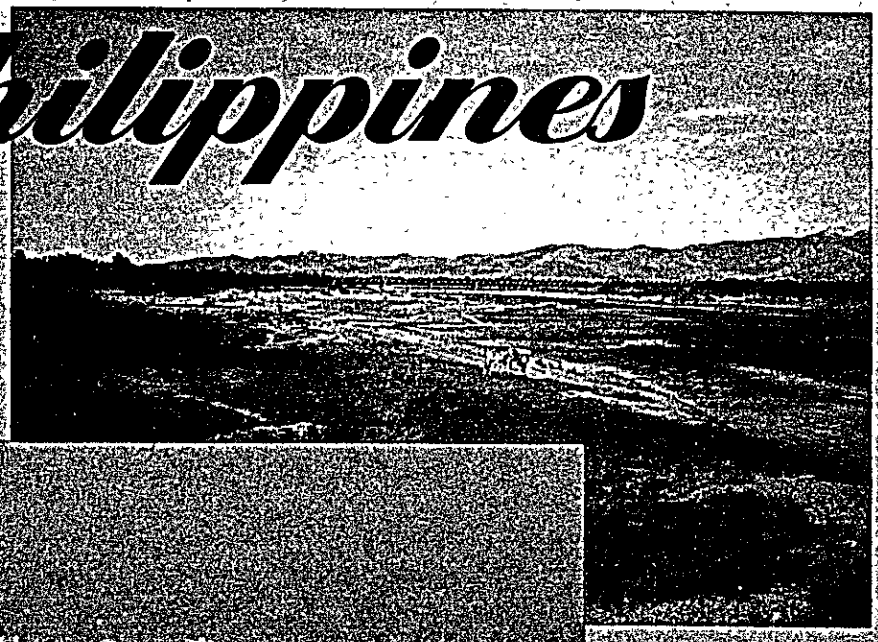
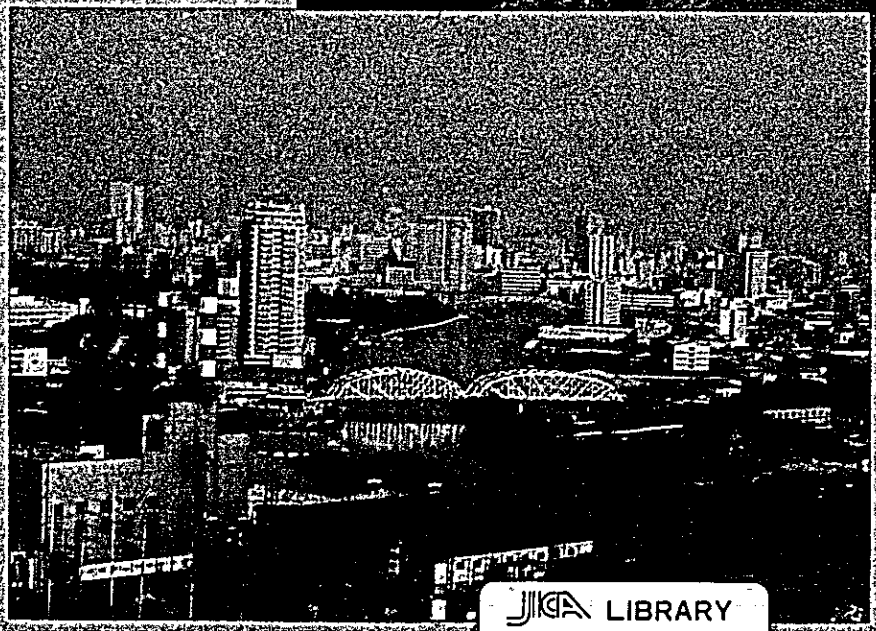
Rivers

