said to be quite viable taking into account the future economic development conditions in the basin, and even under present conditions.

f) Dike Embankment and Cut-off Channel

The economic efficiency (EIRR) of the dike embankment and cut-off channel is estimated under the future condition as follows:

| Project | Major work component | Project cost $10^6$ P | EIRR (%) |
|---|---|---|---|
| 1) Dike embankment | Embankment including revetment, sluice and riverbank tree zone in the Main Cagayan from river mouth to Tuguegarao | | |
| - River mouth ~ Nassiping | 82.7 km long, Em.V=9.3 million $m^3$ | 2,844 | 28.1 |
| - Alcala ~ Tuguegarao | L=57.5 km, Em.V=8.5 million $m^3$ | 2,891 | 27.0 |
| 2) Cut-off channel | | | |
| - Gabut COC | L=0.9km, Ex.V=4.0 million $m^3$ | 1,008 | 16.6 |
| - San Isidro COC | L=2.1 km, Ex.V=7.4 million $m^3$ | 1,722 | 18.8 |
| - Tuguegarao COC | L=6.7 km, Ex.V=17.5 million $m^3$ | 4,662 | 15.0 |

g) Other Flood Control Schemes

After the review of bank protection works in the 1987 Mater Plan, 73 bank protection schemes in total are proposed along the Cagayan River and its tributaries,. An average economic efficiency (EIRR) of these schemes was calculated at 6.9% under present condition and 15.1% under future conditions. The rate under future conditions was slightly higher than the social discount rate. Many farmers live along the river, most of who suffer from poverty because of frequent flood disaster. Local governments controlling these areas are keen on these bank protection works. Since their EIRRs slightly exceed 15%, these schemes are recommended for implementation in general. Among the 73 schemes, however, the recommendable schemes could be selected after individual economic screening. In the Lower Cagayan River Basin, 21 bank protection works were identified in this study. These works were also verified through evaluation indices. Their overall EIRRs were calculated at 10.2% under present conditions and 19.2% under future conditions. Among 21 bank protection works, EIRRs of two works were lower than 15%, as shown in Table 10.8.3.

In addition to these structural measures, non-structural measures were discussed in Section 7.4. In these measures, an evacuation system including a flood forecasting and warning system (FFWS) is a project accompanying some amount of capital investment. According to the estimate of the evacuation system, its cost amounted to 398 million Pesos in financial terms. It was converted to 338 million Pesos in economic terms. On the other hand, its benefit is said to be 5% of annual flood damage or 112 million Pesos in its target area, according to the reference of "Potential Economic Benefits from Improvements in Weather Information" by J.C. Thompson, World Weather Watch Planning Report No. 27, WMO, 1968". However, this project is a rehabilitation work, so the existing system is still functioning inefficiently. Then, the net benefit of the proposed project, i.e., difference of the evacuation system's effects between with-project and without-project conditions, is assumed to be 3% of the total benefit in this study. Incidentally, in the SAPS study on the flood forecasting and warning system, the net benefit of this project was assumed at 3% of annual flood damage, as well. Thus, its annual benefit was estimated in 67 million Pesos. Accordingly, its economic efficiency was calculated at 9.7% of EIRR under present conditions. It was also calculated at 18.0% under future conditions. Thus, the evacuation system project is evaluated as economically viable.

2) Watershed Conservation Plan

a) Reforestation Schemes

Reforestation is generally recognized to provide much public benefits for the natural and social environment. However, project evaluation of reforestation project has not been conducted so far, because of the difficulty in quantifying its benefits. In this study, therefore, a tentative economic evaluation was tried in the following manner. Among the effects above, the following tangible benefits were enumerated for the reforestation project.

i) Storage function of rainfall water: effect of water volume reserved under ground was quantified by means of equivalent irrigation dam cost.
ii) Function of flood control: peak-cut effect through rainfall water storage was quantified by means of equivalent flood control dam cost.
iii) Function of erosion control: this effect was quantified by means of equivalent sabo dam cost.
iv) Function of soil collapse control: this effect was quantified by means of equivalent hillside retaining wall cost.

As a result, these benefits were estimated in economic terms as follows: 0.30 billion Pesos for rainfall water storage effect, 0.50 billion Pesos for peak-cut effect for flood, 0.55 billion Pesos for erosion control and 0.63 billion Pesos for soil collapse control. However, these matured benefits are assumed to arrive 20 years after the commencement of reforestation.

On the other hand, the economic cost of the reforestation schemes was estimated at 4.26 billion Pesos in total, which was converted from 5.01 billion Pesos in market prices. The O/M cost of the project was estimated at 0.41 billion Pesos in economic terms.

Applying these cost and benefit estimates, its economic efficiency was calculated at 4.5% of EIRR under present conditions. It was also calculated at 16.3% under future conditions. Thus, the project is economically viable, although its EIRR was not so high. However, it should be promoted from the point of global environmental conservation in the world no matter what its economic efficiency may be.

b) Sabo Schemes

Sabo dam schemes are expected to prevent sedimentation of earth and sand into Magat Dam. The benefit of these sabo dams is quantified by means of valuation of irrigation water from the reservoirs concerned. The irrigation water was estimated as 10 Pesos/$m^3$, which was estimated on the basis of initial investment cost and O/M cost of the dam. The sedimentation volume was estimated at 11.4 million $m^3$/year on average for 20 years. Since around one-third of this volume is considered to go into dead storage space in the reservoir, the total volume that decreases effective water is estimated at two-thirds of the total sedimentation volume. Accordingly, the project benefit was estimated at 65 million Pesos/year. The benefit will be accumulative every year, because the irrigation dam volume decreases every year.

On the other hand, the total investment cost was estimated at 5.47 billion Pesos in market prices. It was converted to 4.65 billion Pesos in economic terms. O/M cost of the sabo dams was assumed at 0.1% of the direct main work cost. Then, O/M cost was calculated at 3.5 million Pesos per annum in economic terms.

Its economic efficiency was calculated at 8.7% of EIRR under present conditions. It was also calculated at 16.8% under future conditions. Thus, the sabo projects is viable from the economic point of view.

3) Irrigation Development Plan

a) Irrigation Schemes Reviewed in 1987 Master Plan

The 1987 Master Plan proposed nine irrigation schemes and five rehabilitation and/or improvement schemes. Since then, NIA and other agencies concerned have been developing numerous irrigation projects in the basin. Reviewing these backgrounds, the 20 irrigation schemes were identified including the schemes in the 1987 Master Plan. Needless to say, other on-going and planning projects will be implemented by the agencies concerned in their generally appropriated budgets for agricultural development schemes. In this part, thus, these 20 schemes are evaluated from the economic point of view.

b) Economic Cost

The capital investment costs of the schemes proposed in the 1987 Master Plan were recalculated referring to the original estimates and the price deflator mentioned in section (1)-b) in this section. The newly identified schemes were estimated referring to their development plan reports and the recent cost information from the agencies concerned.

Annual O&M costs consist of salaries of personnel, materials and labor costs for repair and maintenance, running costs of irrigation facilities. Besides, some irrigation facilities need replacement costs for pumps and other durable materials at certain intervals within their project life.

c) Economic Benefits

In the flood control projects, agriculture benefits were combined as comprehensive scheme of area development. In the evaluation of irrigation schemes, thus, the evaluation was separated into two ways: (i) irrigation schemes having no harmful effects of flood and (ii) irrigation schemes to which flood control is indispensable. In the former case, the irrigation scheme is evaluated in the normal way. In the latter case, the scheme is evaluated ignoring the effects of flood control for irrigation activities in order to verify its viability as an independent irrigation project.

In addition, some agricultural lands are laid down to other purposes such as irrigation facilities and canals. These lands are considered as negative benefit, because crops cannot be cultivated after laid down. This negative benefit is enumerated through an annual production foregone.

d) Economic Evaluation

EIRR for each scheme was calculated applying the economic costs and benefits above. They are summarized in the table below. The details are enumerated in Table 10.8.4.

| Project | Without Flood Control | | Combined to Flood Control | |
|---|---|---|---|---|
| | Under Present Condition (%) | Under Future Condition (%) | Under Present Condition (%) | Under Future Condition (%) |
| I. Affected by Flood (Need Flood Control) | | | | |
| 1. Alcala Amulung West Irrigation Project | - | - | 18.1 | 22.8 |
| 2. Solana Pump Irrigation System Rehabilitation & Extension Project | - | - | 20.1 | 25.0 |
| 3. Enrile Pump Irrigation Project | 13.0 | 17.8 | 18.2 | 23.1 |
| 4. Zinundungan Irrigation Extension Project | 12.7 | 16.3 | 15.0 | 18.8 |
| 5. Lal-lo West Pump Irrigation Project | 12.0 | 16.5 | 14.9 | 19.5 |
| 6. Nassiping Pump Irrigation Project | 13.9 | 18.5 | 17.0 | 21.8 |
| 7. Rehabilitation of CIADP (Magapit & Iguig-Alcala-Amulung PISs) | 15.7 | 21.8 | 22.7 | 28.7 |
| 8. Pinacanuan River Irrigation System | 23.7 | 28.2 | 27.1 | 31.9 |
| 9. San Pablo-Cabagan Irrigation System | 16.9 | 22.8 | 21.1 | 27.0 |
| 10. Santa Maria Communal Pump Irrigation System | 17.1 | 23.1 | 21.4 | 27.3 |
| 11. Delfin Albano Pump Irrigation Project | 13.9 | 18.5 | 17.0 | 21.8 |
| 12. Tumauini Reservoir Project | 14.0 | 17.8 | 16.4 | 20.4 |
| 13. Mallig River Irrigation System | 26.7 | 31.5 | 30.5 | 35.5 |
| 14. Nueva Vizcaya Bagabag Irrigation System | 28.1 | 33.0 | 32.0 | 37.1 |
| 15. Ilagan Pump Irrigation Project | 11.5 | 15.9 | 12.6 | 17.2 |
| 16. Sto. Nino Pump Irrigation Project | 12.2 | 16.8 | 12.8 | 17.6 |
| II. No Need of Flood Control | | | | |
| 1. Upper Ilagan Western Barangay. Pump Irrigation Project | 12.3 | 16.8 | - | - |
| 2. Dabubu Irrigation Project | 14.8 | 18.6 | - | - |
| 3. Lower Chico River Irrigation System | 24.3 | 29.0 | - | - |
| 4. San Mariano Pump Irrigation Project | 13.1 | 17.8 | - | - |
| 5. Dibuluan River Irrigation Project | 15.9 | 19.8 | - | - |
| 6. Rizal Irrigation Project | 15.3 | 19.1 | - | - |
| 7. Debibi Groundwater Irrigation Project | 15.1 | 17.0 | - | - |
| 8. Villaverde Irrigation Project | 15.1 | 17.0 | - | - |

Among the 20 proposed schemes under future condition, EIRRs of all schemes exceeded 15% of the opportunity costs of capital. In particular, rehabilitation and/or improvement schemes have quite high EIRRs as shown in the table. Thus, they are considered as viable from the economic point of view.

(3) Economic Evaluation of Integrated Package Plans

1) Integration of Sectoral Schemes to Package Plans

In order to formulate the Reviewed Master Plan, package plans were organized to select recommendable schemes in the basin in consideration of the results derived from the sectoral analysis. The seven package plans were formulated finally. The packages include bank protection of 73 sites and non-structural measures in addition to flood control and irrigation projects. The details of these packages are described in Subsection 10.7.2.

2) Economic Cost

The economic costs of the respective packages are summarized as follows:

(Unit: Million Pesos)

| Package Alternative | Dam | Flood Control | Irrigation | Total |
|---|---|---|---|---|
| Package 1 | 2,696 | 25,304 | 7,605 | 35,605 |
| Package 2 | - | 25,304 | 7,605 | 32,909 |
| Package 3 | 2,696 | 16,014 | 2,727 | 21,437 |
| Package 4 | - | 16,014 | 2,727 | 18,741 |
| Package 5 | 4,989 | 28,654 | 8,595 | 42,238 |
| Package 6 | - | 28,654 | 8,595 | 37,249 |
| Package 7 | 4,989 | 16,014 | 2,727 | 23,730 |

O&M costs for the respective schemes are calculated as total of the respective individual scheme. In flood control and dam schemes, the O&M cost is assumed at 0.5% of the total direct construction cost. In irrigation projects, the O&M cost is estimated on consumption of electricity for pumps and other costs individually.

3) Economic Benefits

The annual average benefits were calculated as the sum of the benefits estimated in the respective schemes. They were calculated as shown in the table below. The table summarized the annual benefits after the completion of the respective schemes under present conditions. The annual benefits under the future conditions were summarized in the year 2010 and the target year 2020.

(Unit: Million Pesos at Economic Terms)

| Package Alternative | Under Present Conditions | Under Future Conditions | |
|---|---|---|---|
| | After Completion | In 2010 | In 2020 |
| Package 1 | 5,676 | 8,664 | 16,400 |
| Package 2 | 4,785 | 7,419 | 12,261 |
| Package 3 | 2,804 | 4,324 | 7,130 |
| Package 4 | 1,929 | 3,093 | 5,191 |
| Package 5 | 6,217 | 9,823 | 16,400 |
| Package 6 | 5,475 | 8,597 | 14,279 |
| Package 7 | 2665 | 4,345 | 7,335 |

4) Economic Evaluation

Applying the economic costs and benefits above, EIRRs were calculated as shown in the table below.

| Package Alternative | EIRR (Present Conditions) (%) | EIRR (Future Conditions) (%) |
|---|---|---|
| Package 1 | 12.6 | 19.7 |
| Package 2 | 11.7 | 18.9 |
| Package 3 | 10.6 | 17.3 |
| Package 4 | 8.7 | 15.3 |
| Package 5 | 12.0 | 19.5 |
| Package 6 | 11.9 | 19.3 |
| Package 7 | 9.5 | 16.6 |

All of the packages are viable from the economic point of view, because their EIRRs are more than 15%, the social discount rate. Among the packages under future conditions, the most effective one was Package 1, as shown in the table. As mentioned before, Package 1 includes the following schemes: (i) Alcala-Buntun dike and Gabut cut-off channel, (ii) Tuguegarao dike and cut-off channel, and Enrile dike, (iii) flood control projects relating to Siffu No.1 dam, (iv) four irrigation projects between Alcala and Tuguegarao, i.e., Alcala-Amulung West PIP, Solana PIS, Enrile PIP, and Iguig-Alcala-Amulung PIS, and (v) eleven irrigation projects relating to Siffu No.1 dam, i.e., Mamil PIP, Santa Isabel PIP, Zinundungan irrigation extension project, Lal-lo West PIP, Nassiping PIP, Magapit PIS, Pinacanauan River irrigation system, San Pablo-Cabagan irrigation system, Santa Maria Communal PIS, Delfin Albano PIP, Tumauini multipurpose project.

## 10.9 Implementation Schedule

### 10.9.1 Basic Concept

The basic concepts for establishing the implementation schedule of the Reviewed Master Plan are given below.

1) Target year for the implementation of the Reviewed Master Plan is set in the year of 2020.
2) Total investment amount by the target year 2020 for the Cagayan river basin water resources development including irrigation development as well as flood control is assumed at about 30 billion Pesos as described in CHAPTER 4 Socio-economic Framework Plan.
3) The total investment amount above is allocated / distributed evenly for annual investment as much as possible and practical, i.e. equal annual investments during the Reviewed Master Plan period.
4) The priority projects will be implemented in a possible early stage of the whole period. The priority projects are selected based on the following criteria:
   a) The projects with high economic return (Higher EIRR),
   b) The projects to contribute for equitable development within the basin, i.e. the projects in lower developing area within the basin,
   c) The projects to contribute to poverty alleviation.

In view of the above items b) and c), the combined projects with flood control and irrigation in the Lower Cagayan was selected as the highest priority projects.

### 10.9.2 Implementation Schedule

The implementation schedule of the Reviewed Master Plan was prepared as presented in Figure 10.9.1. The assumed cost disbursement for the Reviewed Master Plan is shown in Table 10.9.1.

## 10.10 Implementing Structure

Implementing structures to be discussed herein include institutional arrangement and organization of the implementing structure specifically for implementation of the Reviewed Master Plan Projects and Programs.

### 10.10.1 Institutional Arrangement

Institutional arrangement herein describes necessary arrangement of law and regulations relating to an organization and funding for implementing Reviewed Master Plan Projects and Programs. These arrangements should be conducted well in advance of the implementation of the Projects and Programs to eliminate unnecessary problems to be encountered in the implementation stage.

(1) Water Code and its Implementing Rules and Regulation

As presented in Section 1.12, there are some problems in the current law and regulations. NWRB is now reviewing the Implementing Rules and Regulations (IRR) of Water Code. The GOP should undertake the following measures to cope with the problems and in the revision of the IRR.

1) Major river basins

a) GOP should promulgate officially the major river basins together with the name of a responsible governmental agency. It should be clarified which agency is responsible for river administration, National Government or LGUs concerned. It is recommended that the Cagayan River Basin should be officially announced as a major river basin, and the National Government is responsible for overall river administration.

b) River administration should cover overall management of the river basin including a) watershed management, b) flood control, c) water resources management, d) water quality management and e) river environment management. Under the current law and regulations, there are many agencies involved in river management. There is no unified responsible agency for river administration in the Philippines. It is recommended that GOP announce officially that DPWH is the responsible agency for river administration including implementation of the Master Plan Projects and Programs of the Cagayan River Basin.

c) The river management should be conducted in cooperation with other agencies concerned such as DENR, NWRB, PAGASA, DA/NIA, LGUs etc. Work demarcation of those agencies in relation to river administration should be reviewed and clarified with mutual consent of all the agencies concerned in writing, by a so called Memorandum of Agreement.

2) River areas and flood control areas

a) DPWH should designate the river area and flood control areas prior to the implementation of the Projects and Programs

b) NWRB should announce such river areas and flood control areas officially to the public

3) Land use regulation

a) Water Code and its Rules and Regulation provides clearly the land use regulation. However, there are many illegal uses of river areas. Therefore, NWRB should announce officially to eliminate such illegal land use.

b) According to the Water Code, cultivation in the riverbed is prohibited. This cultivation may be understood as sand mining in riverbed. It should be clarified and should be included in the revised IRR.

c) NWRB should provide special provisions to allow farmers to use land in the river area for agricultural cultivation unless land use should obstruct flood flow. NWRB should draft such provisions and promulgate it officially. This is essential for the people residing in the river area subject to relocation to maintain their livelihood.

4) Flood plain land and flood control areas

a) NWRB should designate flood plain land based on the hazard map presented in this Master Plan and officially announce it to the public.

b) Flood control areas may be defined based on the basic design presented in this Study. For the river reaches of the Lower Cagayan, which is subject to the feasibility study under this JICA Study, flood control areas are the same as the river areas. NWRB should announce it officially to the public.

5) Water Permit / Authority

a) There are 1,584 water right grantees in Region2 and CAR as of 1999. NWRB gives such water right in consideration of the available water and maintenance flow.

b) According to NWRB, water right is given as requested by water users within 90% of available water in quantity. However, NWRB should check the figure of 90% in view of that if remaining 10% is sufficient for river maintenance flow.

c) Required river maintenance flow should be estimated precisely with due consideration of ecology, water quality, navigation, recreation, etc. It is recommended that drought runoff (350-day runoff) should at least be released to downstream as maintenance flow.

(2) Local Government Code

1) Local Government Code is aiming at promoting localization and decentralization of the Government services. Local Government is operating its services within an available budget and its capability. Majority of annual budget comes from IRA (Internal Revenue Allotment), which is very limited and minimal in view of the cost sharing on implementing Master Plan Projects and Programs.

2) National Government is intending to upgrade the capacity of LGUs so that LGUs can undertake flood control projects. However, owing to the limited budget and insufficient technical knowledge, LGUs alone may not implement such big projects as the Cagayan Flood Control Project. It should be clarified what LGUs should share. The Study Team recommends that LGU should be involved in the project implementation with cost sharing in some part in view of the beneficiary-to-pay principle and for capability building of the LGUs.

3) All these matters above mentioned should be settled prior to the project implementation with mutual agreement between National Government and LGUs by means of concluding a Memorandum of Agreement.