in the

Philippines



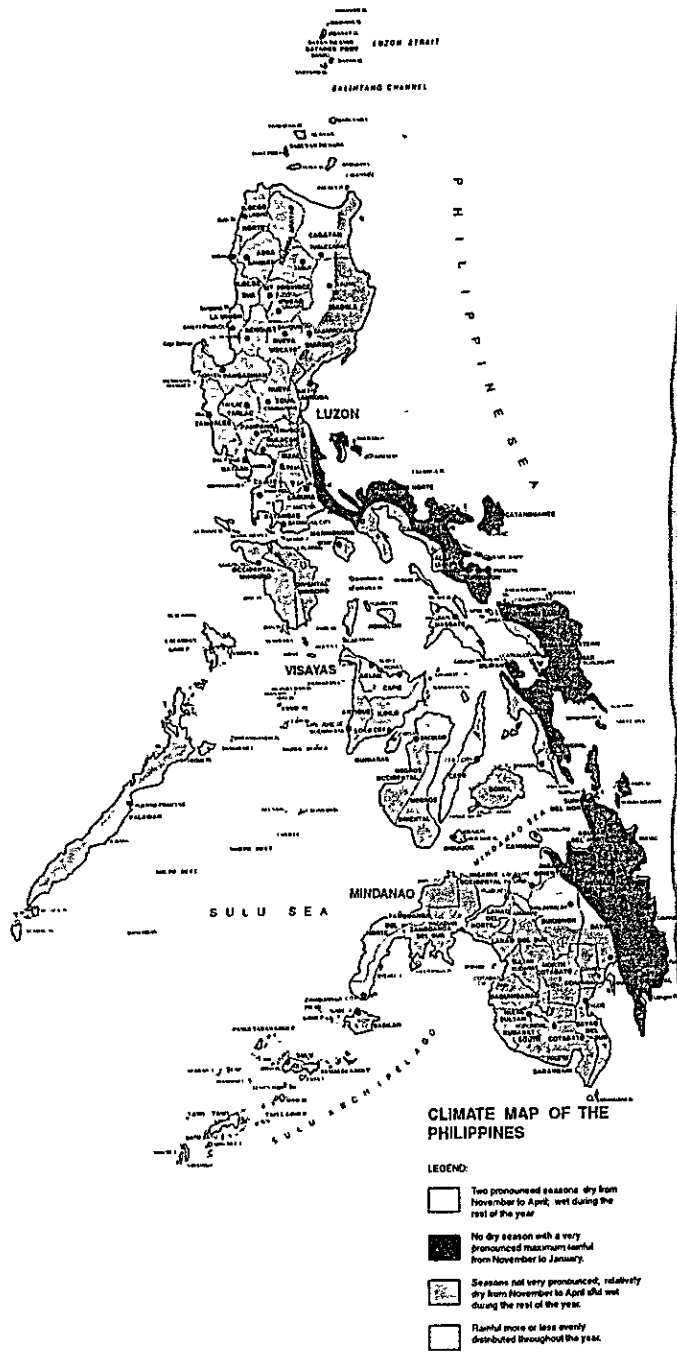


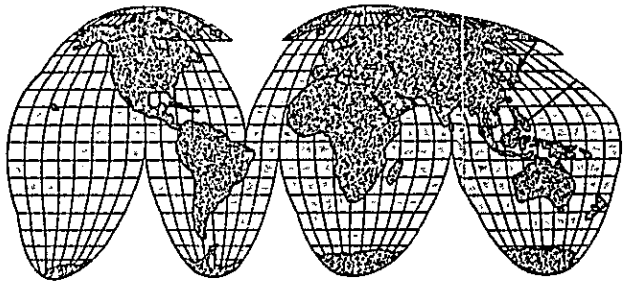
Manila, Philippines
March 1997

JICA

CONTENTS

Cover Photo : Laoag River at Cauplasan Bridge
: Pasig River at Ayala Bridge





PREFACE

At a glance, there seems to be a wide contrast between Japan and the Philippines because of their differing economy and culture, among others. People think that Japan and the Philippines are two very different countries, but what many do not know is that, there exist similar characteristics between these countries in terms of their geographical location and geological structure.

Geographically, both countries are situated in the Asian continent and geologically, both have the same structures. The geographical location and meteorological condition of both countries make them vulnerable to flood disasters. Both countries consist of many islands and both belong to the Circum-Pacific Volcanic Belt which explains why earthquakes and volcanic eruptions are frequent. They are located in the monsoon region so they suffer from torrential rains and typhoons which cause flooding, debris flow and landslides.

While they may have these similarities, the way these situations are dealt with significantly vary. Japan has much experience in flood mitigation while the Philippines has just recently adopted measures in alleviating the adverse effects of flood and other geological disasters.

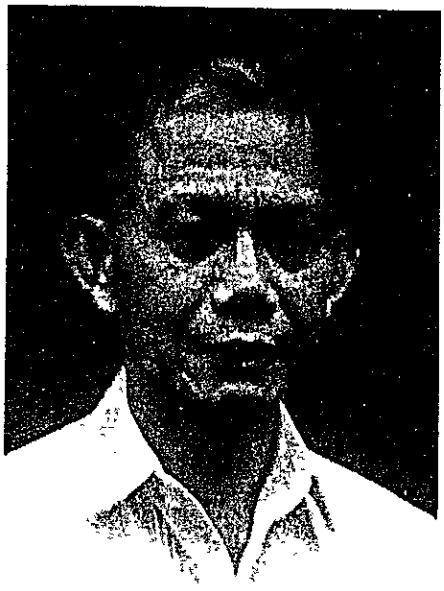
It is therefore due to the vast experience of Japan in river works for flood control that the Philippine government has requested for Japanese assistance for the implementation of its vital projects.

This publication introduces the major Philippine rivers with supplementary photographs.

I hope that the concerned engineers and personnel will find this publication very useful especially in mitigating the adverse effects of flood and other disasters.

HIROSHI GOTO
Resident Representative
Japan International Cooperation Agency
Manila, Philippines

FOREWORD



The Philippines is one of the most disaster-prone countries in the world. It lies along the path of about twenty tropical cyclones a year, seven or eight of which affect the mainland and inflict enormous damage to human lives and properties. These weather disturbances are accompanied by destructive wind forces that cause storms and heavy rainfall which result in the inundation in the river basins and low-lying areas, as well as slope failures.

The Philippines is now well on the road towards achieving the modernization goals. However, the more we attain progress and the closer we get to reaching our development goals, the more we increase our vulnerability and risk to disasters.

This publication discusses rivers in the Philippines, particularly twelve major river basins and Metro Manila which are covered by the Medium-Term Philippine Development Plan (MTPDP) 1993-1998, and rivers in selected urban centers, studies for which JICA has already conducted.

This publication contains comparative data for each river basin in terms of population, land use, previous floods and proposed design discharge. The pictures taken at each river site give us a more detailed understanding of the situation at each river.

This publication will be readily useful especially to those who are involved in river-related works, contribute to improve river environment and hopefully help to prevent/mitigate floods as well.

GREGORIO R. VIGILAR
Secretary
Department of Public Works and Highways

Part I: Outline

1.1 Geography, Topography, Geology, Coastal Areas and Climate

1.1.1 Geography

The Philippines is an archipelago consisting of about 7,100 island and islets with an aggregate land area of approximately 300,000 km². Ninety percent of the area are in the 11 largest islands, approximately two thirds in the islands of Luzon and Mindanao, while 463 smaller islands have an aggregate area of only 2,500 km². The entire island group is closely scattered within the zone bounded by latitudes 4.5° to 21 ° and longitude 117° to 127°, which is the tropical belt and southeast of the Asian mainland.

1.1.2 Topography

The country has a variety of topographical features, from the low marsh, which is about a foot or so above high water at the head of Manila Bay, to the high mountain masses, the highest peak being Mt. Apo in Mindanao with an elevation of approximately 2,954m above mean sea level. The largest mountain areas and the most extensive plains are found in the island of Luzon. Large inland lakes are few in the Philippines but semi-enclosed bays are too many to mention. There are four large marshes - two in Mindanao, one in Central Luzon and one in Mindoro island.

1.1.3 Geology

Great variety of rocks exist in the country : igneous, sedimentary, and metamorphic. Basement complex is generally made up of gabbro, andesites, agglomerates, serpentine, greisses, schist, volcanic breccias, volcanic tuff, quartzite and basalt flows. Igneous rock is generally basic to semi-basic, that is, low to intermediate in silica content.

Philippine soils have considerable depth even on relatively steep slopes due to rapid chemical weathering and slow physical weathering of rocks. However, due to this rapid chemical decomposition, organic matter in the Philippines is very small. Plant material in the tropical forest is about 2 to 3 times that in the temperate forest, but because of rapid chemical decomposition, very little humus is found in tropical soil. Carbon dioxide and organic acids provided by this plant material through decomposition attack the rocks, causing the rapid chemical weathering of the same.

1.1.4 Coastal Areas and Climate

The Philippine territory has a total water area of 438,951 sq. nautical miles or 150,759,282 ha., and the consolidated coast-line measurement is 21,591.7 statute miles.

The country has the longest discontinuous coastline in the world, stretching 34,000 km. Its extensive sea coast has good harbors, navigable rivers and lakes.

The Philippines is located in the tropics and the climate prevailing in any particular place in the country is influenced by its geographical position and wind system prevalent in different locations at certain times of the year. The classification of Philippine climatic conditions is based more on the types of rainfall than on the slight differences in temperature. This is so because the variability of rainfall, combined with the influence of the country's topography and air stream direction, affect the climate greatly. Four types of climate are adopted and are categorized as dry season and wet season induced by minimum or maximum rain periods, as indicated below.