(3) NIPAS Act

1) NIPAS Act is aimed at maintaining natural environment to ensure the conservation of biological diversity.
2) There are so many illegal activities in the Cagayan River Basin in the light of the Code, slash and burn farming, farming in the river area, etc. It is recommended that a special program may be formulated with a task force to cope with such problems together with the problems on Water Code.

(4) Relocation / Resettlement

1) Many people will be subject to relocation / resettlement by the project implementation. The number of households to be resettled is estimated at 2,433 for the Lower Cagayan Flood Control Project.
2) Relocation and resettlement should be handled by LGUs since they know well the local conditions. It should be implemented with assistance of the National Government

### 10.10.2 Basic Concept of Establishing the Implementing Structure

The 1987 Master Plan had little studied on the organizational matters for implementing the Master Plan Projects and Programs, since peace and order situation at that time were very critical. According to the results of hearing to the local people, currently the social, economic and political situation has been remarkably improved. Therefore, the review of the Master Plan this time includes institutional study.

The basic concepts of establishing the implementing structures are given herein.

A proposed organization for implementing the Projects and Programs in the reviewed Master Plan of the Cagayan River Basin Water Resources Development is given in Figure 10.10.1. Basic considerations on this proposed organization are given hereunder.

(1) Cooperation among the National Government and LGUs concerned

As described in Section 2.12, LGUs have little experience in implementation of large-scale projects and have few engineers, the National Government is obliged to undertake the implementation of the Master Plan Projects and Programs. However, LGUs, in line with Local Government Code, should be involved as far as possible in the implementation. It is recommended that the scope of works by LGUs be as given below.

1) Resettlement area development and resettlement activities
2) Plantation of the tree zone
3) Land acquisition for Right of Way (ROW: land areas to be occupied by the project structures) and land acquisition of other river areas for which the National Government should share the cost since the land ownership belongs to the National Government.
   This should be confirmed among the related agencies and LGUs.
4) Assistance to the National Government and other minor works as required.

(2) Nature of the Projects

The Master Plan for the Cagayan River Basin Water Resources Development is a multi-sector project consisting of all components inclusive of watershed management, water resources development and water supply, flood control, river water quality management, and river environment management.

Among those components, three major components as watershed management, flood control and water resources development for water supply are particularly reviewed in this JICA Study. The flood control project will be the first step to initiate basin-wide vigorous / strategic economic and social development.

(3) Special Institutions in the Philippines as practiced

There are some multi-sectors projects in the Philippines both on-going and completed. In the multi-sectors projects, the three different institutional arrangements have been made as explained below.

1) Coordination Committee System

Coordination committee system has been widely applied in the Philippines. The projects, which are of multi-sectors but may be implemented independently in view of project area, funding sources, project implementation period and project functions without much connection among the involved agencies may be implemented by the coordination committee system.

Coordination committee may be established with mutual consent of all the agencies concerned.

2) Commission System

Commission system is adopted for Agno River Basin Development Project and Pasig-Marikina Rehabilitation Project at present.

Commission system may be applied for such project as multi-sector long-term project needing close cooperation with each other in terms of cost sharing and schedule control for construction of multi-functional with different technical and social natures like a river basin development.

The Commission may be established by the order of the President.

3) Authority System

The Authority system may be applied to complicated projects and/or programs, which need more comprehensive cooperation and coordination among the agencies concerned. Especially, in case that many sub-projects are simultaneously implemented as components of an overall development projects / programs, and such projects / programs taking long time for implementation and continuous activities for operation and maintenance like a basin-wide development project, Authority system will be more effective. Authority system has been widely applied in the world like a Tennessee Valley Authority. There are also examples in the Philippines, such as the Laguna Lake Development Authority, National Economic Development Authority, etc.

Authority shall be established upon a bill-passed in parliament.

(4) Creation of Cagayan River Basin Development Authority

Taking into account the above mentioned factors, it is recommended that Cagayan River Basin Development Authority be established by such time that the Master Plan Projects and Programs will be implemented in full scale. In this case of the Authority, the following should be taken into account.

1) One river-one plan-one management

One river-one plan-one management strategy was firstly applied to the TVA in US as one of the success stories for river basin development. In view of this, it is recommended to establish the Cagayan River Basin Development Authority as a body of one management,

2) Involvement of current line agencies

The current government line agencies will undertake as much as possible the projects within the task and duty as mandated in accordance with present regulations. In principle, DPWH will undertake the flood control projects and NIA / DA will undertake the irrigation projects

3) Coordination Committee

The coordination committee will be created under the Authority to coordinate all the works to be undertaken by respective agencies. Members of the coordination committee will consist of representatives of related agencies comprising DPWH, DENR, DA (NIA), PAGASA, LGUs and other related agencies as required.

4) PMO and sub-PMO

Project Management Offices (PMOs) will be organized by sector, i.e. watershed management, Land use specifically irrigation development, and flood control as major components for river basin development.

5) Consultant

Consultants will be employed as advisors to the Project Coordination Committee and for each sector project including PMOs.

Organizational set-up of implementing structure will be developed step-wise. The lower Cagayan flood control project and irrigation project will be implemented as 1$^{st}$ phase projects. In this case, Coordination Committee System will be adopted. Then this will be shifted to Commission System and further to Authority System step by step. This strategy was accepted by the Steering Committee of this JICA Study.

### 10.10.3 Duties and Tasks of Each Component of the Structures

The duties and functions of each component in case of Cagayan River Basin Development Authority are assumed as given below.

(1) Cagayan River Basin Development Authority

1) Full responsibility for implementation of all the projects which are included in the Reviewed Master Plan at this moment and will expand to include other water-related sectors in the future
2) Overall planning, budgeting, supervising for implementation of the Master Plan Projects and Program
3) Reporting to and getting approval of the higher authority, the Office of the President / NEDA and DBM

(2) Coordination Committee

1) Overall coordination of project implementation among all the member agencies

2) Advice and recommendation to the Authority for implementation of the projects especially inter-agency projects

(3) Project Management Offices (PMO)

1) PMO will be set-up for each project category for actual implementation of the projects by work field of respective agencies
2) PMO for watershed management to be led by DENR
3) PMO for flood control to be led by DPWH which will be further divided into PMO for resettlement & Livelihood Program by LGU, PMO for Lower Cagayan Flood Control Project by DPWH, PMO for Flood Forecasting and Warning System Project by PAGASA and DPWH, and PMO for Evacuation system by OCD, RDCC and C/M/BDCCs
4) PMO for land use, specifically irrigation project to be led by DA / NIA
5) PMO for Special Entities by the representatives of AFMA and CEZA

# *Part-III*
# *FEASIBILITY STUDY OF PRIORITY PROJECTS*

# CHAPTER 11 PRIORITY PROJECTS FOR FEASIBILITY STUDY

## 11.1 Basic Approach of the Feasibility Study

The Reviewed Master Plan presented in Chapter 10 of this Report has proposed the projects in the sectors of a) Flood control, b) Irrigation, c) Watershed management, d) Water supply and power generation, e) Water quality management and f) River environment management. Among the proposed sector projects, flood control and irrigation projects have been given priorities for implementation in view of the development policy of the Government, regional economic target and results of the workshops conducted during the Study period.

The Reviewed Master Plan reveals that the flood control projects are the prerequisite for the development of the Cagayan River basin, and the flood control projects of the lower Cagayan River should be implemented firstly from the viewpoints of engineering and economical effectiveness. Therefore, the flood control projects in the lower Cagayan River have been taken up for the feasibility study.

The Reviewed Master Plan also states that irrigation projects should be given the priority for the development of the basin following the flood control projects. The agricultural development is the key industry in the Cagayan River basin as DA has identified the Cagayan basin as a part of breadbasket in the country specifically as for rice and corn production.

The Alcala Amulung West Pump Irrigation Project is one of the most promising projects in view of the NIA's development strategy and effective use of land resources after implementation of the flood control projects. Therefore, the Alcala Amulung Project has been selected to conduct the pre-feasibility study. The study is in compliance with the Terms of Reference given by JICA.

The reason to take up the pre-feasibility study, instead of the feasibility study, for the Alcala Amulung West Pump Irrigation Project is insufficiency of data available for the study such as topographic maps, etc.

The studies for the flood control projects and the irrigation project comprise studies of structural measures, non-structural measures and supporting measures, respectively.

### 11.2 Flood Control Projects

### 11.2.1 Structural Measures

(1) Objective Priority Projects subject to Feasibility Study

The feasibility study is conducted for the following flood control projects in the lower Cagayan River. Figures 11.2.1 and 10.4.1 show general locations of each flood control project and urgent bank protection works in the lower Cagayan.

1) Left dike systems in the lower most reach from river mouth to Nassiping
2) Right dike systems in the lower most reach from river mouth to Nassiping
3) Left dike systems in the middle lower reach from Alcala to Tuguegarao
4) Right dike systems in the middle lower reach from Alcala to Tuguegarao
5) Cut-off channels in the middle lower reach from Alcala to Tuguegarao

Apart from the above projects, the following urgent bank protection works are incorporated in the lower Cagayan as already studied in the previous Subsection 10.4.2 in CHAPTER 10.

6) Urgent bank protection works at 21 sites in the lower Cagayan

(2) Project Formulation Criteria

Summarized below are the criteria for conducting the feasibility study.

*General*

1) Objective river reaches
   - From river mouth to Cabagan, total river length of 170 km
2) Structural measures to be designed are as follows.
   - Design flood of 25-yr flood is applied.
     The design discharge in the lower Cagayan is summarized below and as shown below and in Figure 7.1.3 in CHAPTER 7.
     : River mouth to confluence with Chico River: 17,900 $m^3/s$
     : Confluence with Chico to Tuguegarao: 17,700 $m^3/s$
   - In river planning and designing, features of river morphology described in the Subsection 1.5.3 River Morphology in CHAPTER 1 of ANNEX VI are fully considered.
   - Dike system consist of dike, maintenance road, drain and tree zone in principle
   - Cut-off channel are designed at significant meandering reaches of Gabut, San Isidro and Tuguegarao
   - Culvert is provided for local drainage in the landside

- Abandoned river course by construction of cut-off channel is conserved as fish pond and/or retarding basin as it is in principle
- Urgent bank protection works are incorporated as already studied in CHAPTER 10

*River width and cross-section*

3) The river width was designed to have more than 10•A, where A is basin area in $km^2$ in principle. According to the above, river width is estimated at 1.7 km at river mouth and 1.5 km at Alcala. Further, taking into account respective site conditions such as the present land use, existing riverbank elevation and channel width, possible resettlement, etc., the river width was determined.
   This proposed river width is applied as it is even for a framework plan with a 100 yr probable flood.
4) National highway on the right bank from Alcala to Iguig is functioning as a flood dike. However, in this case, about 2000 households equivalent to a 50% of the total ones in the municipalities of Iguig and Amulung are needed to resettle. Hence, right dike alignment is changed towards more riverside to minimize the above resettlement.
5) River cross-section consists of low water channel as the existing one and high water channel newly confined by dikes. The width of cut-off channel is designed at 500 m estimated as an average width of the existing low water channel.
6) Earth dike system was designed to confine flood flow. Maintenance road is provided in landside along dike in case no available road nearby. The dike section is designed as a trapezoidal one as shown in Figure 11.2.2.
7) An open space confined by both the dikes on the left and right banks is regarded as a river area.
8) Tree zone is designed in combination with the dike. The tree zone is provided to protect earth dike from severe flow attacks eventually and to mitigate sediment damage to assets and agricultural crops due to siltation by the tree zone in the period before construction of dike. Location of the tree zone is selected considering site conditions such as severe flow attack, present land use condition, space availability, etc. The tree zone is provided so that proper and sustainable river management and maintenance systems are to be established in DPWH Region 2 in cooperation with the related LGUs.

*River profile*

9) Riverbed profile was proposed at the present mean riverbed elevations. It should be noted that riverbed excavation is not considered in the 1$^{st}$ phase because water level rising is negligible small and excavation work is costly.

10) Design high water level was set based on calculated water level for design discharge by non-uniform flow method.

11) Elevation of dike crown was set adding 2 m free board above the design high water level.

Attention has been paid for the following to conduct the feasibility study:

a) Aparri municipality presents coastal erosion in the northern part of the Cagayan River mouth. No detailed data on coastal erosion has been obtained so far. Therefore, it is recommended that required data such as erosion records, current, drift sand, topographic map and so on be firstly accumulated and the erosion countermeasures should be studied separately from this flood control project.

b) Aparri seaport exists in the river mouth of the Cagayan. However, it is reported that the port is not being functioned and/or utilized at present. In case of reopening the port, it should be shifted to the International Irene Seaport nearby.

(4) Structural Measures of Priority Projects for the Lower Cagayan River

The 16 proposed river improvement works are outlined below. These locations are as illustrated in Figures 11.2.3 and 10.4.1.

*Left dike systems in the reach from river mouth to Nassiping*

1) Mabanguc dike (10.9 km in long)
2) Catugan dike (7.4 km)
3) Lasam dike (7.0 km)

*Right dike systems in the reach from river mouth to Nassiping*

4) Camalaniugan dike (13.1 km)
5) Lal-lo dike (12.9 km)
6) Gattaran dike (6.1 km)
7) Nassiping dike (9.7 km)

*Left dike systems in the reach from Alcala to Tuguegarao*

8) Alcala-Buntun dike (33.5 km)
9) Enrile dike (12.2 km)

*Right dike systems in the reach from Alcala to Tuguegarao*

10) Tuguegarao dike (21.3 km)

11) Amulung dike (12.6 km)

12) Iguig dike along national highway (3.2 km)

*Cut-off channels in the reach from Alcala to Tuguegarao*

13) Gabut COC (0.7 km long)

14) San Isidro COC (1.6 km)

15) Tuguegarao COC (5.8 km)

*Urgent bank protection works in the lower Cagayan*

16) Urgent bank protection works in the lower Cagayan (21 sites)

Major work items for the above respective ones are described in ANNEX VI in detail and the preliminary design results are explained in the following CHAPTER 12, respectively.

(5) Consultancy and Engineering Services

For implementation of the flood control projects, a stage wise construction system will be adopted in the Cagayan River. Ahead of the construction works in the first phase, engineering services are conducted by the selected consultants and the major scope of the services will be as follows.

*Detailed design stage*

1) to carry out river survey, geological investigation, additional topographic survey and soil investigation,
2) to review previous study and formulate definite plan of the projects
3) to prepare detailed design for the projects,
4) to prepare the documents for tendering,
5) to assist in evaluation of prequalification of contractors,
6) to conduct information campaign and publicity of the projects, and
7) to transfer of knowledge on the related fields to DPWH personnel.

*Construction supervision stage*

8) to assist the DPWH in evaluation of bids and awarding of the contract for construction works,
9) to check detailed working drawings for construction of structures prepared by the contractor, and to modify them, if needed,
10) to check and test shop works before shipment and issue necessary certificates,
11) to carry out additional investigation and surveys at need,

12) to assist DPWH to approve the working and shop drawings, construction program and schedule furnished by the contractor,

13) to assist DPWH to carry out inspection of the works and to monitor work progress,

14) to assist DPWH to conduct final inspection and completion test of completed works,

15) to assist DPWH to monitor the impacts to the environment by construction works,

16) to prepare the completion reports and drawings of the completed structures and facilities,

17) to prepare a manual for operation and maintenance of the constructed facilities, and

18) to transfer of knowledge on the related fields to DPWH personnel.

### 11.2.2 Non-structural Measures

The non-structural measures consist of (1) evacuation system including the flood forecasting and warning system and evacuation center, and (2) resettlement area development.

(1) Evacuation System Improvement

1) Improvement of Flood Forecasting and Warning System

The feasibility study for the improvement of the existing flood forecasting and warning systems has been made under the following conditions:

a) The improvement concentrates on that for the local flood forecasting and warning system facilities in the Cagayan River basin and does not include a communication system between local and central system in Manila.

b) The improvement aims at strengthening of the Tuguegarao subcenter and capacity building of the community disaster management in Tuguegarao.

The improvement project includes the following items:

a) Improvement of the existing flood forecasting and warning system facilities for FFWS of PAGASA and FFWSDO of NIA:

- Rehabilitation of telemetering system,
- Restoration of computer system,
- Provision of telefax communication facility in RDCC, PDCC and MDCC,

- Supply of spareparts and others.

b) Improvement of Tuguegarao subcenter and disaster management capacity in Tuguegarao:
  - Establishment of a local hydrological observation station in the Tuguegarao River,
  - Establishment of local communication network among subcenter, RDCC and members, MDCC, evacuation centers and Barangays.

c) Consultancy and Engineering Services:
  - For improvement of FFWS and FFWSDO:
    - Improvement of flood warning information such as preparation of information materials and dissemination flow chart, review of flood warning level, and simulation of floods,
    - Detailed design, construction supervision, and operation and maintenance of the facilities,
  - For strengthening of Tuguegarao subcenter:
    - Preparation of strengthening plan for the Tuguegarao subcenter, and technical guidance for operation of the subcenter,
  - For community disaster management capacity building in Tuguegarao:
    - Enhancement/design of community flood disaster mitigation such as detailed design, construction supervision, and operation and maintenance of local hydrological station and local FFWS communication network,
    - Education and training of disaster management staff.

2) Improvement of Evacuation Center

The feasibility study for the improvement of the existing evacuation center has been made under the following conditions:

a) The purpose of the improvement is to provide safe and comfortable evacuation centers and improve Disaster Coordinating Councils' (DCCs') and peoples' capability and preparedness in the evacuation related activities so that local people are willing to be evacuated to the centers and flood damages are mitigated.

b) Local Government Units (LGUs) are the main players for the evacuation of the local people so that the existing problems are recommended to be solved by LGUs.

The improvement project includes the following items:

a) Strengthening of existing evacuation centers
   - Supply of tents to accommodate evacuees,
   - Construction of additional deep wells in the evacuation centers for supply of drinking water,
   - Construction of additional comfort rooms in the evacuation centers,
   - Supply of cooking facilities to the evacuation centers.

b) Strengthening of capability of DCCs
   - Preparation or updating of the disaster preparedness plans including supply plan of sufficient food to the evacuation centers,
   - Training of DCC staffs.

c) Strengthening of capability of the local people
   - Conduct of drills.

(2) Resettlement Area Development

Basic concept of and approach for resettlement plan is mentioned in Subsection 7.4.2 and Section 9.5.

Even though farmers can continue their farming in their paddy and upland crop field that will be in future river area, crop production may reduce because of increased flood scale. So, in addition to resettlement plan itself, livelihood sustainability plan is also necessary for the people related to the resettlement. For example, may be suggested are preparation of additional new works such as engagement with agricultural processing industry (rice milling, etc.) and agro-pastoral enterprises.

## 11.3 Irrigation Projects

### 11.3.1 Proposed Project

(1) The Project

In accordance with the terms of reference, pre-feasibility study on irrigation project is conducted. Since it is concluded from the Reviewed Master Plan Study described in Chapter 9 and Section 10.6 that the Alcala Amulung West Pump Irrigation Project (AAWPIP) is the most optimum irrigation development plan, this project is selected for the study in this chapter. Location of the project is shown in Figure 11.2.3.

NIA completed a feasibility study for a part of the project or 2,120 ha in 1997 including topographical survey, and prepared topographic map of 1:4,000 scale. Later NIA conducted geological investigation at proposed site of intake pump station.

From above conditions, the Study Team considers that this study may be regarded in future as a feasibility study on condition that required physical surveys including topographic survey and detailed review of the NIA F/S and this pre-F/S be conducted.

(2) Irrigation Service Area

The project area is located in Northern Luzon, Cagayan Province of Region 2 at around 25 km north of Tuguegarao. Within the project area of 10,200 ha, demarcation of the irrigation service area is basically determined by the following aspects into consideration; 1) topographic condition, 2) soil condition and existing land use. Based on the assessment, the irrigation service area is determined to be 7,060 ha in net.

On the basis of the results of the field investigation and flood analysis, higher plain (about 5,000 ha) where currently cultivated with paddy is mostly inundated less frequently or probably less than 1/5. On the other hand, lower plain (about 3,500 ha) presently used as cornfield is affected by flood more frequently or 1/5 years or more. The paddy field area is named Area A and the corn field Area B, except that a part of paddy field in a backswamp is included in Area B. Area A can be implemented early in near future. Area B needs flood control measures before implementation.