Climatological Type in the Philippines

Type	Characteristics of Climate	Typical Regions
1st type	Two pronounced seasons: dry from November to April and wet during the rest of the year.	Ilocos, Central Luzon, Southern Tagalog (eastern part), Western Visayas (eastern part)
2nd type	No dry season with a very pronounced maximum rainfall from November to January.	Bicol (western part), Eastern Visayas, Southeastern Mindanao
3rd type	Seasons not very pronounced: relatively dry from November to April and wet during the rest of the year.	Bicol (eastern part), Western Visayas (western part), Central Visayas (eastern part), Northern Mindanao (northern part), Southwestern Mindanao (eastern part)
4th type	Rainfall more or less evenly distributed throughout the year.	Cagayan Valley (western part), Bicol (eastern part), Central Visayas, Mindanao (southern part)

The country has a wide range of precipitation with the highest intensity of 9,006 mm recorded in Baguio City in 1910 and lowest of 94.2 mm in Vigan, Ilocos Sur in 1948, both in Luzon. The average is 2,360 mm per year over the numerous stations in the islands.

1.2 Population and Land Use

1.2.1 Population

Total population of the Philippines as of 1995 was 68.6 million, that corresponds to the population density of 228.7 persons/km^2. Out of the total country population, about 14% with a population density of 12,500/km^2 persons lives in the Metropolitan Manila Area, the National Capital Region and the political and commercial center of the country. The annual county's population growth recorded its peak of 3.08%/year in 1970, and since then, tends to decrease

recording 2.32%/year in 1995. The following table shows the country's 1995 population and population density by region.

Population and Density by Region as of 1995

Region	Population (thousands)	Density (person/km²)
NCR (National Capital Region)	9,454	14,864.8
CAR	1,255	68.6
Region 1	3,804	296.3
Region 2	2,536	94.5
Region 3	6,933	380.3
Region 4	9,941	211.9
Region 5	4,325	245.3
Region 6	5,777	285.7
Region 7	5,015	335.4
Region 8	3,367	157.1
Region 9	2,795	174.7
Region 10	2,483	176.9
Region 11	4,604	169.6
Region 12	2,360	162.0
Region 13	1,942	103.0
ARMM	2,021	177.1
Total	68,614	228.7

Source : National Statistics Office

1.2.2 Land Use

The Philippines has a territory of 300,000 km², classified into forest land of 158,883 km² and alienable/disposable land of 141,117 km² as of December 1995. The alienable/disposable land covers the urban area, the industrial areas and all other alienable and disposable land, while the forest land includes the residential area of 32,729 km² (23.1%), the timberland of 101,159 km² (71.7%), the national parks of 13,411 km² (9.4%), the military & naval reservation of 1,303 km² (0.9%), the civil reservation of 1,660 km² (1.2%) and the fishpond of 756 km² (0.5%), the breakdown of which by region is tabulated below.

Land Classification by Region as of December 1995

(Unit : Km^2)

Region	Total Land	Alienable and Disposable Land	Forest Land
NCR	636	482	154
CAR	18,293	3,407	14,887
Region 1	12,840	8,101	4,740
Region 2	26,838	9,601	17,237
Region 3	18,231	10,519	7,712
Region 4	46,924	21,613	25,312
Region 5	17,632	12,221	5,412
Region 6	20,223	14,088	6,135
Region 7	14,951	9,592	5,359
Region 8	21,432	10,237	11,195
Region 9	15,997	7,623	8,375
Region 10	28,328	10,669	17,658
Region 11	31,693	12,124	19,568
Region 12	14,373	5,468	8,904
ARMM	11,608	5,428	6,180
Total	300,000	141,172	158,828

Source : National Mapping and Resource Information Authority, DENR

1.3 Hydrology

1.3.1 Rivers

There are 421 principal river basins in the country with their drainage areas varying from 41 km^2 to 27,280 km^2. About 60% of these river basins have river basin drainage areas ranging from 100 km^2 to 500 km^2 as listed below.

Distribution of River Basin Drainage Area

Range of Drainage Areas (km2)	Number of River Basins
50-100	51
101-200	113
201-500	155
501-1000	63
1001-2000	22
2001-5000	9
5001-10000	5
More than 10000	3

Source : Principal River Basins of the Philippines, NWRC, 1976

The largest river basin in the country is that of Cagayan River, which has a catchment area of 25,649 km² located in Cagayan Valley Region. This river, together with 17 other rivers with a drainage area of at least 1,400 km² each, are called the major river basins.