(3) Present and Proposed Cropping Pattern and Land Use

The basic concept for irrigated agriculture development is to increase rice production as well as promoting crop diversification to secure food production and increase cash income of the beneficiaries. Proposed cropping pattern is designed taking into consideration of climate, irrigation water supply, agronomic characteristics, farmers' intention as well as national policy and other relevant issues. (Figure 11.3.1)

**Proposed Cropping Pattern**

| Classification | Period | Area (ha) | Cropping Intensity |
|---|---|---|---|
| Paddy | | | |
| - Wet season | April to August | 7,060 | 100 |
| - Dry season | December to April | 7,060 | 100 |
| Upland Crops | August to November | 3,530 | 50 |
| Total | | 17,650 | 250 |

Presently the project area is cultivated with paddy and corn complexly. After the implementation of the project, land use pattern in the area will change as shown below.

**Present and Proposed Land Use** (ha)

| Classification | Present | Proposed |
|---|---|---|
| Paddy Field | 4,730 | 7,060 |
| Corn Field | 2,820 | 0 |
| Irrigation Canal with Road | 0 | 790 |
| Non-Irrigable Area (Village and Highland) | 1,200 | 1,200 |
| Grass and brush | 300 | 0 |
| River | 700 | 700 |
| Others | 450 | 450 |
| Total | 10,200 | 10,200 |

(4) Anticipated Crop Yield and Production

Proper farming practice is the most essential factor for realizing full exploitation of the agricultural potentiality in the area. Proper amount of fertilizer and chemicals will be applied through improved farming practices with project condition. Unit yield of paddy in the future conditions is estimated on the basis of the past trends of unit yield, the results of unit yield on well managed irrigation area in and around the project area. For the achievement of the anticipated crop yield and production, optimum application of farm inputs will be required together with effective water management. Total production of the farm crops is estimated by multiplying the anticipated unit yield with the future cultivation area for both future "with project" and "without project" conditions. The future area of paddy and corn fields are assumed to be the same as those at present. Unit yield of paddy "without project" is based on NIA data, and those of others are decided from the 1987 Master Plan. The anticipated unit yield, production and increment of crops in "with and without project" conditions is tabulated as follows

**Incremental Production - With and Without Project**

| Item | Without Project | With Project | Increment |
|---|---|---|---|
| 1. Total Area (ha) | | | |
| Paddy field | 4,730 | 7,060 | 2,330 |
| Diversified cropland | 2,820 | 0 | -2,820 |
| Grass and brush | 300 | 0 | -300 |
| Total | 7,850 | 7,060 | -790 |
| 2. Harvested Area (ha) | | | |
| Paddy-Wet season | 4,500 | 7,060 | 2,560 |
| -Dry season | 470 | 7,060 | 6,590 |
| (Total) | 4,970 | 14,120 | 9,150 |
| Corn | 4,850 | 1,150 | -3,700 |
| Tobacco | 100 | 120 | 20 |
| Vegetables | 240 | 980 | 740 |
| Beans | 200 | 800 | 600 |
| Peanuts | 180 | 400 | 220 |
| Sweet potatoes | 30 | 0 | -30 |
| Total | 10,470 | 17,650 | 7,180 |
| 3. Unit Yield (ton/ha) | | | |
| Paddy-Wet season | 2.50 | 4.50 | 2.00 |
| -Dry season | 3.10 | 5.00 | 1.90 |
| Corn | 2.50 | 3.75 | 1.25 |
| Tobacco | 1.00 | 2.00 | 1.00 |
| Vegetables | 6.00 | 13.00 | 7.00 |
| Beans | 1.00 | 1.50 | 0.50 |
| Peanuts | 0.70 | 1.00 | 0.30 |
| Sweet potatoes | 5.00 | - | - |
| 4. Production (ton) | | | |
| Paddy-Wet season | 11,250 | 31,770 | 20,520 |
| -Dry season | 1,457 | 35,300 | 33,843 |
| (Total) | 12,707 | 67,070 | 54,363 |
| Corn | 11,875 | 4,313 | -7,563 |
| Tobacco | 100 | 400 | 300 |
| Vegetables | 1,440 | 12,740 | 11,300 |
| Beans | 200 | 1,200 | 1,000 |
| Peanuts | 126 | 800 | 674 |
| Sweet potatoes | 150 | 0 | -150 |

### 11.3.2 Irrigation and Drainage Plan

(1) Water Sources

The water source for the project area is the discharge of the Cagayan River. The maximum discharge of 25 years return period is 18,700 m3/s while the minimum of 5 years return period is 304 m3/s. Although the seasonal fluctuation of the river surface water level is very wide from EL. 17.33 m in 25-year return period to EL. 1.38 m in 5-year period, the river discharge can be consecutively used for irrigation purposes by lifting up by means of pumps to be installed under the Project. In the project area, some communal and private irrigation systems (approx. 200 ha) are operating at present in use of groundwater. Since the shallow tube well and deep well cannot supply enough water during drought, they can be neglected for formulating irrigation development plan.

(2) Irrigation Plan

<u>Pump Station Site</u>

Tamban site is selected for proposed intake pump station after comparative study presented in Supporting Report.

<u>Pump Type</u>

Submersible pump is selected from technical and economical viewpoint. The comparative study is shown in Subsection 12.5.1 and supporting data.

<u>Irrigation Water Requirement</u>

Irrigation Water Requirement is calculated in accordance with the proposed cropping pattern by the following manner;

- Crop evapotranspiration (ETcrop) is estimated on the basis of FAO Penman-Monteith method together with crop coefficient.
- Net irrigation requirement (NIR) is calculated by adding percolation water and water required for a nursery period and land preparation to ETcrop and reducing effective rainfall.
- Diversion water requirement or water duty is calculated by adding operation and conveyance loss to NIR.

The calculation is made in monthly base as shown in Table 11.3.1 and 11.3.2, in use of following.

- Percolation: 1.5 and 2.0 mm/day for higher and lower plain, respectively
- Land soaking and flooding: 150 mm and 15 mm
- Effective rainfall: 5-year probability of non-exceedance
- Irrigation efficiency: 0.54 (application: 0.8, conveyance: 0.8, operation: 0.85)

On this basis, peak irrigation water requirement for determining the design capacity of irrigation facilities is calculated to be 1.8 lit/sec/ha in the field previously used as corn field (lower plain) and 1.7 lit/sec/ha in existing paddy field (higher plain).

(3) Drainage Plan

General

Present flooding condition of the project area is so worse that it cause not only inundation of wide area especially on a present corn field but also low productivity and crop damage of paddy during flood time.

The drainage plan in the irrigation development area is proposed by means of improving the existing Pangul river through relocation, flood dike construction and drainage network construction. Additionally crossing drain should be provided to securely drain runoff water from the outside of the project area. An example of inundation in the Drainage Area (DA) 2 during flood time is presented in Figure 11.3.2.

Drainage Requirement

In accordance with NIA criteria, the drainage requirement for the paddy filed is estimated to be 8.6 lit/sec/ha for the excess water in 10-year return period, which is generally applied for drainage plan in Northern Cagayan. Accordingly this value is applied for this pre-feasibility study.

Additionally the excess water drained from surrounding mountainous side across the irrigation canals should be considered for drainage plan. The unit runoff is estimated by the flood analysis. In accordance with the analysis, this value is estimated at 19.4 lit/sec/ha and thus to be considered for the drainage plan.

### 11.3.3 River Relocation and Flood Dike Construction Plan

The Pangul River flowing south-east of the project area has wide catchment area of some 350 km2, which inundates the field particularly lower part of present cornfield. This will be the constraints for future irrigation development. To alleviate the damages by flooding in the area to materialize the target, it is proposed to relocate existing Pangul River channel to the outside of the irrigation area as shown in Figure 12.5.1. In addition, flood protection dike is to be constructed surrounding the proposed irrigation area. The details are described in Supporting Report.

### 11.3.4 Farm Road Plan

The farm road and farm to market road in the project area is rehabilitated and newly constructed for the purpose of O&M of the irrigation and drainage facilities, transportation and marketing of farm products and inputs.

### 11.3.5 Water Management and Operation & Maintenance Plan

The irrigation service area is located in alluvial plain just upstream of the narrows from Magapit through Nassiping to Tupang. The service area of 7,060 ha are served by intake pump station, booster pump station, main canal 28 km, lateral / sub-lateral canal 61 km, main drain 8 km, lateral drain 28 km and other related structures.

The purpose of operation of these facilities is to attain the maximum efficiency of irrigation water to meet with the crop water requirement, in other words, to distribute irrigation water how much, when and where, it is required.

(1) Water Management

In general, a delivery and application program is prepared based on the various data and information, because it should be well-fitted to the local and current conditions. In order to realize effective water use, such data and information as listed below should at first be prepared and/or collected before the operation.

- Detailed topographic maps
- Detail soil maps
- Cropping patterns and cropped areas
- Physical conditions of soils such as water holding capacity, basic intake rate, etc.
- Meteorological data such as rainfall, temperature, related humidity, sunshine, wind speed and evaporation
- Canal seepage loss
- H-Q Curve for each measuring device

In water management, another important issue is to monitor, analyze and evaluate the actual activities, and to reflect the results on the water delivery and application program in the next year. Hence staffing and organization should be ensured for effective execution of monitoring activities.

Establishment and strengthening of Irrigators' Association (IA) is important for effective collection of irrigation service fee (ISF) and operation and maintenance of irrigation system.

(2) Operation and Maintenance Plan

Operation of the project facilities in irrigation project means the execution of water management program mentioned above. It includes activation of pumps and gates so that the desired discharge can be supplied at the appropriate time, which is considered as the "hardware" of the water management action.

In this project, a continuous water supply method is proposed, though further study should be made at the next stage. In the continuous water supply method, supply amount will be regulated by opening and closing the gates in the light of water delivery and application program. To simplify the gate operations, a measuring device is indispensable, and it should be provided.

In parallel with proper operation, suitable and continuous maintenance of the project facilities are essential to secure proper stable function of the facility as well as to ensure the realization of economic life of the facility.

# CHAPTER 12 PRELIMINARY DESIGN

## 12.1 General

The priority projects selected for the feasibility or pre-feasibility studies as discussed in the preceding CHAPTER 11 have been designed preliminarily. The priority projects are enumerated as follows:

1) Flood control structural measures including dike systems, cut-off channels and urgent bank protection works in the lower Cagayan River,
2) Flood control non-structural measures including evacuation system and resettlement area development,
3) Irrigation development project including agricultural support facilities.

The following are results of the preliminary design.

## 12.2 Flood Control Structural Measures

### 12.2.1 General

In this section, preliminary design for structural measures of the priority projects is explained in the following. The design results are compiled in the Supporting Report III-3, Drawings. Table 12.2.1 shows outline of the feasibility projects.

### 12.2.2 Design Criteria

Design criteria described in Subsection 11.2.1 are in principle applied to the preliminary design. Other key criteria are as follows.

1) The present condition for the basis of design is the ones of topographic maps with 1/10,000, 1/5,000 and 1/1,000 scales and channel cross-sections respectively surveyed by the Study Team in 2000.
2) For design of the river improvement works and related structures, Design Guidelines Criteria by DPWH, Philippines and Structural Standard for River Facilities by Ministry of Land, Infrastructure and Transport, Japan are applied in principle.

### 12.2.3 River Channel Improvement Works

The locations of the proposed river improvement works are presented in Figure 11.2.1 and their preliminary designs are presented in Supporting Report III-3, Drawings.

(1) River Width and Dike Alignment

Based on the design criteria described in Subsection 11.2.1, the river width was determined as described in ANNEX VI in detail. This proposed river width is applied as it is even for a framework plan with a 100 yr probable flood.

As already explained in CHAPTER11, the river area is delineated on the detailed plan in Supporting Report III-3, Drawings. It is defined as an open limits consisting of water channel and floodplain confined by proposed dikes and/or present riverbank lines.

(2) River Cross-section

The river cross-section consists of low water channel as the existing one and high water channel to be newly confined by dikes. River cross-sections at major points are presented in Supporting Report III-3, Drawings.

Dike system consists of earth dike, maintenance road and drain. The drain shall be a boundary line of the river area, which is defined as open space confined by both dikes of left and right banks. A standard dike section is a trapezoidal section as shown in Figure 12.2.1.

The inlet of the abandoned river channel by newly constructed cut-off channel is closed with excavated earth for an about 100 m wide (closing dike) and its riverbank is protected with revetment works in combination of a series of spur dikes. On the other hand, remained river channel of the abandoned are conserved as they are for retarding basin in inner drainage and for fishponds.

Sluice equipped with slide gate and drainage culvert with flap gate are provided crossing in the dikes. Those are explained in the following Subsection of 12.2.3.

(3) Riverbank Tree Zone

A tree zone is eventually considered to protect earth dike from severe flow attack. The tree zone is provided ahead of dike construction. Therefore, sediment damage to assets and agricultural crops is mitigated due to siltation resulting from decreased velocity in the tree zone. Hence the tree zone is constructed in riverside along dike for 70 km long in the total dike length of 150 km, provided that proper and sustainable river management and maintenance systems are to be established in DPWH Region 2 in cooperation with the concerned LGUs. Such tree zones are to be provided in the initial stage ahead of dike constructions to regulate flood flows over the floodplain and stabilize low water channel.

The tree zones were designed at the 4 dike systems of a part of Catugan dike, Alcala-Buntun dike, Tuguegarao dike and Enrile dike having a 30 m wide, respectively.

(4) Cut-off Channel

A cut-off channel was designed to lower floodwater levels by improving significant river meander at 3 reaches of Gabut, San Isidro and Tuguegarao. At Gabut and San Isidro cut-off channels, overflow bridge is provided to connect so as not to interrupt the current traffic in the divided communities, respectively. The details are as shown in DRAWING BOOK.

(5) Longitudinal River Profile

A river profile is designed as follows and the designed river profile is shown in Figure 12.2.2.

Riverbed profile was proposed at the present mean riverbed elevations. The riverbed elevation of cut-off channel was designed at the above-proposed elevations.

Design high water level was set based on the calculated water level for design discharge by non-uniform flow method. Manning's roughness coefficients are 0.04 for low water channel and 0.06 for high water channel with a confined dike, as applied in the reviewed Master Plan.

### 12.2.4 Estimation of Bill of Quantities

Work quantities of priority projects are summarized in the ANNEX VI. Resettlement in the right of way and river area is explained in the later Section 15.1 in CHAPTER 15.

## 12.3 Flood Control Non-structural Measures

### 12.3.1 Flood Forecasting and Warning System Strengthening Project

(1) Improvement of the existing flood forecasting and warning system facilities for FFWS of PAGASA and FFWSDO of NIA:

<u>Rehabilitation of telemetering system</u>

- This item includes replacement of telemetering system and water level sensors.

<u>Restoration of computer system</u>

- This item includes replacement of computer system in Magat Dam to calculate inflow volume and renewal of computer system for flood forecasting analysis at Tuguegarao subcenter.

Provision of telefax communication facility in RDCC, PDCC and MDCC

- For timely and efficient dissemination of flood warning, telefax communication facility shall be introduced to Tuguegarao subcenter, RDCC, PDCC, and CDCC/MDCC.

Supply of spareparts and others

- Spareparts for the rainfall and water level gauging equipment shall be supplied and properly stocked with log books.

(2) Improvement of Tuguegarao subcenter and disaster management capacity in Tuguegarao:

Establishment of a local hydrological observation station in Tuguegarao River

- Provision of rainfall and water level gauging stations is recommended in the Tuguegarao River in order to monitor the basin rainfall and discharge. The location immediate downstream of the narrow section near Callao Cave is assessed technically as the best site taking account of topography and maintenance condition.

Establishment of local communication network among subcenter, RDCC and members, MDCC, evacuation centers and Barangays

- Establishment of telephone and fax communication among the Tuguegarao subcenter, RDCC and members of RDCC.
- Establishment of telephone and fax communication between the Tuguegarao subcenter and CDCC of the Tuguegarao City.
- Establishment of VHF radio communication among CDCC, each Barangay in Tuguegarao and evacuation centers.

(3) Consultancy and Engineering Services:

*For improvement of FFWS and FFWSDO*

Improvement of flood warning information

- This item includes preparation of information materials and dissemination flow chart, review of flood warning level, and simulation of floods.
- The information materials (flood bulletin) shall include expected raining period, expected gross rainfall, and expected runoff and water level information.
- Terms and their definitions of Alert Water Level, Alarm Water Level and Critical Water Level shall be reviewed.

Detailed design, construction supervision, and operation and maintenance of the facilities

- This item includes detailed design, construction supervision, and operation and maintenance of the telemetering system, computer system and telefax communication facilities.

*For strengthening of Tuguegarao subcenter*

Preparation of strengthening plan for the Tuguegarao subcenter and technical guidance for operation of the subcenter

- The strengthening plan will include increase of manpower, improvement of facilities and securing of budget.

*For community disaster management capacity building in Tuguegarao*

Enhancement/design of community flood disaster mitigation

- This item includes detailed design, construction supervision, and operation and maintenance of local hydrological station and local FFWS communication network.

Education and training of disaster management staff

- The Public Information Drive (PID) should be upgraded and implemented as the formal program in order to realize the regular disaster management education, especially focusing on the local residents.

(4) Cost Estimate

Cost for the Flood Forecasting and Warning System Strengthening Project is estimated as follows:

(unit : Million Pesos)

| Activities | Amount |
|---|---|
| 1. Improvement of FFWS and FFWSDO Facilities | |
| 1.1 Rehabilitation of Telemetering System | |
| a) FFWS | 89.3 |
| b) FFWSDO | 0.0 |
| 1.2 Restoration of Computer System | |
| a) FFWS | 1.2 |
| b) FFWSDO | 0.4 |
| 1.3 Provision of Telefax Communication Facility (RDCC/PDCC/MDCC) | 2.4 |
| 1.4 Spareparts and Others | 9.2 |
| Total of 1. | 102.5 |
| 2. Special FFWS and Disaster Management in Tuguegarao | 6.2 |
| 2.1 Establishment of Local Hydrological Observation Stations | |
| 2.2 Local Communications Network | |
| a) Among Subcenter, RDCC and Members | 7.2 |
| b) Among MDCC, Evacuation Centers and Barangays | 8.0 |
| Total of 2. | 21.4 |

| | |
|---|---|
| 3. Consultancy and Engineering Services | |
| 3.1 Improvement of FFWS/FFWSDO | |
| a) Improvement of flood warning information | 13.2 |
| b) D/D, S/V, O/M of FFWS/FFWSDO facilities | 17.2 |
| 3.2 Strengthening of Tuguegarao Subcenter | 6.5 |
| 3.3 Community Disaster Management Capacity Building in Tuguegarao | |
| a) Enhancement/Design of Community Flood Disaster Mitigation | 9.9 |
| b) Education and Training of Disaster Management Staff | 39.7 |
| Total of 3. | 86.5 |
| 4. Base Cost (1.+2.+3.) | 210.4 |
| 5. Project Administration Cost (0.2% of Base Cost) | 0.4 |
| 6. Contingency (15% of Base Cost) | 31.6 |
| 7. Grand Total | 242.4 |

Annual operation and maintenance cost is assumed to be 3% of the construction cost. Taxes and duties are not included in the above estimates.

### 12.3.2 Evacuation Center Strengthening Project

(1) Strengthening of existing evacuation centers

Supply of tents

- Tents are recommended for temporary accommodation for excess evacuees during calamity in case the designated evacuation centers are full of evacuees. Required number of the tents (a capacity of 12 persons) is estimated at 1,204 numbers on condition that 2 years probable flood occurs in the Lower Cagayan River basin and the additional schools are used as the evacuation centers as well as the present evacuation centers designated.

Construction of additional deep wells and comfort rooms, and supply of cooking facilities

- Construction of the additional deep wells to supply drinking water and comfort rooms in the evacuation centers, and supply of the cooking facilities to the centers are requisite in order to improve the existing centers.
- Required number of the additional deep wells is estimated at 271 on condition that an evacuation center shall have two wells or one well shall be used by 150 persons.
- Required number of the additional comfort rooms is estimated at 1,512 on condition that a comfort room shall be used by 25 persons.
- Required number of the cooking facilities is estimated at 10,180 on condition that a facility shall be used by 5 persons.

(2) Strengthening of capability of DCCs

Preparation or updating of the disaster preparedness plans

- In order to attain smooth and efficient operation of community disaster management systems, the disaster preparedness plans shall be prepared or updated by each CDCC/MDCC and BDCC.

Training of DCC staffs

- Yearly training shall be made for staffs of PDCC, CDCC/MDCC and BDCC.

(3) Strengthening of capability of the local people

Conduct of drills

- Yearly drill shall be made for local people, which is managed by CDCC/MDCC and BDCC.

(4) Cost Estimate

Cost for the Evacuation Center Strengthening Project is estimated as follows:

unit : Million Pesos

| Activities | | Amount |
|---|---|---|
| 1. | Purchase of tents | 55.4 |
| 2. | Construction of deep wells | 24.9 |
| 3. | Construction of comfort rooms | 52.2 |
| 4. | Purchase of cooking facility | 5.9 |
| 5. | Preparation and updating of disaster preparedness plan | 13.5 |
| 6. | Education and training of DCC staffs and local people | 4.4/year |

### 12.3.3 Resettlement Site Development Project

In accordance with information from related municipalities, there are 6 resettlement sites to be developed, namely Lasam, Alcala East, Alcala West, Amulung East, Amulung West and Iguig. In other municipalities, resettlement can be conducted near the original resident area without particular plan.

Resettlement area may be placed on spoil bank area. However, there is no such case in the F/S area, because surplus of excavated material is proposed only at Tuguegarao COC site.

Estimated resettlement area and informed candidate resettlement sites are as below (ref. to Table 12.3.1).

Lasam: 872 HH, 17.4 ha

Alcala: 359 HH, 7.2 ha, northern hill of poblacion and western hill of Tamban

Amulung: 918 HH, 18.4 ha, eastern hill of Anquiray and corn field between Annabuculan and Unag

Iguig: 784 HH, 15.7 ha, southern hill

In case of Lasam, no suggestion is obtained. The site may be along the proposed flood dike.

Typical resettlement site development layout is shown in Figure 9.5.1.

## 12.4 Irrigation Development Project

### 12.4.1 Basic Concept for the Design

(1) Intake and Booster Pump Station

The required number and capacity of pumps are determined on the basis of the irrigation area and design irrigation water requirement, also taking lifting capacity, the cost and weight of a pump into consideration. The proposed pump description is tabulated as follows:

**Main Features of Proposed Pump**

| | Intake Pump | | Booster Pump | |
|---|---|---|---|---|
| | Stage-I | Stage-II | Stage-I | Stage-II |
| - Required Number | 4 – D900 | 4 – D800 | 2 – D800 | 2 – D900 |
| - Design Capacity ($m^3$/min) | 7.0 | 5.3 | 2.7 | 3.5 |
| - Total head (m) | 20 | 20 | 5 | 5 |
| - Type | Submersible | Submersible | Submersible | Submersible |

Total electric power input capacity is estimated about 4.0 MW. Annual average pumping quantity is estimated at 140 and 73 million m3 for the intake and booster pump stations, respectively. The required annual energy is estimated at around 12.3 MWH in total.

(2) Irrigation Canals

Layout of irrigation network

The irrigation network will consist of main system (main, lateral, sub-lateral canals) and on-farm system (main and supplementary farm ditch), and canal related structures, and are provided completely separated from the drainage system for effective O&M of the facilities. The irrigation canals are of open-channel type of canals so as to connect each of the irrigation blocks. The lateral canals and sub-lateral canals are branched off from the main canal and farm ditches are diverges from lateral canals and sub-lateral canals. The area of each irrigation block is from 70 ha to 700 ha and averaging 200 ha. (Figure 12.5.1)

Irrigation Canals

All the main canal, lateral canals and sub-lateral canals are lined with concrete with trapezoidal flow section in terms of easy O&M and smaller hydraulic head loss as well as for effective use of water with a minimum loss due to leakage, while farm ditch is of earthen type. The cross sectional scale of the irrigation canals is determined by use of the Manning Formula. The roughness coefficient is assumed to be 0.015 for concrete surface and 0.030 for earth surface.

Hydraulic profile design is important and must be practical. Design energy head loss at each structure on the irrigation canal is set at least 5 – 10 cm in the main canal system and 2 – 5 cm in the on-farm canal system.

Canal-related structures

Necessary and indispensable facilities like headgate, turnout, drop, siphon, culvert and etc. are installed on the canals and washing basins are installed in the convenient points for the beneficiaries along the canals.

(3) Drainage Canals

Drainage Network

The drainage system consists of drains to evacuate the excess water from the irrigated land and collector drain to flow out the rainwater from outside the project area. The drains are classified into farm drain, which is provided to drain the excess water from the irrigation block, lateral drain to collect excess water from the farm drains and main drain and collector drain to collect drain water from lateral drain to drain into natural stream directly.

Drainage Canals

All of the drainage canals are of earthen type with trapezoidal flow section. The cross sectional scale of the drainage canals is determined by use of the Manning Formula. The roughness coefficient is assumed to be 0.030.

Primary features of canals and drains and related structures are summarized as follows:

**Proposed Canals, Drains and Related Structures**

| Canal Name | | Canal Length (m) | Structures (nos) | | | |
|---|---|---|---|---|---|---|
| | | | Culvert | Siphon | Cross Drain | Footpath |
| Irrigation | Main Canal | 27,500 | 20 | 2 | 39 | 16 |
| | Lateral/sub-LC | 61,750 | 22 | 10 | 25 | 57 |
| Drainage | Main | 8,300 | 10 | | | |
| | Lateral | 27,200 | 40 | | | |
| TOTAL | | 124,750 | 82 | 12 | 64 | 73 |

(4) Land Development

Topographical conditions of the project area are basically flat. Land development works, namely rough leveling, is required only where the average land slope is more than 1% while the area sloping less than 1% can be gradually leveled under farming practices. The area required for land development is approximately 150 ha, which is 5% of existing cornfield, estimated by the site investigation and using 1/10,000 topographic maps.

(5) Farm Road

The proposed farm roads are divided into three types in terms of their design, inspection roads (two types) and footpath. The inspection road has function of connecting the main facilities and for O&M of the main irrigation system and access to the public road network. The footpath is mainly used for transportation of farm products and inputs, and are aligned so as to enclose a unit farming block. The following table shows the outline of the proposed road network:

**Proposed Farm Road**

| Classification | Width (m) | Total Length (km) |
|---|---|---|
| Inspection Road | | |
| -main | 6 | 27.5 |
| -Lateral/sub-lateral/FD | 4 | 202.5 |
| Footpath | 2.5 | 494.2 |

(6) Resettlement

There are 9 households to be resettled due to the project implementation as shown in Table 12.4.1. As number of the household is small and there is enough space near the site, resettlement can be conducted near the original resident area without particular plan.

### 12.4.2 Post-harvest Facilities

To reduce losses at the harvesting and post-harvesting stages, rice mill and multi-purpose dryer are required in the villages to make easy access by farmers together with extension services of post-harvesting techniques. The facilities are designed as shown below:

Rice Mill

For the incremental production of paddy of 54,000 ton, required rice mill capacity is calculated at 7 units of 5 ton/hour as presented in Supporting Report.

Multi-purpose Dry Yard

The dry yard, being required for treatment of paddy and other crops for storage and marketing, the total required floor space is estimated at 170,000 $m^2$ as shown in Supporting Report.

### 12.4.3 Work Quantities

The work quantities under the project is tabulated in Table 12.4.2.

# CHAPTER 13 CONSTRUCTION PLAN AND COST ESTIMATE

## 13.1 General

This Chapter presents the construction plan and cost estimate of the priority projects which are Lower Cagayan River Flood Control Project and Alcala-Amulung West Pump Irrigation Project. In accordance with the implementation schedule of the revised Master Plan (Figure 10.9.1), it is planned that the Flood Control project in the Lower Cagayan River will be completed by the target year 2020 over the divided 4 phases and that the Alcala-Amulung West Pump Irrigation Project will be completed by the year 2015 in two stages.

(1) Flood Control

Structural Measures

The Lower Cagayan River from the river mouth to Cabagan of about 170 km length is subject to the feasibility study for the flood control project. The measures to be taken are 1) urgent bank protection works, 2) river bank tree zones, 3) dike system with maintenance road, 4) cut-off channels, and 5) bank protection under the design flood of 25 years.

Non-structural Measures

The proposed non-structural measures subject to the feasibility study as part of the flood control project include 1) flood forecasting and warning system (FFWS), 2) evacuation center, and 3) resettlement area development.

Supporting Measures

Institutional arrangements such as strengthening the water code with the rules and regulations, operation and maintenance system, and implementation structure will have to be undertaken.

(2) Irrigation

Structural Measures

Alcala Amulung West Pump Irrigation project (AAWPIP) was selected as the priority irrigation project to be subject to a pre-feasibility study.

Supporting Measures

A rice mill plant system and drying yard will have to be introduced as supporting measures for the irrigation project.

This Chapter deals with the proposed structural and non-structural measures and supporting measures for the flood control and irrigation projects to estimate the project cost providing a construction plan and schedule for the feasibility study.

## 13.2 Construction Plan and Schedule

### 13.2.1 Basic Conditions

There are various factors and conditions for establishing the construction plan of the project works to be carried out in the existing river channel. Such works are much affected by the natural factors particularly the climate at the work site and availability of construction resources in and around the project area. The following are the basic conditions adopted to formulate a construction plan and schedule:

(1) Annual workable days are assumed at 210 days for earthworks and 260 days for concrete and other works assuming the number of holidays and suspended days due to rainfall in the wet season.

(2) Working days and hours are set at 25 days per month and 8 hours per day in principle.

(3) Locally available construction resources are to be used as much as practicable. The following information was determined from site survey in June 2001:

- Skilled and unskilled labors are available in the Philippines and in Region 2.
- The embankment materials will have to be taken from excavated soil from the cut-off channels and borrow pits in the surrounding area of the construction site.
- Big boulders for masonry and other works are available from Sanbavro, Isabela and Tuguegarao rivers and other areas as shown in Figure 3.12 of ANNEX III in the supporting report.
- A ready mixed concrete factory of 40 $m^3$/hr. production capacity is available at Gataran and Tuguegarao.
- Construction equipment is available in the Philippines for rental or purchase. However, the reliability of rental equipment should be checked carefully.
- Other construction materials, such as cement, steel reinforcement bar, and concrete aggregates, are available at Tuguegarao and other major cities in the Cagayan river basin.

(4) Existing transportation conditions are as follows in the Lower Cagayan River area:
   - The Irene seaport (Batulinao port) will be used for loading and unloading of project cargoes in sea transportation.
   - Existing paved or non-paved roads are available on both sides of the river for access and for use as construction roads for the project.

(5) Public electrical power is available at almost all construction sites by extension except on the left bank of the lower most reach of the Cagayan River.

(6) Water required for construction will be pumped from surrounding rivers.

(7) Construction works are assumed to be implemented by contract system.

(8) The preparatory works such as site camp and temporary access road construction are included in the contract system.

### 13.2.2 Flood Control Projects

(1) Priority Projects

The following 17 candidate sub-projects are identified in the Lower Cagayan River Flood Control Project as the priority projects.

| No | Candidate sub-projects | Scope |
|---|---|---|
| 1 | Urgent bank protection works | 21 sites |
| 2 | River bank tree zones | 70 km |
| | Left dike systems in the lowermost from river mouth to Nassiping | 25.3 km |
| 3 | (1) Mabanguc dike, length 11.3 km | |
| 4 | (2) Catugan dike, length 6.0 km | |
| 5 | (3) Lasam dike, length 8.0 km | |
| | Right dike systems in the lowermost from river mouth to Nassiping | 42.0 km |
| 6 | (1) Camalaniugan dike, length 13.1 km | |
| 7 | (2) Lal-lo dike, length 12.9 km | |
| 8 | (3) Gattaran dike, length 6.1 km | |
| 9 | (4) Nassiping dike, length 9.7 km | |
| | Left dike systems in the reach from Alcala to Tuguegarao | 46.2 km |
| 10 | (1) Alcala – Buntun dike, length 34.0 km | |
| 11 | (2) Enrile dike, length 12.2 km | |
| | Right dike systems in the reach from Alcala to Tuguegarao | 37.0 km |
| 12 | (1) Tuguegaro dike, length 21.3 km | |
| 13 | (2) Amulung dike, length 11.6 km | |
| 14 | (3) Iguig dike along national highway, length 4.1 km | |
| | Cut-off channels in the reach from Alcala to Tuguegarao | 8.1 km |
| 15 | (1) Gabut Cut-Off Channel (COC), length 0.7 km | |
| 16 | (2) San Isidoro COC, length 1.6 km | |
| 17 | (3) Tuguegarao COC, length 5.8 km | |

Phased implementation in order from the river mouth toward upstream is proposed as presented in Figure 13.2.1 and in table below for the above mentioned priority sub-projects aiming at the target year of 2020 assuming a 6 to 10 years implementation period per phase. As described in Subsection 11.2.1

and 12.2.3, special considerations are given for the provision of riverbank tree zone for the river channel improvement works. Then, in the construction plan of the flood control project, the particular item is given for the construction of the riverbank tree zone.

| Phase | Sub-project to be implemented |
|---|---|
| 1st(2002-2007) | 1) Urgent bank protection works, 21 sites |
| | 2) River bank tree zones |
| | 3) Left and Right dike systems reaches from Rivermouth to Magapit |
| 2nd(2004-2011 ) | 1) Left and Right dike systems reaches from Magapit to Nassiping |
| | 2) Amulung dike system reaches from Alcala to Amulung |
| | 3) Gabut cut-off channel |
| 3rd(2007-2015) | 1) Alcala-Buntun dike system reaches from Alcala to Solana |
| | 2) Iguig dike system reaches in Iguig |
| | 3) San Isidoro cut-off channel |
| 4th(2011-2020) | 1) Tuguegarao dike system reaches from Tuguegarao to Cabagan |
| | 2) Enrire dike system reaches from Tuguegarao to Cabagan |
| | 3) Tuguegarao cut-off channel |

The basic design of the river cross section consists of a low water channel and a high water channel confined by dikes. The width of cut-off channel is designed at 500 m which is estimated as the average width of the existing low water channel. Earth dike system was designed to confine flood flow. Maintenance road is provided in land side along the dike in case there is no available road nearby. A trapezoidal dike section is adopted as shown in Figure 12.2.1

The tree zone of 70 km long is to be constructed on the riverside along the proposed dike. The total proposed dike length to be constructed under this project is 150 km.

(2) Construction Plan and Schedule

The proposed implementation schedule for the Lower Cagayan River Flood Control Project of 1st phase in 4 phases is given in Figure 13.2.2. The proposed construction time schedule is shown in Figure 13.2.3.

Urgent bank protection works

Accelerated implementation in order of priority will have to be taken for the proposed urgent bank protection works in the Flood Control Project upon early completion of the detailed design in the year 2002. The proposed construction period is 2 years started in the year 2003.

The protection length is approx. 19.0 km at 21 construction sites on the lower Cagayan and Tuguegarao rivers. The construction priority will be given in order of 1) urbanized and densely populated area, 2) sparsely populated area, and 3) agriculture land.

The construction works will be carried out by combination of manpower and mechanical power by applying bulldozer, backhoe, truck crane, portable concrete mixer and other light type of equipment.

River bank tree zone

The construction of the river bank tree zones of about 70 km long in the lower most reach of the river from the mouth to Nassiping is assumed to be implemented by LGUs. The implementation will have to be started at an early stage, preferably at the beginning of 2003 after the establishment of the execution crews in 2002 in due consideration of the growth rate of planted trees.

The planting period of 70 km long river bank trees is scheduled for 5 years from the year 2003 until the year 2007 corresponding to the end of the implementation period of the 1$^{st}$ phase of the Lower Cagayan River Flood Control Project.

Tree planting will be mainly carried out by manpower supported by hauling vehicles for transporting trees and small type pumps for sprinkling water to the planted trees.

Construction of dike system

(Phase 1)

The proposed dike systems in the 1$^{st}$ phase implementation are 43.3 km in total length at 4 sites in the lowermost reach from the river mouth to Magapit. The construction period for the left and right dike systems is scheduled for 4 years started in the year 2004. The dike lengths and estimated embankment volumes are summarized below.

| System | Dike name | Length (km) | Embank. Volume ($m^3$) |
|---|---|---|---|
| Left dike systems | Mabanguc dike | 11.3 | 1,196,000 |
| | Catugan Sur dike | 6.0 | 812,000 |
| | Sub total | 25.3 | 2,008,000 |
| Right dike systems | Camalaniugan dike | 13.1 | 1,150,000 |
| | Lal-lo dike | 12.9 | 1,039,000 |
| | Sub total | 26.0 | 2,189,000 |
| Total, left and right | | 43.3 | 4,197,000 |

The dike embankment is a major construction work with its total volume of 4.2 million $m^3$. Material source is conceived to be from borrow pits near the construction site and abundant fine sand distributing in the river. The geo-technical and material investigation report recommends that the fine river sand be used for the inside of the dike embankment to reduce the amount of clay material, which is expensive due to long transportation distance.

Thus, the embankment material will be taken from soil borrow pits in the surrounding area and fine river sand along the lower most part of the Cagayan river. The embankment work is planned to be conducted over 4 years starting in the year 2004 and assuming a construction rate of approx. 1.1 million $m^3$ per year (4,200,000 $m^3$/4 yeas). For the embankment operation, it will be required to haul the embankment materials long distances.

Thus, the required major fleet will be as follows to assure the proposed standard progress of the embankment operation.

| No | Equipment | Capacity (class) | No. of unit, required |
|---|---|---|---|
| 1 | Motor scraper | 16 $m^3$ | 4 |
| 2 | Bulldozer | 21 t | 2 |
| 3 | Swamp bulldozer | 21 t | 2 |
| 4 | Tractor shovel | 2 $m^3$ | 2 |
| 5 | Dump truck | 12 – 20 t | 10 |
| 6 | Vibration roller | 10 t | 2 |
| 7 | Tamping roller, self propelled | 20 – 30 t | 2 |
| 8 | Tamping roller, towed w/ballast | 12 – 17 t | 2 |
| 9 | Backhoe | 0.6 – 1.2 $m^3$ | 2 |

The other works such as construction of maintenance roads, culverts will be carried out concurrently or in parallel with the dike embankment operation.

(Phase 2)

The proposed dike systems in the 2nd phase implementation are 35.4 km in total length at 3 sites in the lowermost reach from Magapit to Amulung. The dike lengths and estimated embankment volumes are summarized below.

| System | Dike name | Length (km) | Embank. Volume ($m^3$) |
|---|---|---|---|
| Left dike systems | Lasam dike | 8.0 | 909,000 |
| Right dike systems | Gattaran dike | 6.1 | 560,000 |
| | Nassiping dike | 9.7 | 467,000 |
| | Amulung dike | 11.6 | 1,257,000 |
| | Sub total | 27.4 | 2,284,000 |
| Total, left and right | | 35.4 | 3,193,000 |

The embankment volume is 3.2 million $m^3$ in total. The source of material is conceived as borrow pits near the construction site, abundant fine sand distributing in the river and excavated soil at the Gabut cut-off channel, which is also planned to be constructed in the 2nd phase works. The excavation volume from the Gabut cut-off channel is estimated at approximately 4.6 million $m^3$.

The embankment work is planned to take place over 4 years starting in the year 2008 assuming an approximate 0.8 million $m^3$ embankment rate per year. The same type of earthmoving equipment will be used as described for the embankment operation of Phase 1.

(Phase 3)

The proposed dike systems in the 3rd phase implementation are 38.1 km in total length at 2 sites in the reach from Amulung to Tuguegarao. The dike lengths and estimated embankment volumes are summarized below.

| System | Dike name | Length (km) | Embank. Volume ($m^3$) |
|---|---|---|---|
| Left dike systems | Alcala-Buntun dike | 34.0 | 6,574,000 |
| Right dike systems | Iguig dike | 4.1 | 196,000 |
| Total, left and right | | 35.4 | 6,770,000 |

The embankment volume is estimated at 6.8 million $m^3$ in total. The material source is conceived as borrow pits near the construction site, abundant fine sand distributing in the river and excavated soil from the San Isidro cut-off channel, which is planned to be conducted in the 3rd phase works with an excavation volume of approx. 9.5 million $m^3$.