Major River Basins in the Philippines

Name of River Basin	Region	Drainage Area (km²)	Level* Area (km²)	Annual Runoff (MCM)
Cagayan	Cagayan Valley	25,694	3,546	53,943
Mindanao	Southern Mindanao	23,169	5,132	26,899
Agusan	Northern Mindanao	10,921	2,494	27,880
Pampanga	Central Luzon	9,759	6,660	10,930
Agno	Central Luzon	5,952	1,883	6,654
Abra	Ilocos	5,125	299	12,551
Pasig-Laguna	Southern Luzon	4,678	1,065	7,485
Bicol	Bicol	3,771	549	5,102
Abulug	Cagayan Valley	3,372	178	7,121
Tagum-Libuganon	Southern Mindanao	3,064	504	6,128
Ilog-Hilabangan	Western Visayas	1,945	645	2,474
Panay	Western Visayas	1,843	430	2,344
Tagoloan	Northern Mindanao	1,704	173	4,350
Agus	Southern Mindanao	1,645	36	918
Davao	Southeastern Mindanao	1,623	164	3,246
Cagayan	Northern Mindanao	1,521	86	3,883
Jalaur	Western Visayas	1,503	301	1,912
Buayan-Malungun	Southeastern Mindanao	1,434	150	2,870

Note * : Plain includes the level land with slopes of less than 3% which is suitable for irrigation development.

Source : Principal River Basins of the Philippines - NWRC

1.3.2 Lakes

There are about 59 lakes throughout the country. The six (6) largest lakes are the following: Laguna de Bay with an area of 922,142 km²; Lake Lanao in Lanao del Sur, 347.06 km²; Lake Taal in Batangas, 266.77 km²; Lake Mainit in Surigao del Norte, 150.22 km²; Lake Naujan in Mindoro Oriental, 69.93 km²; and Lake Buluan in Sultan Kudarat, 59.57 km².

1.4 Statistics on Disaster

The Philippines, by virtue of its geographical location, is one of the most disaster-prone countries in the world. It lies along the path of about twenty tropical cyclones a year, seven or eight of which affect the mainland and inflict enormous damage to human lives and properties. These weather disturbances are accompanied with destructive wind forces that cause storm surges and heavy rainfall which result in inundation in the river basins and low-lying areas, as well as slope failures.

It is also a volcanic country as 19 active volcanoes are dotting the archipelago from north to south. Throughout its length and breadth, one can see conical hills and mountains which in the geologic past have spewn the countryside with ashes, gases and other volcanic debris and from its throat have gushed destructive lava flows. Like Hawaii, Japan and Indonesia, the country has had fearful and disastrous experiences as a result of catastrophic volcanic eruptions.

Aside from the presence of volcanoes, the country is seismically active as it has structural lines which represent major fault zones. The first one runs through the notable length of the country from north to south. The second has an important structural features which crosses the first main fault line at right angles at the border between northern and southern Luzon.

Most, if not all of the weather related disasters in the country are due directly and indirectly to tropical cyclones. Strong winds, excessive rainfall and storm surges are usually experienced during a tropical cyclone's passage. During the months of July to September, the presence of tropical cyclone Northeast of the Philippines may intensify the Southeast flow, bringing considerable rain and resulting in inland flooding over low-lying areas and river basins.

Summary of the Effects of Destructive Typhoons (1970 - 1995)

Year	Dead Persons	Missing Persons	Estimated Cost of Damages (Billion Pesos)
1970	1,328	494	0.501
1971	89	110	0.040
1972	298	5	0.178
1973	74	89	0.251
1974	153	89	0.365
1975	39	8	0.019
1976	313	185	0.725
1977	99	23	0.335
1978	663	395	1.575
1979	69	68	0.415
1980	143	29	1.465
1981	484	264	1.274
1982	337	223	1.659
1983	126	28	0.522
1984	1,979	732	5.869
1985	211	17	2.725
1986	171	43	1.776
1987	1,020	213	4.083
1988	429	195	8.676
1989	382	89	4.494
1990	670	262	12.678
1991	5,199	1,281	4.584
1992	117	53	5.072
1993	794	200	19.987
1994	242	48	3.198
1995	1,204	642	15.256
Total	16,633	5,785	97.722