The embankment work is planned for a 5-year work period starting in the year 2011 assuming approximately 1.4 million $m^3$ per year rate of embankment. A motor scraper will be used for the Iguig dike embankment to haul the material from the San-Isidro cut-off channel. The embankment operation for the Alcala-Buntun dike, dump trucks will be used for long distance hauling of embankment material from borrows pits or riverbeds.

(Phase 4)

The proposed dike systems in the 4th phase implementation are 33.5 km in total length at 2 sites in the reach from Tuguegarao to Cabagan. The dike length and its estimated embankment volume are summarized below.

| System | Dike name | Length (km) | Embank. Volume ($m^3$) |
|---|---|---|---|
| Left dike systems | Enrile dike | 12.2 | 927,000 |
| Right dike systems | Tuguegarao dike | 21.3 | 3,134,000 |
| Total, left and right | | 35.4 | 4,061,000 |

The embankment volume is estimated at 4.1 million $m^3$ in total. The material source is conceived to be excavated soil from the Tuguegarao cut-off channel, which is planned for the 4th phase works with an excavation volume of approximately 19.1 million $m^3$.

The embankment work is planned for a 6-year work period commencing in the year 2015 assuming approx. 0.7 million $m^3$ rate of embankment per year. From an economical point of view, the embankment operation is planned to use a motor scraper to haul from the Tuguegarao cut-off channel which is situated a short distance from the Enrile and Tuguegarao dikes.

Construction of cut-off channels

(Phase 1)

No cut-off channel is planned in the 1st phase.

(Phase 2)

Gabut cut-off channel is planned to be constructed in the 2nd phase implementation of the Lower Cagayan Flood Control Project. The channel length is 700 m with its excavation volume of approx. 4.6 million $m^3$. The channel is scheduled to be constructed in 4 years construction period in parallel with the left and right dike systems started in the year 2008. A construction sequence will be as follows.

| Step | Works |
|---|---|
| 1 | Excavation of center area of channel under dry condition and temporary stock of excavated material nearby existing Cagayan river |
| 2 | Excavation of end point of channel |
| 3 | Excavation of beginning point of channel |
| 4 | River diversion |
| 5 | Reclamation of old Cagayan river |

The major work is huge amount of common soil excavation. No rock excavation will be required in the channel route. It is proposed firstly that the excavated soil will be utilized for the reclamation material for the existing Cagayan river which will becomes as old river channel after the completion of the new cut-off channel. Secondary, the excavated soil will be utilized as the embankment material for the reclamation of low land of the proposed resettlement area.

The channel excavation is scheduled to be conducted in 4 years work period. A standard progress for the excavation requires 1.2 million $m^3$ per year and or 800 $m^3$ per hour assuming workable days of 210 days and 6.5 hours of daily effective operation. For the excavation operation, hauling distance is relatively short. Thus, required major fleet will be as follows to assure the proposed standard progress of the excavation operation for the Gabut cut-off channel.

| No | Equipment | Capacity (class) | No. of unit, required |
|---|---|---|---|
| 1 | Motor scraper | 16 $m^3$ | 5 |
| 2 | Bulldozer | 28 –32 t | 2 |
| 3 | Swamp bulldozer | 21 t | 2 |
| 4 | Tractor shovel | 2 $m^3$ | 2 |
| 5 | Dump truck | 12 – 20 t | 10 |
| 9 | Backhoe | 0.6 – 1.2 $m^3$ | 2 |

(Phase 3)

San Isidro cut-off channel is planned to be constructed in the 3rd phase implementation. The channel length is 1,600 m with its excavation volume of approx. 9.6 million $m^3$. The channel is scheduled to be constructed in 5 years construction period in parallel with Alcala-Buntun and Iguig dikes embankment operation started in the year 2011. The same construction sequence is same as in 2nd phase will be applied.

No rock excavation will be required in the channel route. The excavated soil should also be effectively used in a same manner as in the 2nd phase.

The channel excavation is scheduled to be conducted in 5 years work period. A standard progress for the excavation requires 1.9 million $m^3$ per year. For the excavation operation, hauling distance is relatively short. Thus, same type of earthmoving equipment to the 2nd phase implementation will be applied to assure the proposed standard progress of the excavation operation for the San Isidoro cut-off channel.

(Phase 4)

Tuguegarao cut-off channel is planned to be constructed in the 4th phase implementation. The channel length is 5,800 m with its excavation volume of approx. 19.1 million $m^3$. The channel is scheduled to be constructed in 6 years construction period in parallel with Tuguegarao and Enrile dikes embankment operation started in the year 2015. The same construction sequence applied in 2nd and 3rd phases will be applied from the downstream toward upstream.

The excavated soil should also be effectively used as in the preceding phases.

The channel excavation is scheduled to be conducted in 6 years work period. A standard progress for the excavation requires 3.2 million $m^3$ per year. For the excavation operation, hauling distance is relatively short. Thus, same type of earthmoving equipment as for the 3rd phase implementation will be applied to assure the proposed standard progress of the excavation operation for the Tuguegarao cut-off channel.

<u>Non-structural measures</u>

Evacuation system and resettlement area developments are proposed as the non-structural measures in the Lower Cagayan River Flood Control Project. The evacuation system comprises 1) Flood Forecasting and Warning System (FFWS) and 2) construction of evacuation center. The FFWS is comprised the following works:

- Improvement of the existing local FFWS facilities in the Cagayan river basin, but excluding a communication system between local and central system.
- Introduction of Tuguegarao River water level station and local communication network among sub-center, disaster coordinating councils

and evacuation centers.

- Strengthening of Tuguegarao sub-center and community disaster management capacity building in Tuguegarao.

The construction of evacuation center comprises the following work items:

- Procurement and construction of tents, deep wells, evacuation centers, cooking tools and other requirements related to the evacuation system.
- Improvement for the evacuation centers and strengthening of disaster coordinating councils and peoples` capability in the evacuation-related activities such as preparation of disaster preparedness plan.

The FFWS and construction of evacuation center are scheduled to implement incorporated into the 1st phase.

The following works are required on the proposed resettlement area development:

- Land acquisition and compensation
- Development of resettlement area
- Construction of public facilities, such as schools, barangay halls
- Construction of infrastructures such as roads, electric power lines, water supply

The resettlement area development is scheduled to be implemented to meet the phased implementation of the Lower Cagayan River Flood Control Project.

Supporting measures

As the supporting measures of the flood control projects, institutional establishment among the water code for the rules and regulations, operation and maintenance system, and implementation structure will have to be conducted to meet and following to the phased implementation of the Lower Cagayan River Flood Control Project.

### 13.2.3 Irrigation Projects

(1) General

For irrigation projects, phased implementation is also applied to meet to the implementation schedule of the flood control projects. The proposed irrigation project is Alcala Amulung West Pump Irrigation Project (AAWPIP) and is arranged as follows in terms of phasing.

| Phase | Project | Development area (ha) |
|---|---|---|
| 1st (2002-2007) | Alcala Amulung West PIP, stage 1 | 4,090 |
| 3rd (2007-2015) | Alcala Amulung West PIP, stage 2 | 2,970 |

(2) Priority Project

The priority project, AAWPIP, is planned to develop in 1st and 3rd phases for 7,060 ha in total area. Stage wise development is proposed, namely stage 1 of 4,090 ha which locates in the higher plain and stage 2 of 2,970 ha which locates in the lower plain based on the existing topographic conditions. The objective area for stage 1 can be developed in early stage even without implementation of the flood control project, which stage 2 area is to be developed after the implementation of the flood control project to prevent possible inundation. So, it is scheduled to implement the stage 1 in the 1st phase and the stage 2 in the 3rd phase of the overall implementation of flood control projects by target year of 2020.

(3) Construction Plan and Schedule

General

The project site locates in the left bank of Lower Cagayan River and opposite site of Amulung town. The project is pump irrigation system by using surface water of Cagayan River. The construction period of the AAWPIP in stage 1 is scheduled at 4 years started in 2004 as shown in Figure 13.2.4. The construction plan on the AAWPIP is presented briefly as follows.

Construction of intake pump and booster pump station

The intake and pump station site is selected on stable bank at the opposite site of Alcala town. The foundation will be the rock that N value more than 30 at 2 to 7 m below ground surface according to the investigation by NIA. Thickness of overburden materials is assumed at 3 to 16 m.

An intake will be constructed by open canal system equipped with mechanical screens. The pump head is 20.0 m. The pump type is of vertical mixed flow with volute casing of 900 mm diameter. The number of pump unit and electric motor is planned at 8 sets each in total for stage 1 and 2, 4sets each for stage 1 and stage 2 respectively. The capacity of electric motor plans at 500 kW for each unit. A pump house constructs having 500 $m^2$ of floor space in total as for stage 1 and 2.

Major construction items and its work quantities for the intake and booster pump stations are tabulated as follows for stages 1 and 2 works.

| No | Major construction items | Unit | Q`ty, stage 1 | Q`ty, stage 2 |
|---|---|---|---|---|
| 1 | Intake pump station | | | |
| | 1) Transmission line expansion | km | 5 | 0 |
| | 2) Pump and motor | set | 4 | 4 |
| | 3) Excavation, rock | $m^3$ | 20,000 | 20,000 |
| | 4) Building | $m^2$ | 500 | 0 |
| 2 | Booster pump station | | | |
| | 1) Pump and motor | set | 4 | 4 |
| | 2) Excavation | $m^3$ | 500 | 0 |
| | 3) Building | $m^2$ | 200 | 0 |

The construction works of the intake and booster pump stations are categorized as 1) civil works, 2) Electro-mechanical works, and 3) building works. The intake civil works will be carried out by partial coffer the Cagayan river and applying earthmoving equipment.

To procure pump, motor and other electro-mechanical equipment from abroad, 1 year will be necessary including the design, manufacturing and transportation. For installation, another 1-year will be required. Required power for the pump operation will be supplied from the existing national grid of 69 kV passing through the right bank the Cagayan river by extension of transmission facilities crossing the Cagayan river are required to construct. Pump house building will have to be completed before arrival of the electro-mechanical equipment to the site. The following equipment will be introduced for construction of intake and booster pump stations in stage 1.

| No. | Equipment | Capacity (class) | Number of unit, required |
|---|---|---|---|
| 1 | Bulldozer | 21 t | 2 |
| 2 | Backhoe | 0.6 $m^3$ | 2 |
| 3 | Tractor shovel | 1.2 $m^3$ | 2 |
| 4 | Dump truck | 12 t | 5 |
| 5 | Concrete mixer | 0.3 –0.5 $m^3$ | 3 |
| 6 | Truck crane | 20 t | 2 |
| 7 | Giant breaker, hydraulic | 1,300 kg | 2 |

<u>Construction of main irrigation and drainage system, on-farm system</u>

Concrete lined main and lateral irrigation canals are constructed. Farm ditches are constructed by earth. Total canal length to be constructed is approx. 140 km. Basically, existing natural drains is planned to be used as for the drainage system. However, construction of about 20 km long new drainage canal is required.

Major construction items and its work quantities for the irrigation and drainage canal system with related structures are tabulated as follows.

| No | Major construction items | Unit | Q`ty, stage 1 | Q`ty, stage 2 |
|---|---|---|---|---|
| 1 | Main canal | km | 27.5 | 0 |
| 2 | Related structures to main canal | nos. | 90 | 70 |
| 3 | Lateral canal | km | 29.5 | 32.3 |
| 4 | Related structures to lateral canal | nos. | 74 | 70 |
| 5 | On-farm system | ha | 0 | 150 |
| 6 | Main drainage system | km | 28 | 10 |
| 7 | Related structure, main drainage system | nos. | 30 | 25 |
| 8 | Pangul river training | LS | 1 | 0 |

Excavation and embankment volume are estimated at approx. 1.1 million $m^3$ and 1.0 million $m^3$ respectively in stage 1. Excavated soil will be used as the embankment material in principle. Related structures will be constructed in parallel with the canal construction. The following equipment will be introduced for construction of irrigation and drainage canals with the related structures in stage 1.

| No. | Equipment | Capacity (class) | Number of unit, required |
|---|---|---|---|
| 1 | Bulldozer | 21 t | 2 |
| 2 | Backhoe | 0.6 $m^3$ | 3 |
| 3 | Dump truck | 12 t | 6 |
| 4 | Vibration roller | 5 t – 10 t | 3 |
| 5 | Concrete mixer | 0.3 –0.5 $m^3$ | 3 |
| 6 | Truck crane | 20 t | 2 |

Supporting measures

Rice mill plant and drying yard will be introduced in the 1st stage to meet the development scale of paddy field as the supporting measures for the irrigation projects.

## 13.3 Mode of Construction Execution

### 13.3.1 Implementation Mode

The proposed structure measures both for the flood control and irrigation projects in the 1st phase will be implemented under the following formation.

- Urgent bank protection works by selected contractor under the international competitive bid.
- River tree zones: by LGUs
- Flood control works and irrigation development by selected contractor under the international competitive bid.

### 13.3.2 Implementation Schedule

(1) Overall Implementation Schedule

Flood control projects

Phased implementation for the priority projects in the Lower Cagayan River Flood Control Project was proposed aiming at the target year of 2020 as shown in Figure 13.2.1 as overall implementation schedule. The proposed implementation schedule on the flood control project is presented for implementation in order from the river mouth to upstream so as not to cause negative impacts against upstream and downstream reaches.

Irrigation projects

The proposed irrigation sub-projects are also implemented by phasing the stage 1 and 2 following to the implementation schedule of the flood control projects. The period of the stage 1 is 6 years from 2002 to 2007, while that of the stage 2 in 8 years from 2008 to 2015.

(2) Implementation Schedule, 1$^{st}$ Phase

Flood control projects

The followings are the basic concepts to implement the proposed flood control projects.

- To implement from the river mouth toward upstream for main construction works
- To conduct by dividing into several construction packages for main construction works
- To commence the proposed bank protection works in an early stage
- To commence the construction of river tree zones in an early stage

The following 4 priority sub projects are planned to be implement in the 1$^{st}$ phase of the Lower Cagayan River Flood Control Project.

1) Urgent bank protection works at 21 sites
2) River tree zones
3) Left dike system reaches from the rivermouth to Magapit, Mabanguc and Catugan dikes
4) Right dike system reaches from the rivermouth to Magapit, Camalaniugan and Lal-lo dikes.

Total implementation period for the 1$^{st}$ phase is scheduled at 6 years including the lead time and the construction execution. Figure 13.2.2 and 13.2.3 show a proposed implementation schedule and construction time schedule in the 1$^{st}$ phase.

The lead time for the main works in the 1st phase is assumed under the following activities and its duration required.

| Activities | Duration (month) |
|---|---|
| Financial arrangement | 6 |
| Selection of consultant | 6 |
| Tender design | 12 |
| Tendering and contract | 12 |

As described in Subsection 11.2.1 and 12.2.3, special consideration are given for the provision of riverbank tree zone for the river channel improvement works. Then, in the construction plan of the flood control project, the particular item is given for the construction of the riverbank tree zone.

Urgent bank protection works should be arranged in the initial stage for its tender design and tendering. Land acquisition and compensation on the right of way for dikes and tree zones start first ahead of the above respective construction works. Similarly, resettlements except the right of way in the river area, which is defined as an open space confined by both the left and right dikes, are carried out concurrently with the above respective works.

Irrigation project

The followings are the basic concepts to implement the proposed irrigation project.

- To implement following the flood control projects
- To conduct by contract basis
- To commence from the higher plain to protect from probable inundation

The priority project, Alcala Amulung West Pump Irrigation Project (AAWPIP) of 4,090 ha, the stage 1 out of 7,060 ha, is planned to be implement in a period of 6 years. Activities required in the lead time for irrigation project are same to the flood control project. Land acquisition and compensation, development of resettlement and evacuation are carried out prior to or in initial stage the construction execution. A proposed construction time schedule for the irrigation project in the 1st phase is shown in Figure 13.2.4.

### 13.3.3 Funding / Finance

- National Government and LGUs should share project cost.
- The following cost sharing is assumed in principle according to the practice in the Philippines for flood control projects:
  - Main construction works will be undertaken by the National Government with its finance.

- LGUs will undertake resettlement, and tree zone construction.

The cost required for the structural measures will be funded by both Philippines Government for local currency portion and from possible foreign funding sources for foreign currency portion.

### 13.3.4 Contract Package and Bidding Mode

The contract package and bidding mode are proposed as shown in the table below for the main construction works in the 1st phase taking into consideration of type and scale of construction works required and expected finance source.

| Package Number | Scope of construction works | Mode of bid* |
|---|---|---|
| Flood control | | |
| Package A | Urgent bank protection works, 21 sites | ICB |
| Package B | Left and right dike systems, 43.3 km | ICB |
| Irrigation | | |
| Package C | Alcala Amulung West Pump Irrigation Project, stage 1 | ICB |

* LCB: Local Competitive Bid, ICB: International Competitive Bid

### 13.3.5 Accredited Contractor in Region 2

The Philippine Contractors Accreditation Board published the "Rules and Regulations on Governing Licensing and Accreditation of Constructors in the Philippines". Contractors in Philippines are classified and categorized under this rules and regulations.

The classification means that the area of operation wherein a constructor can engage in based on the technical experience of his sustaining technical employee. It is classifying 1) General Engineering, 2) General Building, and 3) Specialty.

The category indicates the graded level of aggregate capability of a constructor based on pre-determined criteria which include financial capacity, equipment capacity, experience of firm, and experience of technical employees. The category is AAA, AA, A, B, C, and D. The number of contractors accredited in DPWH region 2 is 15 in total, among which 2 and category AAA and 13 on category A. Stock holders` equity of Pesos 10 million and 1 million respectively are for minimum requirement of financial capability for category AAA and A respectively.

### 13.3.6 Implementation Organization

Figure 13.3.1 shows a proposed implementation organization for the contract basis construction execution for the flood control and irrigation projects in the 1st phase.

## 13.4 Cost Estimate

### 13.4.1 Conditions and Assumptions for Cost Estimate

(1) Constitution of Project Cost

The project cost estimates were prepared with the following cost composition and approaches:

<u>Structural measures</u>

| No. | Project cost items | Notes |
|---|---|---|
| 1 | Direct construction cost | Estimated, refer to S. Report |
| 2 | VAT (Value Added Tax) | 10% of 1 |
| 3 | Sub total | |
| 4 | Land acquisition, compensation cost | Estimated, refer to S. Report |
| 5 | Administration expenses | 3% of 1 |
| 6 | Engineering services expenses | 12% of 1 |
| 7 | Sub total | |
| 8 | Price contingency | 5% p.a. for LC, 2% p.a. for FC |
| 9 | Sub total | |
| 10 | Physical contingency | 8% of 9 |
| 11 | Total | |

<u>Non-structural measures and supporting measures</u>

| No. | Cost items | Notes |
|---|---|---|
| A | Non-structural measures | |
| 1 | Evacuation system | |
| | 1) FFWS | Estimated, refer to S. Report |
| | 2) Evacuation center | Estimated, refer to S. Report |
| 2 | Resettlement area development | |
| | 1) Land acquisition and compensation | Estimated, refer to S. Report |
| | 2) Development of resettlement area | Estimated, refer to S. Report |
| | 3) Construction of public facilities | Estimated, refer to S. Report |
| | 4) Construction of infrastructures | Estimated, refer to S. Report |
| B | Supporting measures | Estimated, refer to S. Report |

(2) Direct Construction Cost

The direct construction cost is estimated by multiplying work quantity and unit construction cost in principle, except for lump sum items such as preparatory works. The work quantity is estimated based on project layout, outline dimensions of structures, and proposed capacities of the facilities.

(3) Unit Construction Cost for Structural Measures

The unit construction cost of each work item is determined by the following manner as tabulated in ANNEX IX.

- Providing the breakdown for major items such as huge volume of embankment and excavation.

- Unit construction cost in 1987 Master Plan using price deflator upon review of it.
- Referring the unit price obtained from DPWH and the recent bidding data of similar projects in the Philippines.

(4) Unit Cost of Land Acquisition and Compensation for Non-structural Measures

Unit cost for land acquisition and compensation estimates were prepared by referring to data from the Provincial Assessor's Office, DPWH, LGU(s) and other agencies concerned in Region 2. The unit costs are listed in ANNEX IX.