Source : Office of Civil Defense

Damages Caused by Major Natural Disasters (1980 - 1985)
(More than 100 Dead Persons Casualties)

Year	Type of Disaster	Date of Occurrence	Area Affected	Casualties		Value of Damages (billion pesos)
				Dead	Missing	
1980	T Aring	Nov. 1-7	Regions 1 to 6&8	103		1.356
	Flooding	Dec. 19-25	Regions 10&11	336		0.346
1981	TS Daling	Jun. 28-Jul. 2	Regions 4&5	210	19	0.062
	T Dinang	Dec. 23-27	Regions 4,5&8	188		0.587
1982	T Bising	Mar. 23-28	Regions 7,8&10	112		0.588
1983	T Bebeng	Jul. 14-16	Regions 3 to 5&8	115		0.467
1984	TS Maring	Aug. 27-30	Regions 1 to 4,6 to 8,10&11	121	26	0.411
	T Nitang	Aug. 31-Sep. 4	Regions 1,4,6,7,8&10	900		3.914
	TS Undang	Nov. 3-6	Regions 4-A to 8	895	2,526	0.002
1986	T Gading	Jul. 6-10	Regions 1 to 4 & NCR	106		0.679
1987	T Pepang	Oct. 21-25	Regions 1 & 2	100	13	0.519
	T Sisang	Nov. 23-27	Regions 4,5 & 8	100		1.119
1988	T Unsang	Oct. 21-26	Regions 1 to 11	157		5.636
	T Yoning	Nov. 5-8	Regions 4 to 9	217	133	2.748
1989	Flooding	Jan. 15-20	Regions 5 & 8	101		0.392
	T Rubing	Oct. 2-7	Regions 1,2 & CAR	119	28	0.191
1990	Earthquake	Jul. 16	Regions 1 to 4, CAR&NCR	1,283		12.2
	T. Ruping	Nov. 10-14	Regions 4 to 12	508		10.846
	Mt. Pinatubo	Jun. 12-15	Region 3	850		10.424
	TS Uring	Nov. 2-5	Regions 6 & 8	5,101		1.044
1993	T Kadiang	Sep. 30-Oct. 7	LPA east of Aurora	126	26	8.752
	T Monang	Dec. 3-4	840 kms east of Samar	272	90	2.34
	T Puring	Dec. 24-29	1,100 kms east of Mindanao	157	52	2.732
1995	TS Mameng	Sep. 27-Oct. 1	Regions 1,3 to 8,10 & NCR	133	130	3.1727
	TS Pepang	Oct. 26-30	Regions 4,6,7 & 8	116	125	0.4235
	T Rosing	Oct. 31-Nov. 3	Regions 1 to 5,7,NCR&CAR	916	376	10.819

T : Typhoon, TS : Tropical Storm
Source : National Disaster Coordinating Council

1.5 Outline of Legislation

The present water legislation in the Philippines is based on the Water Code enacted in 1976, giving rational concepts of integrated and multipurpose management of water resources, sufficiently flexible to adequately meet future developments. The Water Code declares the National Objectives and principles concerning the Water Resources of the Country, and prescribes the policies, and the Implementing Rules and Regulations (IRR) relative to the following :

(1) Policies

(a) Ownership of waters

(b) Appropriation of waters

(c) Utilization of waters

(d) Control of waters

(e) Conservation and protection of waters, watersheds and related land resources

(f) Administration of waters and enforcement of the provisions of this code

(g) Penal Provisions

(h) Transitory and Final Provisions

(2) Implementation Rules and Regulations

(a) Appropriation and utilization of waters

(b) Control, conservation and protection of waters, watersheds and related land resources

(c) Administration and enforcement

1.6 Water Related Organizations

The major water related works in the Philippines are being undertaken by twelve departments of the national government. Table 1-6-1 shows their major responsibilities and concerns. Overall management of water resources is the basic mandate of the National Water Resources Board (NWRB), which is a collegiate, quasi-judicial body under the DPWH and is composed of six Cabinet Secretaries (DPWH, NEDA, DOA, DTI, DENR, and DOH) and four heads of water agencies (MWSS, LWUA, NIA, and NPC). This management embraces the control, supervision and regulation of the utilization, exploitation, development and protection of water resources. Other agencies with regulatory functions for water resources include EMB of DENR for water quality, and EHS of DOH for drinking water. DILG is also involved in the development and institutional aspect of water supply for domestic/municipal use.

The provision of water services for particular sectoral uses and purposes such as water supply and sanitation, irrigation, drainage, hydropower, flood control and environmental protection; and the management of these services is undertaken by implementing agencies of government, and to a lesser extent by autonomous cooperative and private entities, in accordance with their own particular interests and responsibilities. Autonomous entities (water districts, irrigators associations of communal irrigation system, etc.) are often supported and/or regulated by government agencies (LWUA, NIA, DILG, etc.)

Fig. 1-6-1 Functional Relationship for Water Related Works

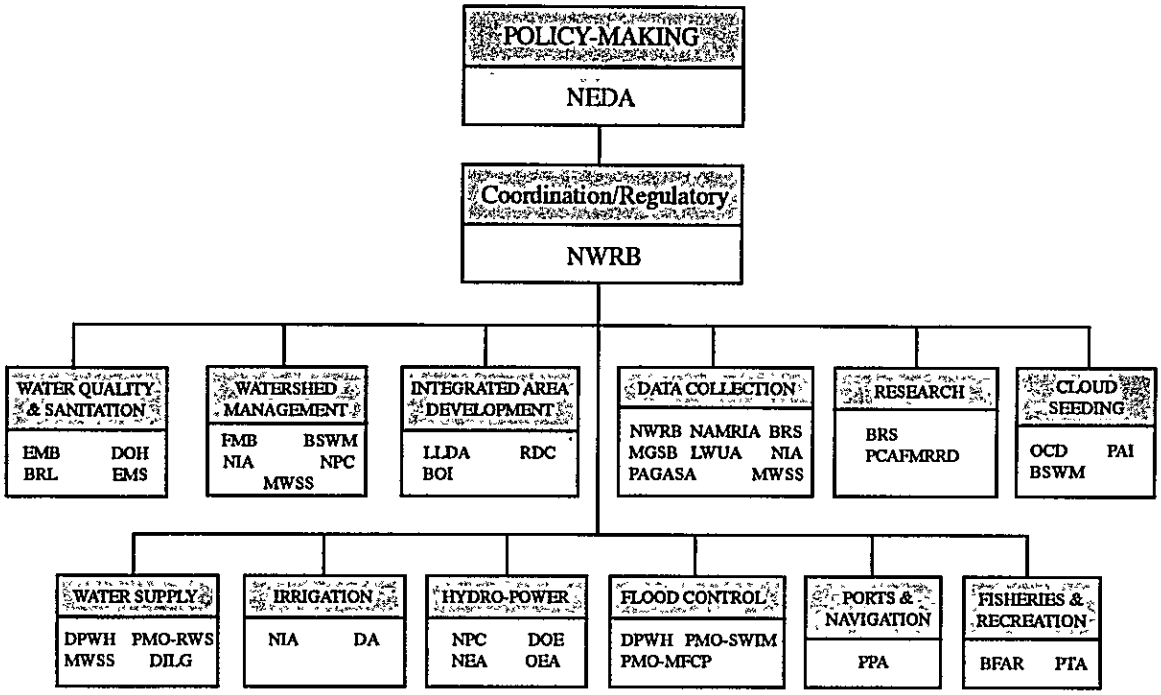


Fig. 1-6-2 Organizational Relationship for Water Related Works

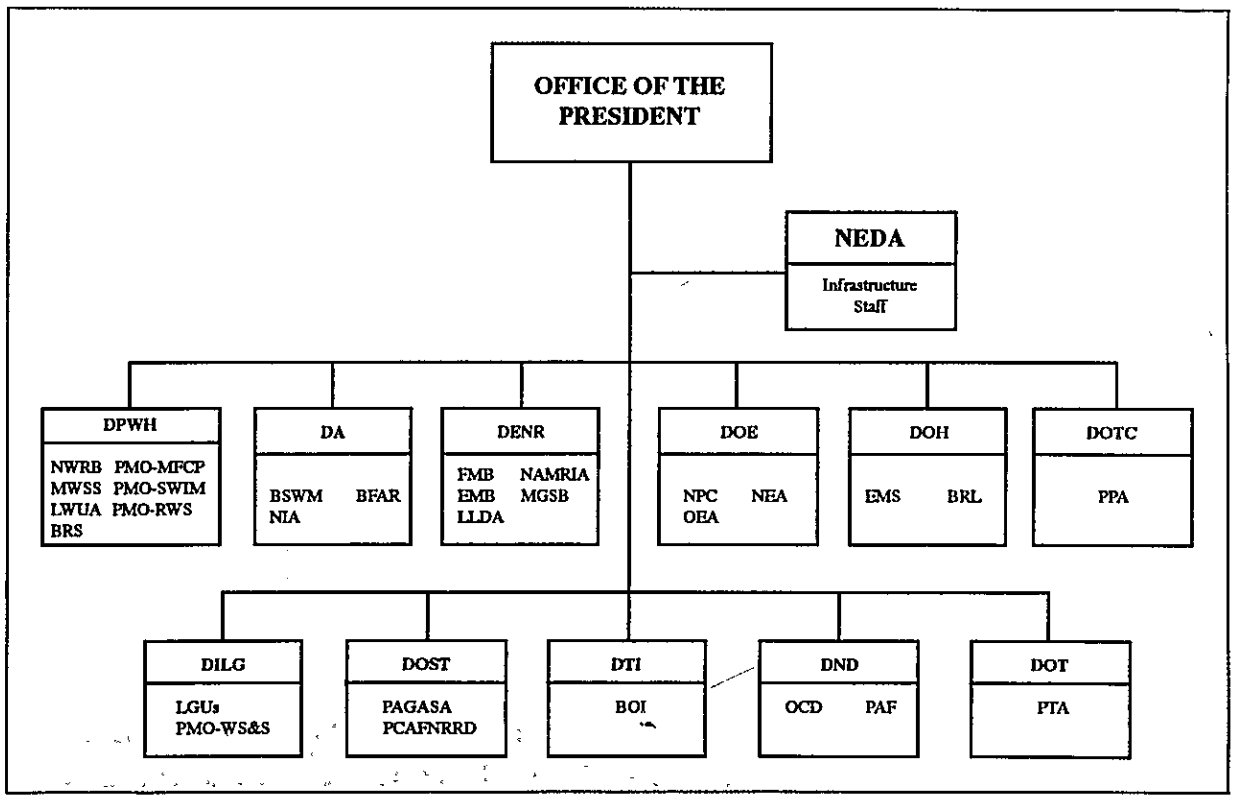


Table 1-6-1 Government Agencies Related to Water Works (1/2)

DEPARTMENT OF GOVERNMENT	LINE BUREAU OF ATTACHED AGENCY	RESPONSIBILITIES/CONCERNS RELATED TO WATER
1. National Economic and Development Authority (NEDA)	1. Infrastructure Staff	Formulates and approves policies on water resources.
	2. Regional Development Councils (RDCs)	Sets direction of economic and social development in region through which regional development efforts are coordinated.
	3. Investment Coordination Committee/NEDA Board	Evaluates/appraises/approves major development Projects
2. Department of Public Works & Highways (DPWH)	3. National Water Resources Board (NWRB)	Coordinates and regulates water activities in the country; supervises and regulates operations of water utilities outside the jurisdiction of LWUA and MWSS; formulates and recommends policies on water resources.