(5) Price level is June 2001

(6) Exchange rates used in the cost estimate are US$ 1.0 = Pesos 50.0 = JY 120.0

(7) Classification of Local and Foreign Currency Portions

The cost estimate is made in local currency (LC) and foreign currency (FC) portions. The classification criteria of LC and FC is as follows:

(Local Currency Portion)

- Labor costs
- Locally available materials
- Inland transportation cost for materials to be imported
- Value Added Tax (VAT)
- Government administration expenses
- Land acquisition and compensation
- Evacuation system cost excluding foreign currency portion of FFWS
- Resettlement area development cost
- Local portion of engineering services expenses
- Contingencies for local portion.

(Foreign Currency portion)

- Cost of materials and facilities to be imported
- Depreciation cost of construction equipment
- Foreign currency portion of FFWS as a component of evacuation system
- Foreign portion of engineering services expenses
- Contingencies for foreign portion

(8) Rate of FC and LC portion

Following to the classification criteria for FC and LC and a proposed construction plan, the rate of foreign and local currency portions is as follows for the direct construction cost of the 1st phase implementation:

| Sector / Projects | FC Portion (%) | LC Portion (%) |
|---|---|---|
| 1. Flood control projects | | |
| 1) Urgent bank protection works | 50 | 50 |
| 2) Left dike system | 66 | 34 |
| 3) Right dike system | 66 | 34 |
| 2. Irrigation projects | | |
| 1) AAWPIP, stage 1 | 50 | 50 |

### 13.4.2 Project Cost for Flood Control Projects

Available fund is unclear at present to implement the project. So, the project cost was estimated by 2 alternatives that is to implement divided into 4 phase and other in 3 phase in the year 2002 to 2020 for the Lower Cagayan River Flood Control Project.

(1) Project Cost in 4 Phases

The project cost for the Lower Cagayan River Flood Control Project has been worked out among the 1) structural measures, 2) non-structural measures, and 3) supporting measures divided into 4 phases aiming at the target year of 2020 as shown in Table 13.4.1 to 13.4.5 and summarized in table below:

Unit: million Pesos

| Phase / Implementation Period | Total | FC | LC |
|---|---|---|---|
| Phase 1 (2002-2007) Rivermouth to Magapit | 2,786 | 1,448 | 1,339 |
| Phase 2 (2004-2011) Magapit to Amulung | 2,828 | 1,445 | 1,383 |
| Phase 3 (2007-2015) Amulung to Tuguegarao | 4,420 | 2,337 | 2,083 |
| Phase 4 (2011-2020) Tuguegarao to Cabagan | 5,347 | 3,156 | 2,190 |
| Total | 15,381 | 8,385 | 6,996 |
| Total, equivalent US$ (million) | 308 | 168 | 140 |

This phasing is recommendable implementation compared with 3 phase based on the financial and management aspects.

The project cost for the implementation of phase 1 in the Lower Cagayan River Flood Control Project was worked out at Pesos 2,786 million or equivalent US$ 55.7 million of which will be shared by respective agencies concerned as presented in table below:

Unit: million Pesos

| Measures | Agency | Cost Sharing | Cost |
|---|---|---|---|
| Structural measures | National Government | 1) Main works including all indirect cost <1 | 2,336.4 |
| | | 2) Land acquisition and compensation | 55.0 |
| | LGUs | 1) Tree zone construction and planting | 19.2 |
| Non-structural measures | National Government | 1) Cost for evacuation system | 39.9 |
| | | 2) Construction of public facilities for resettlement area | 0 |
| | LGUs | 1) Land acquisition and compensation of resettlement area | 23.9 |
| | | 2) Evacuation center | 138.3 |
| | PAGASA | 1) FFWS <2 | 143.3 |
| Supporting measures | National Government | 1) Institutional establishment and implementing structure | 30.0 |

Note <1: including VAT, administration expenses, E/S, contingencies for structural, non-structural and supporting measures

Note <2: including 1) improvement of FFWS and EEWSDO facilities, 2) Special FFWS and disaster management in Tuguegarao, and 3) contingency of 1) +2) only.

Disbursement schedule in phase 1 implementation is shown in Table 13.4.6.

(2) Project Cost in 3 Phases

As an alternative, the project cost by 3 phase implementation for the Lower Cagayan River Flood Control Project was estimated as tabulated in ANNEX IX and summarized in table below.

Unit: million Pesos

| Phase / Implementation Period | Total | FC | LC |
|---|---|---|---|
| Phase 1 (2002-2007) Rivermouth to Nassiping | 4,603 | 2,547 | 2,055 |
| Phase 2 (2006-2013) Nassiping to Buntun Bridge | 5,527 | 2,456 | 3,071 |
| Phase 3 (2011-2020) Buntun Bridge to Cabagan | 5,205 | 3,255 | 1,950 |
| Total | 15,335 | 8,258 | 7,076 |
| Total, equivalent US$ (million) | 307 | 165 | 142 |

This phasing is not recommendable due to financial aspect that seems too big investment in 1$^{st}$ phase.

### 13.4.3 Project Cost for Irrigation Projects in 4 Phases

The following is the project cost for the AAWPIP:

Unit: Million Pesos

| Phase / Implementation Period | Total | FC | LC |
|---|---|---|---|
| Phase 1 (2002-2007) | 1,626 | 763 | 863 |
| Phase 3 (2007-2015) | 982 | 479 | 503 |
| Total | 2,608 | 1,242 | 1,366 |
| Total, equivalent US$ (million) | 52 | 25 | 27 |

### 13.4.4 Cost of Phase 1 Project Including AAWPIP Stage 1 and Its Disbursement Schedule

Total cost of the Phase 1 flood control project including AAWPIP stage 1 is estimated as 4,412 million Pesos. Disbursement schedule for the Phase 1 Project is shown in Table 13.4.6.

## 13.5 Operation and Maintenance Costs

<u>Flood Control projects</u>

Annual operation and maintenance costs (O&M) estimates at Pesos 7.93 million or US$ 158,600 in total for phase 1 in 4 phases implementation as detailed in ANNEX IX.

<u>Irrigation projects</u>

Annual operation and maintenance cost estimates at Pesos 30.0 million or US$ 600,000 for stage 1 of 4,090 ha covering the 1) intake and booster pump stations, 2) irrigation and drainage canal systems, and 3) other related facilities as detailed in ANNEX IX.

# CHAPTER 14 IMPLEMENTATION PLAN

## 14.1 General

This chapter presents the implementation plan of the 1st phase project that have been presented in the previous Chapter. The implementation plan herein includes implementing organization and implementing schedule.

## 14.2 Implementing Organization

(1) 1st Phase Projects

The 1st Phase projects recommended are;

a) Flood control projects for the Lower Cagayan including structural and non-structural measures and

b) Alcala-Amulung West Pump Irrigation Project (AAWPIP) including irrigation system construction and supporting measures for improvement of farmer's livelihood.

The Projects components are enumerated below in connection with implementing agencies which may be assumed under the current mandates given to them.

| Project component | Implementing agency Under current mandates |
|---|---|
| 1) Flood Control Project | DPWH |
| a) Structural measures | |
| • Urgent bank protection works | DPWH |
| • Dike system work | DPWH |
| • Tree zone construction | LGUs assisted by DPWH |
| b) Non-structural measures | |
| • Evacuation system | |
| - FFWS | PAGASA and DPWH |
| - Evacuation center | LGUs, DPWH & DCCs |
| - And other related facilities | |
| • Resettlement area development | |
| - Area development | DPWH, DA and LGUs |
| - Supporting measures for sustaining livelihood of resettles | LGUs, DPWH and NIA/DA |
| c) Supporting Measures | DPWH /DA with LGUs |
| 2) Irrigation Project | |
| a) Irrigation system development | DA / NIA |
| b) Supporting measures | DA / NIA |
| - Livelihood improvement program | DPWH / DA and LGUs |
| - Other supporting measures to improve farmer's income | DPWH / DA and LGUs |

(2) Organization

As explained in CHAPTER 10, the implementing organization for the projects and programs recommended in the Master Plan is rather comprehensive to implement inter-agency projects and programs.

The first phase construction works are limited to the Lowermost Cagayan Flood Control Project and AAWPIP. Therefore, the more simple system will be applied.

1) Basic Concept of the Organizational set-up

The basic considerations of the organizational set-up are as follows.

a) Cooperation with National Government and LGUs is considered.
b) Currently existing agencies will be involved as much as possible for the implementation of such works that may be executed within given mandates.
c) For the 1$^{st}$ phase implementation, Coordination system will be applied.
d) The organization for the 1$^{st}$ Phase implementation should be more flexible for future extension and / or transformation to the commission system in the next stage.

2) Organization

Proposed organization chart is shown in Figure. 14.2.1.

1) Superintendence by DPWH

DPWH will be a leading agency for the 1$^{st}$ Phase Project implementation. DPWH will be a superintendent for whole the projects getting all together the Flood Control Project and Irrigation Project.

2) Coordination Committee

Coordination Committee will be created. The members of the Coordination Committee will consist of all the water-related agencies such as DENR, DA, NWRB, PAGASA and OCD from the National Government, and all members of Disaster Coordinating Council in Regional, Provincial, City / Municipality / and Barangay levels and Regional and Provincial Development Councils. The consultant will be employed as advisers for the Coordination Committee as well as for the project supervision.

3) Project Management Office (PMO)

Two PMOs will be established one each for Flood Control Component and Irrigation Component. The former will be led by DPWH and the latter by DA / NIA.

The member of the PMO for flood control component will be the representative of NWRB, PAGASA, and LGUs.

The member of the PMO for irrigation component will be DA / NIA and LGUs.

4) Sub-Project Management Office (Sub-PMO)

Sub-PMOs will be set-up in each sub-component of the project such as:

***Sub-PMO for Flood control component:***

a) Flood control structural measures: DPWH, PMO-MFCDO & Regional Office R-2
b) FFWS: PAGASA and DPWH
c) Evacuation center and other facilities: DPWH and Disaster Coordinating Councils
d) Resettlement area development: DPWH and DA with LGUs (Some resettlement will also be needed in Irrigation project implementation)

***Sub-PMO for Irrigation Component:***

a) Irrigation system construction: DA / NIA
b) Supporting measures: DA / NIA
   Most important activity of the Sub-PMO for supporting measures is to promote the livelihood program for resettled people.

## 14.3 Implementation Schedule of Preparatory Works

Construction schedule for the 1st Phase works has been presented in the previous Chapter. Herein presented is specifically for preparatory arrangement of the Implementation.

(1) Preparatory Works Required

For the smooth commencement of the project implementation, the following preparedness is essential. This statement is given on the assumption that the GOP will look for the financial assistance from foreign lending institutions since this project seems to be big in terms of the project cost beyond the financial capacity of the GOP.

1) Review of law and regulation

As described in CHAPTER 2, there are some problems in the current law and regulations. To eliminate such problems in the implementation of this proposed projects, existing and current law and regulations should be reviewed and revised regulation should be enforced immediately. The necessary revisions, only which are urgently needed, are enumerated below.

   a) Designation of Major Rivers together with river administration for the Cagayan River
   b) Definitions and designations of river area and flood control area
   c) Use of land in river area to eliminate illegal settlement there

2) Memorandum of agreement (MOA) among the agencies concerned
   a) MOA between DPWH and LGUs concerned
   b) MOA among the DPWH and related National Government concerned

3) Clearance of the river area
   a) Relocation of people to be affected by the construction works
   The agreement with the people to resettle in the other areas will be at least necessary before asking foreign assistance. The commitment of foreign assistance may be made after confirmation of the people's agreement.
   b) Land acquisition plan including land ownership survey

4) Preparation of organizational set-up for the project implementation
   a) Preparation of organizational se-up so that it can be realized immediately after the project implementation is decided.

5) Preparation of Implementation Program for asking foreign financial assistance

6) Other necessary arrangement in accordance with current regulation of GOP such as ICC clearance, ECC clearance, etc.

(2) Schedule of Preparatory Works

As presented in the previous Chapter, the financial arrangement should be completed by the end of 2002 next year. To achieve this target, all the preparatory works above mentioned should be completed by the middle of 2002 at the latest.

It is recommended that GOP take necessary actions immediately since no time allowance is available.

# CHAPTER 15 PROJECT EVALUATION

## 15.1 Environmental Assessment

### 15.1.1 Natural Environmental Assessment

(1) Project Description and Impact Activities

The proposed projects are composed of the flood control project and the irrigation development project. The detailed project components are described in CHAPTER 12.

The impact activities can be enumerated corresponding to the phases of the proposed projects: pre-construction phase, construction phase and operation phase. Regarding flood control project, the prime impact activities during pre-construction phase include land acquisition for dikes, cut-off channels and resettlement, or relocation of households being located on acquired lands. The impact activities during the construction phase include plantings in riverbank forest zones, construction works, transportation of construction materials and excavation works. During the operation phase, several factors such as the presence of dikes, forest zones and cut-off channels, are considered to act as impact factors.

As for irrigation development project, on the other hand, the prime impact activities during pre-construction phase include survey of irrigation sites such as geologic survey, topographic survey and hydrological survey. During the construction phase, land preparation, transportation of construction materials and equipments, construction of irrigation and drainage channels, and construction of pump station and transmission line will be the major impact activities. The impact activities during operation phase include the presence of irrigated paddy fields, the operation of pump station, the presence of irrigation and drainage channels and the use of agricultural chemicals and fertilizer.

(2) Prediction of the Impacts

1) Flood Control Project

Conceivable impacts of proposed flood control project on natural environment are summarized as Table 5.3.1 (ANNEX V, Supporting Report).

Basically, the proposed flood control project is not such that generates toxic or hazardous substances, nor that involves dangerous structures, but that improves the river environment in terms of reducing flood risks.

Accordingly, the project cannot act as a source of public pollution or danger. Looking into deeply and carefully every component of the projects, however, it has revealed that the project would cause negative impacts if there would be no adequate considerations about the environment.

Several impacts accompanied by the construction works such as turbid water flows, air and noise pollutions and traffic disturbances will be the significant negative impacts. Turbid water flows would be generated in construction sites during the rainy days in particular. Air and noise pollution as well as traffic disturbance will be caused by heavy construction machinery and transportation vehicles, which may affect the nearby residents of the construction sites and transportation routes.

Cagayan river system is providing a habitat for aquatic organisms, which is manifested by the fact that there are some 50 species of fishes in the river. The implementation of the project would cause some impacts on aquatic organisms, especially on nektons such as Banak (*Mugil caeruleomatus*), Catfish (*Arices manilensis*), Eel/Igat (*Angilla marmorata*), Goby (*Glossogobius giurus, G. celebius*) in the form of habitat disturbance due to the siltation caused by excavation works.

One of the vulnerable and, at the same time, valuable fish species in the river is Ludong (*Cestraeus plicatilis*). It is the catadromous fish going downstream to the river mouth when they spawn in the sea and going upstream when they become fry. The proposed flood control project does not involve the construction of dam or weir; hence, it is not considered that the project will affect their migratory habit or life history. The construction and excavation works, however, would generate turbid water flows and a siltation in the Cagayan River, which would have adverse effects on their migratory habit unless any mitigation measures are taken.

Other conceivable impacts including formation of new scenery created by the construction of dikes and cut-off channels, etc. are considered to be minimal as described more in detail in ANNEX V, Supporting Report. Additionally, there would be no impact on the protected areas, because any activities involved in the project will not be undertaken in and around the protected areas.

2) Irrigation Development Project

Conceivable impacts of proposed irrigation development project on natural environment are summarized as Table 5.3.2 (ANNEX V, Supporting Report).

Most of the impacts of irrigation development project on natural environment are the same as that of flood control projects because the project has similar activities to flood control projects. Main impacts include turbid water flows, air and noise pollutions during the construction phase. There would also be the vegetation clearance and the land preparation, which might cause habitat loss and population decrease of aquatic organisms in particular. It is because the current condition of project site (West Amulung-Alcala) that is rather wet, namely marshy area, will be converted into irrigated paddy. Other impacts generated by the irrigation development project are considered to be minor as described in more detail in ANNEX V, Supporting Report.

(3) Mitigation Measures

1) Flood Control Projects

Examples of mitigations and/or enhancement measures were enumerated according to each impact in Table 5.3.1 (ANNEX V, Supporting Report). As for the various negative impacts during construction phase, the mitigation measures in construction sites will be most effective, such as the adjustment of work schedule, keeping good conditions of construction machinery and transportation vehicles and so on. These mitigation measures are to be carried out by contractors concerned under the supervision of DPWH.

Regarding impacts on terrestrial flora and fauna, they are inevitable to some extent as long as the proposed projects are implemented. Possible mitigation measures are transplantation of valuable species when identified during construction works. With respect to Ludong, the most vulnerable species in the Cagayan River system, the adjustment of construction work schedule will be the most practical and effective measure. That is, since the Ludong goes downstream during October to December and goes upstream during February to March passing the lower reaches of the Cagayan River, excavation works should be avoided over these months so as not to disturb their migration by turbid water flow or siltation. Additionally, the establishment of a wall to prevent the turbid water flow or siltation from generating in the Cagayan River could be another measure for mitigation.

2) Irrigation Development Project

Because the impacts of irrigation development projects are almost the same as that of flood control project, the same measures as that for flood construction works will be effective to minimize the impacts (refer to Table 5.3.2 in ANNEX V, Supporting Report).

(4) Evaluation of Impacts on Natural Environment

The results of impacts of both flood control and irrigation development projects on natural environment are summarized in Tables 15.1.1 and 15.1.2.

It is considered that no major impact, regardless of positive or negative, would occur on natural environment for both flood control project and irrigation development project. Most of negative impacts will be generated and will last during the construction phase, whereas all positive impacts are permanent that will last after the completion of the construction.

Regarding the impact zone, primary impacts are considered to occur within planned structure, i.e. dikes and cut-off channels or irrigation development area. The secondary impacts are considered to occur between right and left banks, and near the construction sites and transportation routes. They include air and noise pollution accompanied by construction works and transportation of various construction materials and will not last but confined within construction phase.

As a conclusion, the proposed projects, flood control and irrigation development, will not generate serious negative impacts, provided that all the enumerated mitigation measures are properly done. Therefore, it is considered that the proposed project has an environmental validity.

### 15.1.2 Social Environmental Assessment

(1) Public Participation

Public consultation meeting was held as a part of public participation, aiming at the understanding of candidate/ proposed projects and obtaining feedback for improvement of the plan and/or design. In the course of the feasibility study, the public consultation meetings were held at two phases: the first was held on May 28$^{th}$ and 29$^{th}$, 2001, at the phase of candidate projects, and the second was held on Oct. 2$^{nd}$ ,2001, at the phase of proposed projects.

1) Results of 1$^{st}$ Consultation Meeting

Following the presentation of the candidate projects done by JICA Study Team, the open forum was held. A majority of the participants fully understood the candidate project design. However, there were several concerns raised by them; project logistics, public acceptability, and social impacts on local communities, especially on their livelihood and residency. Nevertheless, almost all of participants accepted the implementation of the candidate projects and many of them are willing to provide support for its early implementation. As a whole, although the objective of the meeting which is to familiarize the LGU officials with the candidate projects was achieved, further consultation meetings seemed to be required, including the presentation of the function and benefits of the project as well as that of the necessity for cost sharing of the implementation.

2) Results of 2nd Consultation Meeting

Following the presentation of the proposed projects done by JICA Study Team, the open forum was held to discuss and confirm the acceptance of the proposed project focusing on the work sharing, resettlement and cost sharing. In this respect, DPWH R-2 explained that principles/ practice of the work sharing and cost sharing are:

- National government would share the main construction works including its development cost and OM cost after their completion.
- LGUs would share the work of land acquisition, resettlement area development and its cost and activities involved, and the cost of minor works such as forest zone construction.

During the open forum, several issues were raised such as administrative boundary, the confirmation of the number of households to be relocated and so on. In response to the issues raised by LGUs, the JICA Study Team took necessary actions to cope with. One of them is the revision of alignment of dikes so as to minimize the number of households to be relocated and to be accepted by concerned municipalities.

After incorporating the LGUs' opinions into the revised basic design, all the concerned LGUs have accepted the project scheme in principle and submitted the *Certification of Acceptance* subject to the approval of the Sangguniang Bayan, or municipality parliament, although several municipalities, Lal-lo, Amulung and Iguig in which the number of households to be relocated is rather big, gave some conditions requesting financial assistances for their work sharing.

(2) Prediction of Impacts

1) Flood Control Project

Conceivable impacts of proposed flood control project on social environment are summarized in Table 6.5.1 (ANNEX V, Supporting Report).

The implementation of the proposed project would cause various kinds of impacts including both positive and negative ones. One of the significant negative impacts is an involuntary resettlement and related issues such as livelihood uncertainty and/or change of living environment as well as community split. The number of households to be affected and of public facilities is listed in Table 15.1.3 by municipality/city and by barangay, which is based on the topographical maps and aerial photographs. The total number of households to be relocated, will be 343 for caused by the alignment of dikes and cut-off channels whereas that for river area, which is the area confined between right and left banks, will be 2,433, summing up to 2,776 in total. Municipality of Iguig will undergo the biggest number of households relocation due to the alignments of dikes and cut-off channels, with 247 households, followed by Aparri (46). Lasam will do the biggest number for river area, with 872 households, being followed by Amulung (738), Iguig (537) and Alcala (250). Among those to be relocated, minority tribes or informal settlers (squatters) are not identified. Aside form the individual households, the affected public facilities such as schools, churches, barangay halls and daycare centers are enumerated to be relocated as listed in the table.

Another negative impacts than the resettlement consists of the impacts on public health caused by air pollution, noise pollution and/or traffic accidents. These impacts, however, will be happened only during the construction phase, namely the impacts will be temporal. No impacts will be spawned on historical and cultural heritages or recreational spots because the planned project sites are apart from them.

On the other hand, the project will bring lots of positive impacts. The proposed projects will involve construction works, which will require contracts with contractors as well as the employment of a lot of laborers, being estimated as more than 5 million man-days in total up to target year of 2020, and some 2 million man-days during 1$^{st}$ phase, year 2008 through 2011, with the peak number of laborers of some 3,000 persons a day. This, in turn, will contribute to boost the local economy. In addition, the proposed project will alleviate the flood risks over flood prone areas along the Cagayan River, and thus, it will contribute to improve the public health, i.e. lessen such water related diseases as diarrheas, malaria, dengue fever and so on, to encourage the education with safer living environment, and to afford business opportunities.

2) Irrigation Development Project

Conceivable impacts of proposed irrigation development project on social environment are summarized in Table 6.5.3 (ANNEX V, Supporting Report).

Irrigation development will also generate various types of impacts, including positive and negative. Most of them are positive ones because the project is planned over existing agricultural area. However, it involves minor land acquisition for resettlement including 9 households. The project will contribute to activate the local economy in various aspects: specifically it will increase the number of new employment generated by the contracts of construction works and its related surveys such as geological, topographical and hydrological ones. Eventually, the irrigation development project will contribute to the increase of farmers' income and to enhance their livelihood.

(3) Mitigation Measures

Examples of Mitigation/ enhancement measures for social environment were enumerated in Tables 6.5.1 and 6.5.3 (ANNEX V, Supporting Report).

1) Flood Control Project

With respect to the impacts on public health caused by construction works, the mitigation measures related to the construction work seem to be effective as mentioned in Subsection 15.1.1.

As for the resettlement, basically the LGUs are responsible for its procedure, including inventory and formulation of resettlement action plans, compensation and resettlement area development as well as livelihood programs for post-mitigation, in collaboration with DPWH, NHA, and pertaining agencies to the Philippine Government. Table 6.6.1 (ANNEX V, Supporting Report) shows the basic conditions and action for resettlement area development to be undertaken for the proposed flood control project. These actions are to be requisite for communities' understanding of resettlement and its implementation.

2) Irrigation Development

Some minor negative impacts on public health should be minimized by construction related actions, which are the same as that of flood control project.

(4) Evaluation of Impacts on Social Environment

The results of impact evaluations on social environment are summarized in Tables 15.1.4 and 15.1.5.

1) Flood Control Project

The impact zones are considered as follows: primary impact zone of the flood control project is considered to be the area within the planned structures, i.e. dikes and cut-off channels, and the secondary impact zones are within the river area as well as the resettlement area.

The impacts caused by land acquisition and relocation of affected households are evaluated as "major negative impact." Other negative impacts are considered minor because the impacts are minimal or temporal, e.g. the impacts on public health caused by construction works. On the other hand, there are several major positive impacts such as contracts and employment of laborers created by construction works involved in the proposed project. As for these negative impacts, especially for the major negative impacts, it is needless to say that the mitigation measures are to be requisite for the implementation of the project.

The results of consultation meetings showed that LGU officials are concerned about the socio-economic impacts, including livelihood, residency caused by the resettlement even though the respective municipalities submitted the Certification of Acceptance on the project implementation. In this respect, further consultation meetings for understanding of benefits and impacts of the project are required.

As a conclusion, the proposed flood control project has an environmental validity, provided that all the enumerated mitigation measures are done properly, and that further consultation meetings are held.

2) Irrigation Development Project

There will be no impacts evaluated as major negative for the proposed irrigation project, although there will be some minor or negligible ones. On the contrary, a lot of positive impacts will be spawned, for example, the improvement of agricultural productivity and contribution to the local economy, which is a part of the purpose of the project. In conclusion, the proposed irrigation project has an environmental validity.

(5) Recommendations

Taking account of the importance of resettlement problem involved in the proposed project, the Study Team recommends the following:

Regarding basic policy for appropriate resettlement measures, the World Bank's Operational Directive 4.30 on involuntary resettlement should be considered to meet in this resettlement case. In addition to the Operational Directive as well as basic conditions and actions listed in Table 6.6.1 (ANNEX V, Supporting Report), the study team recommends the following in purpose of the better understanding for affected people and of facilitating resettlement procedures

1) Setting a Cut-Off Date

Setting a cut-off date (refers to the date of commencement of the census of affected persons with the project area boundaries. Persons not covered in the census are not eligible for claims for compensation.) and keeping it strictly during compensation procedures should be executed by DPWH, NIA and concerned LGUs.

2) Public Participation and/or Public Involvement

In order to agree on resettlement, affected persons are to be informed and consulted with or involved about resettlement plan, such as necessity of resettlement, compensation rates, relocation site and so on.

3) Resettlement Area Development

Resettlement area should be developed near the former residential area as much as possible, at least in the same municipality. In addition, re-settlers should be relocated per unit of one sitio or even one barangay taking into account that they are forming a community.

4) Awareness Building of Re-settlers

There were such cases that re-settlers have spent the compensation money on such purposes as gambles or amusement at another resettlement case. It is important, therefore, to remind them of the purpose of the compensation money or to build the re-settlers' awareness through the public consultations of the resettlement procedures.

5) Setting of Compensation Rate

Compensation rate should be established based on "Policy Framework for Land Acquisition, Resettlement and Rehabilitation," DPWH, established in November 1999. It must not be changed per person once a certain compensation rate was set. Some re-settlers may try to raise the rate in order to get more money, but if overcome by their demand, it would confuse the whole resettlement procedure and take a long time to settle it.

6) Formulation of the Resettlement Action Plan

It is essential to formulate a resettlement action plan, which is to be similar to that for road construction projects funded by the World Bank, including the following schemes with which its procedure would be performed:

- Description of impacts and socio-economic characteristics of project affected persons;
- Compensation rates and entitlement by present land use and by kind of structure;
- Implementation schedule including its approval of stakeholders and resettlement implementation activities; and
- Monitoring and evaluation plan, by which the resettlement will be monitored and evaluated by EIAPO, DPWH, internally and by an independent agency such as NGO or a university, externally.

7) Land Ownership and Acquisition

The Philippine Water Code provides that landownership shall be rendered to the government once incorporated into a river area. In compliance with the Water Code, the river area between right and left banks along the Cagayan River should be owned by the government, which means the landownership is to be transferred from individuals to the government. The transferring of land ownership, however, requires enormous fund for purchasing the land in river area, which discourages LGUs from work sharing especially from cost sharing, even though LGUs are basically responsible for resettlement of affected households.

In this respect, the study team recommends that farmers shall be able to do farming in their land even after the incorporation into a river area, despite the fact that the flood risks would be raised after the construction of dikes since those areas would be confined within the dikes. Furthermore, in return for the admission of farming, complete land acquisition shall not be undertaken but some compensation shall be rendered for the constraint of private rights, namely prohibition of the construction of structures, including houses, shops, etc, in a river area. Thus, an institutional study will be required for setting of a fair and acceptable compensation rate for constraint of private rights mentioned above.

### 15.1.3 Environmental Management Plan

(1) Basic Concept of Environmental Management

The environmental management plan shall provide the environmental components to be managed, criteria for maintenance and evaluation, methodology to manage and the entity or organization to be responsible. The appropriate environmental management plan will contribute to maintain and enhance the current environment and develop an awareness building and a capacity building of all the concerned people through community information, education and communication (IEC) processes.

As for the proposed project, the environmental management plan covers the following components:

***Natural Environmental Components;*** Terrestrial Flora and Fauna, Aquatic Ecology, Protected Area, Water Quality, Air Quality and Noise.

***Social Environmental Components;*** Resettlement including living environment and Informal Settlers, Economic Activities, Public Health and Sanitation, Historical and Cultural Heritage, and Education

Among all the environmental components enumerated in the Guideline on Environmental Consideration, JICA, the components listed above were the ones on which negative impacts would be given by the proposed projects. Additionally, public health and education, which are suffering from problems caused by flooding currently, were chosen to evaluate the positive effects spawned by the implementation of the project.

The criteria for maintenance and evaluation are basically the present conditions and/or environmental standards provided by laws and regulations such as DAO 14, 34 and 35, for the pollution control. With respect to methodology of the management, it should be accomplished by both environmental mitigation measures and environmental monitoring. The environmental mitigation measures are described in Subsections 15.1.1 and 15.1.2, and the environmental monitoring plan will be described in detail in the following section. In the figure, mitigation and/or enhancement measures are to be undertaken by project proponent, i.e. DPWH for flood control project and NIA for irrigation development project. Environmental monitoring and the evaluation of the results of monitoring are to be conducted by the Multi-partite Monitoring Team (MMT), which will be composed of representatives of the project proponents, DENR, LGUs and stakeholder groups or people's organizations and so on, as described in DAO 96-37 and its procedural manual. Based on the results of the evaluation, necessary actions should be taken depending on the characteristics, magnitude and duration of the problems/impacts. Thus, the environmental management should be undertaken timely, forming a “monitoring, evaluation and taking an action” cycle.

(2) Environmental Monitoring Plan

The environmental monitoring consists of two types; a) compliance monitoring and b) environmental surveillance/ monitoring. The compliance monitoring will deal on the implementation of sound mitigation actions and other related measures designed to ensure environmental considerations in the project sites. The environmental surveillance, on the other hand, will focus on measuring the actual impacts of critical activities on environmental components. The monitoring processes are to be conducted following the Procedural Manual for DAO 96-37.

Tables 15.1.6 and 15.1.7 show the monitoring plan and schedule to be followed by the MMT. The monitoring shall cover the construction phase and initial operation phase (a period of one or two years) of the proposed project. The schedule is to be amended from time to time, depending on the actual conditions in the project site and the results of the monitoring.

## 15.2 Economic Evaluation

### 15.2.1 Structure of Flood Control Benefits

Flood control benefit is quantified as effects of reduction of flood damage under without- and with-project conditions. Thus, the flood damage is the most fundamental information for benefit estimation. In this feasibility study (F/S), the flood damage was estimated on the basis of existing damageable assets in flood prone areas and hydrologic simulation analysis.

The structure of flood damage is already discussed in Section 10.3 in Part-II. The structure is illustrated in Table 10.8.1. This F/S study adopts the following damage components for project benefits taking account of data availability. They are (1) direct damages, (2) infrastructure damages and (3) indirect damages. In the F/S study, the project benefits are estimated through bottom-up estimation method. The flood damages were estimated on the basis of actual distribution of damageable assets in the flood prone areas and hydrologic analysis in Cagayan River Basin.

(1) Direct Damage

The components of direct damage are selected taking existing number of facilities and data availability into consideration. They are as follows.

1) Residential building
2) Manufacturing establishment
3) Wholesale and retail trading establishment
4) Educational facility
5) Medical facility
6) Agriculture production

In terms of building property such as residence and industrial facilities, flood damage is calculated with the following formula in general: [unit property value] x [damage rate]. In a more palpable form, the direct damages to buildings, their assets and agricultural production are estimated in mesh-by-mesh through mesh analysis. They are calculated by mesh-by-mesh.

Although average values of the respective facilities will be discussed in the following Subsection 15.3.4, their values in economic terms were shown in Table 15.3.1. The rates of flood damage to the respective facilities are proportionate with inundation depth. These rates are also tabulated in Table 15.3.2. The rates are based on the new manual named "Manual for Economic Study on Flood Control" published by Ministry of Land, Infrastructure and Transport of the Japanese Government in June 1999.

(2) Infrastructure Damage

Infrastructure damage has rarely been recorded sufficiently, although it is usually larger than the damage to building properties and agricultural production. The ratio of infrastructure damage to that of private property is estimated at the range of 0.37 for Tacloban project to 19.47 for Batangas Project, referring to the past flood control projects in the Philippines. In the new manual of Japan, the damage rate of infrastructures was proposed as 169% of the direct damage. The rate seems to be too large taking into account of the flood control studies in the past in the Philippines. Taking consideration of the regional condition in the basin, the ratio for this study is set at 20%.

(3) Indirect Damage

The following components of indirect damage are selected taking account of data availability.

(a) Residence, cleaning away materials damaged after inundation: Its amount is estimated as a product of daily household income multiplying the number of days spent. The number of days is enumerated in Table 15.3.2.

(b) Business losses of private business establishments: Its amount is estimated as a product of daily value added of the business establishment multiplying the number of days closed and stagnated. The number of these days is enumerated in Table 15.3.2.

(c) Other indirect damages including emergency activities, medical care and cure for victims, prevention activities against crimes, etc.: It was presumed to be 10% of the direct damage.

### 15.2.2 Basic Conditions for Economic Evaluation

(1) Method of Flood Damage Estimation

The number of the existing damageable assets in the inundation areas was counted in mesh-by-mesh. A mesh block (1 km by 1 km) was delineated to cover all inundation areas in Lower Cagayan River Basin. The number of damageable assets was counted through 1:10,000 topographic maps. Inundation depth and duration for meshes were prepared through hydrologic simulation analysis. Finally, the flood damage of the respective meshes was estimated applying the formula mentioned in the previous section.

(2) Conversion Factors for Real Economic Values

1) Conversion Factors

Market values are usually distorted by transfer payments such as taxes and subsidies. These transfer payments are transferred to the government which acts on behalf of the society. Then, they should not be treated as cost. These have to be eliminated from the market values of cost and benefit as a whole.

Wages of skilled workers are considered to reflect an opportunity cost of labor, because the workers are usually shortage in the markets. Therefore, the shadow wage rate of skilled workers is set up as 1.0. On the other hand, unskilled workers are in excess in the basin. Thus, the shadow wage rate of unskilled workers is assumed at 0.6 of legislated wage rate.

The shadow exchange rate is assumed at 1.2 of the prevailing exchange rate, as recommended in "ICC Project Evaluation Procedures and Guidelines" by NEDA.

In simplifying conversion from financial market value to real economic value, conversion factors are set up in consideration of the elements discussed above, i.e., transfer payments, shadow wage rate and shadow foreign exchange. The details of the factors were discussed in Supporting Report, ANNEX X.

| | Item | Local/Foreign Separate Estimate | | Local/Foreign |
|---|---|---|---|---|
| | | Local Portion*1 | Foreign Potion | Combined Estimate |
| 1. | Materials | | | |
| | Cement | 0.51 | 1.06 | 0.89 |
| | Aggregate (Coarse and Fine) | 0.68 | 1.04 | 0.83 |
| | Steel | 0.23 | 1.06 | 0.90 |
| | Fuel and Lubricant | 0.38 | 1.06 | 0.85 |
| | Lumber | 0.79 | 1.01 | 0.88 |
| | Others | 0.72 | 1.05 | 0.88 |
| 2. | Machinery and Equipment Rental | 0.27 | 1.13 | 0.87 |
| 3. | Labor | | | |
| | Skilled | 0.93 | - | 0.93 |
| | Unskilled | 0.60 | - | 0.60 |
| 4. | Indirect Costs | | | |
| | Overhead, contingencies and miscellaneous (OCM) | 0.86 | - | 0.86 |
| | Profit | 0.65 | - | 0.65 |
| | Value Added Tax*2 | 0.00 | - | 0.00 |
| 5. | Government Expenditure*3 | 0.95 | - | 0.95 |
| 6 | Engineering Service*4 | - | 1.22 | 1.10 |
| 7. | Standard Conversion Factor | - | - | 0.85 |

Note: *1 Including all taxes national and local in the Philippines
*2 Imposed on item numbers of (2) and (3) only in this form.
*3. For engineering and administrative overhead
*4 Detailed design and supervising services by foreign consultants

All the market values not to be involved in the table above are converted to economic costs applying standard conversion factor (SCF). The economic costs are assumed to be 85% (SCF) of the financial values.

2) Land Value

Land value should be evaluated on the basis of productivity of the land for productive plots such as crop cultivation, and balance of supply and demand for non-productive land such as residential plots. In this study, most lands which would be expropriated for dikes and cut-off channel are located in rural areas. Then, the economic value of land expropriated was evaluated foregone crop cultivation, as negative benefit.

Yet, new urban central zones will be created in the reach from Buntun Bridge to Upstream of Tuguegarao. In this case, the potential values of the new zones are estimated referring to the market value of land, which are considered to be justified on the balance of supply and demand in the market. This is the same as discussed in the review study of the 1987 Master Plan.

(3) Schedule and Evaluation Period

The JICA study team made two alternatives for implementation, i.e., four phases and three phases. Through a comparison analysis of these alternatives, the four phase plan was proposed to be recommendable for the proposed flood control projects. In this section, the four phase plan is discussed hereinafter. The three phase plan, however, is presented in the Supporting Reports, ANNEX X.

| | | |
|---|---|---|
| a) | Base Year | Beginning of 2002 |
| b) | Construction Period | Three phases: 1st phase from 2002 to 2007, 2nd phase from 2008 to 2011, 3rd phase from 2011 to 2015 and 4th phase from 2015 to 2020 |
| c) | Disbursement Schedule | Disbursed in accordance with actual construction schedule during the construction period above |
| d) | Economic Life | 50 years after the completion of the project |
| e) | Evaluation Period | 56 to 68 years including preparatory works such as detailed design and construction period, and economic life of the project scheme |
| f) | Timing of Benefits Accruing | The benefit accrues in proportion to the progress of the construction works for flood control scheme. Regarding cut-off channels, after the completion. In terms of irrigation scheme, the benefit starts just after the completion and the matured benefit accrues five years after the completion. |
| g) | Social Discount Rate | 15% per annum |

(4) Future Damageable Assets

Socio-economic conditions in the basin will be improved in accordance with the growth of regional economy. Then, the damageable assets could increase along with the growth of socio-economic conditions. Thus, the flood mitigation benefit would increase, and it could be estimated on the basis of socio-economic projection. They are based on population increase, improvement of people's living standard, growth of economic activity in various industries and expansion and rehabilitation of irrigation systems in the basin areas.

### 15.2.3 Distribution of Damageable Assets

Distribution of damageable assets is worked out on the basis municipal information. The inventory of damageable assets in every municipality is given or estimated on the basis of results of the population and housing census, results of establishments' survey of the respective economic sub-sectors, land use maps, topographic maps, administrative municipal map, and socio-economic data.

As regard housing units, the distribution was figured out through the following procedure. The distribution of housing units by mesh was counted through the topographic map. The total number of dwelling units is verified in the 2000 population census. Through this estimation procedure, the number of residential buildings in the potential flood area of the Lower Cagayan River Basin was counted at 85,500 units in total. In terms of other damageable assets such as industrial establishments and crop cultivation lands, their inventory was identified in the same procedure.

The table below shows the distribution of aforesaid facilities and croplands in the potential flood area for 2-year, for 25-year and for 100-year return periods.

| Item | 2-Year Return Period | 25-Year Return Period | 100-Year Return Period |
|---|---|---|---|
| Population (1000) | 105 | 390 | 422 |
| Housing Units (1000) | 22 | 78 | 84 |
| Manufacturing | 152 | 651 | 716 |
| Trading | 308 | 1,517 | 1,738 |
| Educational Facility | 67 | 269 | 288 |
| Medical Facility | 26 | 110 | 129 |
| Agricultural Lands (1000 ha) | 23 | 49 | 51 |
| Irrigated Fields | 6 | 19 | 20 |
| Rainfed Fields | 17 | 30 | 31 |

### 15.2.4 Unit Value of Damageable Assets

(1) Housing Units

Housing unit is classified into four types in general: permanent (Type I), semi-permanent (Type II), strong material (Type III) and makeshift (Type IV). A unit construction cost (Pesos per m²) of new house is estimated in provincial assessor's office as follows: 5,370 Pesos for Type I, 3,450 Pesos for Type II, 2,130 Pesos for Type III and 900 Pesos for Type IV. The average floor area was 29 m² and the average age of dwelling units was 12 years, according to the 1990 census. Based on these data, the average market value was estimated at 121,469 Pesos for Type I, 70,035 Pesos for Type II, 35,209 Pesos for Type III and 12,528 Pesos for Type IV. The building types were composed of: 13,800 units or 10% of the total units of Type I/II, 35,900 units or 27% of Type III and 85,800 units or 63% of Type IV in 1990. Applying this distribution ratio to the value information above, the weighted average market value was estimated at 27,000 Pesos per unit.

It is said that an assessed value for taxation purposes is smaller than an actual market value. The distortion between these assessed value and actual market value is not clear. Although it is shrinking gradually, the difference of between the two is still 200% to 300%, according to an authority. In this current study, thus, the actual market value of dwelling unit was assumed to be 67,000 Pesos, which is 250% higher than the above estimated average value of 27,000 Pesos.

Indoor movable or household effects in an average family were estimated at 75% of the value of housing unit on average, according to the JICA study on "Flood Control Project in Laoag River Basin". Once this ratio was applied, the value of indoor movable was estimated at around 50,000 Pesos.

(2) Manufacturing Industry

The values of asset holdings of manufacturing establishments were reported in the annual survey of establishment by NSO. Based on the survey figures in 1995, damageable assets of manufacturing establishments were revaluated at 27,000 Pesos of building, 350,000 Pesos of durable assets and 46,000 Pesos of inventory stocks. Hence, 2001 values were calculated applying a price index of 1.40 between 1995 and 2001.

(3) Services Industry

1) Wholesale and Retail Trade

The values of asset holdings of wholesale and retail trading establishments were also reported by NSO. Based on the survey figures in 1993, damageable assets of manufacturing establishments were revaluated at 130,000 Pesos of building, 320,000 Pesos of durable assets and 140,000 Pesos of inventory stocks. 2001 values were calculated applying a price index of 1.72 between 1993 and 2001.

2) Educational Facilities

The average number of classrooms per elementary school was calculated as 10 classrooms per school, according to information of Department of Education, Culture and Sports (DECS), Region 2. A standard one-story academic classroom school building with conventional toilet is estimated as 689,000 Pesos in 2001, according to DPWH. Besides the classrooms, it has to install a multi-purpose workshop and faculty rooms, so the total cost is assumed to cost at 50% more than that of the classroom costs. Then, the total building cost was aggregated to around 10 million Pesos in total. Accordingly, the actual damageable value of the school is considered to be a half of the value above taking account of depreciation, the present value of the school was estimated at 5 million Pesos.

In addition, it requires furniture, equipment and inventory stocks. According to the survey of establishment by NSO, a school had the following assets on average in 1991. The composition of these assets was calculated as 28% of depreciable assets and 4% of inventory assets to the building' value. Applying these compositions to the building value above, the average school is estimated to have the following assets in 2001: 1.4 million of depreciable assets and 0.2 million of inventory assets.

3) Medical Facilities

There were 666 medical facilities in Cagayan and Isabela Provinces. They are composed of 71 hospitals and 526 barangay health stations and 69 rural health units in these provinces. According to budgetary requirement for construction of hospitals and other health facilities in Department of Health (DOH), a hospital with 25-beds and a main health center (rural model) cost 52.5 million Pesos including equipment and 2.0 million Pesos in 2001, respectively. Based on the survey of establishment by NSO in 1991, the inventory assets accounted for around 34% of the building value. The actual damageable value of the medical facilities is considered to be a half of the value above taking account of depreciation. Applying this composition to the building value above, the average medical facility is estimated to have 7.0 million Pesos of inventory assets in hospital and 0.3 million Pesos in health center.

(4) Agricultural Production

The degree of crop damage varies from month to month, depending on the cropping stage and timing of flood occurrence. Therefore, the annual average damageable value of crop per hectare is estimated as an aggregate of expected net income and accumulated expenditure for production until the time when flood occurs. In that case, flood frequency and planted area cultivated in each month have to be taken into account as well.

In terms of paddy production, paddy yields were set as 2.7 ton/ha (wet season) and 2.8 ton/ha (dry season) for irrigation system and 2.0 ton/ha for rainfed system under the present cultivation conditions. The damageable value was estimated at 17,500 Pesos/ha for irrigated fields and 12,300 Pesos/ha for rainfed fields in economic terms. After implementing rehabilitation or new irrigation system, paddy yields were set as 4.5 ton/ha and 5.0 ton/ha for two-crop cultivation. In the same manner, the damageable value was estimated at 32,200 Pesos/ha in economic terms.

### 15.2.5 Estimation of Flood Damages

The direct damages are estimated as a product of the number of facilities inundated by flood in affected areas, a damageable value of inundated property and a damage rate in accordance with inundation depth. The number of facilities inundated was counted by the respective return period in Subsection 15.2.3. The inundation depth in the area was identified by the hydrologic analysis.

The infrastructure damage was calculated as 20% of the total value of the direct damage. In addition, the indirect damages were estimated in the procedure discussed in Subsection 15.2.1. Finally, the entire damages are calculated for the respective return period of flood. The flood damages of 25-year probable rainfall under without-project and with-project conditions were summarized in the table below. These damages are estimated under present conditions and under future conditions in the target year 2020.

**Flood Damages of 25-year flood under Present Conditions**

| Item | Implementation Phase (Million Pesos) | | | |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
| Direct Damage | 1,219 | 1,600 | 1,890 | 2,444 |
| Facility | 966 | 1,251 | 1,451 | 1,987 |
| Agriculture | 50 | 83 | 124 | 49 |
| Infrastructure | 203 | 267 | 315 | 407 |
| Indirect Damage | 219 | 281 | 331 | 431 |
| Total | 1,438 | 1,881 | 2,221 | 2,875 |

**Flood Damages of 25-year flood in 2020 under Future Conditions**

| Item | Implementation Phase (Million Pesos) | | | |
|---|---|---|---|---|
| | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
| Direct Damage | 4,050 | 9,059 | 15,108 | 23,666 |
| Facility | 3,294 | 7,340 | 12,183 | 19,248 |
| Agriculture *1 | 81 | 209 | 407 | 474 |
| Infrastructure | 675 | 1,510 | 2,518 | 3,944 |
| Indirect Damage | 730 | 1,608 | 2,667 | 4,204 |
| Total | 4,780 | 10,666 | 17,785 | 27,870 |

Note: *1 Benefits from flood damages to new and rehabilitated irrigation systems were included only a half of the total damages, because they increased owing to a multiplier effect of flood control and irrigation projects.

### 15.2.6 Estimation of Annual Benefit

The annual damage is calculated applying the following formula, on the basis of the flood damages for the respective probable rainfalls.

$$B = \sum_{i=1}^{n} \frac{1}{2}\left[D(Q_{i-1}) + D(Q_i)\right] \bullet \left[P(Q_{i-1}) - P(Q_i)\right]$$

Where, $B$ : Annual average benefit

$D(Q_{i-1})$, $D(Q_i)$ : Flood damage caused by the floods with $Q_{i-1}$ and $Q_i$

discharges, respectively

$P(Q_{i-1}), P(Q_i)$ : Probabilities of occurrence of $Q_{i-1}$ and $Q_i$ discharges, respectively

$n$ : Number of flood applied

The annual average benefit is defined as the reduction of probable damage under with- and without-project conditions. The project was proposed as flood control scheme for 25-year probable rainfall. The annual benefit of the first phase schemes of flood control plan in Lower Cagayan River Basin was estimated at 325 million Pesos under present conditions.

Through the same procedure using the estimates of flood damages, the annual benefits of the respective phasing schemes are calculated as shown in the table below.

(Unit: Million Pesos per Year)

| Socio-Economic Condition | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| 1. Under Present Condition | 325 | 639 | 1,212 | 2,389 |
| 2. Under Future Condition (in 2020) | 1,144 | 2,026 | 3,476 | 4,791 |

### 15.2.7 Economic Cost

The construction costs estimated in Section 13.3 were based on market prices (financial costs). Then, these costs have to be converted to economic costs. To simplify the procedure of conversion from financial cost to economic cost, the direct construction costs are segregated into (i) materials, (ii) machinery and equipment rental, (iii) labor and (iv) indirect costs. The conversion factors of these cost items from financial cost to economic cost were discussed in Subsection 15.2.2.

The economic cost of the respective phases was calculated from the corresponding financial cost through the procedure mentioned above. They are summarized as follows. The costs of the respective phases are estimated as accumulation from the beginning.

(Unit: Million Pesos)

| Item | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Financial Cost | | | | |
| Direct Main Works*1 | 2,094 | 2,303 | 3,474 | 4,192 |
| Compensation | 26 | 4 | 43 | 28 |
| Administration | 48 | 44 | 86 | 111 |
| Engineering Services | 190 | 175 | 344 | 444 |
| Price Contingency | 218 | 101 | 158 | 191 |
| Physical Contingency | 207 | 202 | 316 | 382 |
| Total | 2,786 | 2,828 | 4,420 | 5,347 |
| Economic Cost | | | | |
| Direct Main Works | 1,605 | 1,868 | 2,770 | 3,327 |
| Compensation*2 | 0 | 0 | 0 | 0 |
| Administration | 46 | 42 | 82 | 105 |
| Engineering Services | 222 | 204 | 401 | 517 |
| Price Contingency | 0 | 0 | 0 | 0 |
| Physical Contingency | 175 | 172 | 268 | 325 |
| Total | 2,047 | 2,342 | 3,385 | 4,014 |

Note: *1 Including non-structural measures and supporting measures in addition to value added tax (VAT).
*2 Counted in benefit stream as negative benefit.

In terms of the compensation items, the land acquisition cost is converted as crop production foregone as mentioned in Subsection 15.3.2. The price contingency cost is excluded from economic cost. As a result, the entire economic cost of phase 1 was calculated at 2.05 billion Pesos. Since the financial total cost is 2.79 billion Pesos, the economic construction cost corresponds to 73% of the financial costs.

The O&M cost is annually required during the economic life of the objective project. The total O/M cost of the Phase 1 schemes was estimated at 12.9 million Pesos in economic terms. In terms of FFWS, some of equipment will be replaced every ten-years. Then, the expenditure for replacement has to be added as replacement cost in the cost stream.

### 15.2.8 Economic Evaluation of Flood Control Projects

(1) Economic Viability

In this section, the proposed projects are examined from the economic point of view. The projects are evaluated for the respective phases based accumulated costs and benefits.

The EIRRs of the respective phases are estimated to be 14.8%, 12.3%, 13.0% and 14.1% under present conditions, respectively. However, it jumped up to 27.1%, 25.4%, 26.8% and 27.4% under future conditions. Thus, the EIRRs under future conditions are much higher than the social discount rate of 15%. The flood control projects in Phase 1 seem to be quite viable because their EIRR was 27.1%

under future conditions. Incidentally, their cost-benefit ratio (B/C) is 2.15 and net present value (NPV) is estimated at 1.26 billion Pesos.

| Item | | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|---|
| Under Present Conditions | EIRR (%) | 14.8 | 12.3 | 13.0 | 14.1 |
| | B/C*1 | 0.99 | 0.83 | 0.87 | 0.93 |
| | NPV*1 (Bil. Pesos) | -15 | -319 | -327 | -186 |
| Under Future Conditions | EIRR (%) | 27.1 | 25.4 | 26.8 | 27.4 |
| | B/C*1 | 2.15 | 1.88 | 2.06 | 2.15 |
| | NPV*1 (Bil. Pesos) | 1,255 | 1,673 | 2,565 | 3,216 |

Note: *1 Discounted at 15%

(2) Sensitivity Test

The cost and benefits are estimated with discretion by respective experts in this study. In spite of that, some uncertainty still exists in the estimation. Thus, the sensitivity test is introduced in the following aspects.

a) 5% or 10% higher than the cost estimated
b) 5% or 10% lower than the benefit expected
c) Combined the both aspects at the same time

The results were presented for the Phase 1 schemes under future conditions. As shown in the table below, EIRRs of the all cases exceeded 23%. Thus, the proposed project is sufficiently feasible from the economic point of view.

| | | Benefit | | |
|---|---|---|---|---|
| | | 0% | 5% Down | 10% Down |
| Cost | 0% | 27.1% | 26.0% | 25.0% |
| | 5% Up | 26.1% | 25.1% | 24.1% |
| | 10% Up | 25.2% | 24.2% | 23.2% |

### 15.2.9 Economic Evaluation of Irrigation Project

Among irrigation development projects, Alcala-Amulung-West Irrigation Project is selected for the first priority projects. Referring to the effects of flood control projects, the project is implemented in two phases, i.e., Phase 1 and Phase 3. The project is examined in the respective phases in accordance with the construction schedule.

(1) Economic Benefit

The economic benefit of the proposed project for the phase-1 was estimated at 250 million Pesos per annum. It composed of crop production increment benefit and rice million services in the project site. The increment benefit of crop production was calculated as a difference between with-project and without-project. By the target year, values of crops produced in the project sites would rise in accordance with value in the international market as well as in the domestic markets. The value index for this appreciation was derived from the rice value projected by the World Bank. The total benefits for the respective phases are shown in the table below.

(Unit: Million Pesos per Year)

| Item | Phase 1 | Phase 3 |
|---|---|---|
| Under Present Conditions | 266 | 170 |
| Under Future Conditions (in 2020) | 291 | 186 |

(2) Economic Cost

The construction costs estimated in Section 13.3 were based on market prices. Then, these costs have to be converted to economic costs. The conversion factors of these cost items from financial cost to economic cost were discussed in Subsection 15.2.2. The costs of the respective phases are estimated as accumulation from the beginning.

(Unit: Million Pesos)

| Item | Financial Cost | | Economic Cost | |
|---|---|---|---|---|
| | Phase 1 | Phase 3 | Phase 1 | Phase 3 |
| Direct Main Works*1 | 1,202 | 692 | 864 | 551 |
| Compensation | 20 | 20 | 0 | 0 |
| Administration | 27 | 27 | 25 | 25 |
| Engineering Services | 109 | 109 | 127 | 127 |
| Price Contingency | 147 | 88 | 0 | 0 |
| Physical Contingency | 120 | 75 | 102 | 64 |
| Total | 1,625 | 1,011 | 1,118 | 767 |

Note: *1 Including supporting measures such as rice millers and drying yards. The financial cost of direct main works includes value added tax (VAT).

The O&M cost is annually required during the economic life of the objective project. The total O/M costs of the respective phases were estimated at 26 million Pesos and 18 million Pesos in economic terms. In addition, equipment such as pumps and gates will be replaced every 15-years. Then, the expenditure for replacement has to be added as replacement cost in the cost stream.

(3) Economic Evaluation

The EIRRs of the respective phases are estimated to be 15.6%, and 15.1% under present conditions, respectively. However, it went up to 16.4%, and 16.1% under future conditions. Thus, the EIRRs under future conditions are higher than the social discount rate of 15%. The irrigation development project seems to be viable from the economic view point.

| Item | | Phase 1 | Phase 3 |
|---|---|---|---|
| Under Present Conditions | EIRR (%) | 15.6 | 15.2 |
| | B/C*1 | 1.04 | 1.01 |
| | NPV*1 (Million Pesos) | 27 | 11 |
| Under Future Conditions (in 2020) | EIRR (%) | 16.4 | 16.1 |
| | B/C*1 | 1.10 | 1.08 |
| | NPV*1 (Million Pesos) | 66 | 60 |

Note: *1 Discounted at 15%

# CHAPTER 16 CONCLUSIONS AND RECOMMENDATIONS

## 16.1 Proposed Projects for Urgent Implementation

The Lower Cagayan Flood Control Project including non-structural measures and the Alcala-Amulung West Pump Irrigation Project have been proven to meet the National and Local Governments' policies for the basin development and been found to be feasible technically, economically and environmentally.

Therefore, urgent implementation of these projects, especially the first phase of these projects, is recommended. The first phase consists of the following:

1) Flood Control Structural Measures
    - Urgent bank protection at 21 sites in the Lower Cagayan River,
    - Riverbank tree zone for a the length of 70 km and width of 30 m along the Catugan, Alcala-Buntun, Tuguegarao and Enrile dikes,
    - Left dike system from river mouth to Magapit including Mabanguc dike (11.3 km), and Catugan dike (6.0 km),
    - Right dike system from the river mouth to Magapit including Camalaniugan dike (13.1 km), and Lal-lo dike (12.9 km).
2) Flood Control Non-structural Measures
    - Improvement of evacuation system including flood forecasting and warning system and evacuation center,
    - Resettlement area development.
3) Alcala-Amulung West Pump Irrigation Project, First Stage with the service area of 4,090 ha
4) Agricultural Supporting Measures such as rice mill plant and drying yard

## 16.2 Preparatory Actions for Proposed Projects

Prior to implementation of the proposed Lower Cagayan Flood Control Project and Alcala-Amulung West Pump Irrigation Project, the following actions are required to be taken by the agencies concerned:

1) Designation of the river area and flood control area for river administration,
2) Preparation of land use regulation in the river area to allow the people to cultivate for agricultural purpose and promulgation thereof to the public,
3) Preparation of Agreements for the project implementation and signing by the agencies concerned,
4) Survey on land owners in the project area and preparation of land acquisition and compensation programs,

5) Obtaining of concurrence of the local people on the implementation of the projects and resettlement,
6) Organizing of farmers for implementation of agricultural supporting measures such as rice mill plant and drying yards,
7) Conduct of environmental impact assessment,
8) Necessary arrangement for receiving approval for the project implementation such as ECC, ICC clearance, and preparation on Implementation Program,
9) Arrangement of financial support by foreign aid, if necessary,
10) Prior arrangement of operation, maintenance and management system for the projects in advance of the project completion.

## 16.3 Implementation of Bank Protection Works in Middle/Upper Cagayan and Tributaries

Bank erosion in the middle and upper Cagayan River and the major tributaries are very serious. The DPWH Regional Office R-2 has conducted the feasibility study thereof with the technical assistance of the Study Team. These bank protection works are not included in the proposed first phase works, however it is recommended to implement urgently these bank protection works.

## 16.4 Implementation of Other Recommended Projects

Implementation of the following economically feasible projects is also recommended, although budgets of these projects are outside of the strategic investment amount of 30 billion Pesos considering allocation of regular budget of the agencies concerned and /or looking for private investment:

1) Watershed management including reforestation of 3,188 $km^2$ and construction of 26 sabo dams,
2) Irrigation projects identified in the Reviewed Master Plan beside the Alcala-Amulung West Pump Irrigation Project,
3) Implementation of dam and hydropower projects such as Alimit No.1 Dam Project including provision of flood control space to the existing Magat Dam to be financed by NPC and/or private sectors,
4) Implementation of the Matuno multipurpose dam project.

## 16.5 Recommended Actions for Cagayan River Basin Development

Taking a long-term view, the following actions by the agencies concerned are recommended to proceed with the economic development of the Cagayan River basin:

1) Review of Water Code and strict application of the Code,
2) Collection of data and establishment of database for the socio-economic data and technical/ engineering data for the water resources development,
3) Study on the most appropriate organizational arrangements for implementation of basin water resources development and river management. For this purpose, recommended strongly is to formulate a Master Plan of the Nation-wide Flood Control Project.