	4. Metropolitan Water-works & Sewerage System (MWSS)	Constructs, maintains and operates domestic/municipal water supply and sewerage projects in Metropolitan Manila and contiguous areas including watershed mng'mt.
	5. Local Water Utilities Administration (LWUA)	Specialized lending institution for promoting, develop-ing, regulating & financing water utilities (excl. Metro-Manila).
	6. Bureau of Research & Standards (BRS)	Undertakes hydrological surveys and data collection.
	7. PMO - Major Flood Control Projects (PMO-MFCP)	Manages the planning, design, construction, organiza-tion and maintenance of major flood-control projects.
	8. PMO - Rural Water Supply (PMO-RWS)	Manages the planning, design, construction, organiza-tion & maintenance of foreign-assisted rural water supply projects.
	9. PMO - Small Water Impounding Projects (PMO-SWIM)	Manages the planning, design and construction of locally-funded and foreign-assisted SWIM projects.
3. Department of Agriculture (DA)	10. National Irrigation Administration (NIA)	Undertakes program-oriented and comprehensive water resources projects for irrigation purposes, as well as concomitant activities such as flood control, drainage, land reclamation, hydraulic power development, watershed management, etc.
	11. Bureau of Soils & Water Management (BSWM)	Undertakes assessment, development and conservation of existing and potential soil and water sources for agriculture; undertakes cloud seeding activities.
	12. Bureau of Fisheries & Aquatic Resources (BFAR)	Formulates plans for the proper management, accelerated development and proper utilization of the country's fisheries and aquatic resources.
4. Department of Energy (DOE)	13. National Power Corporation (NPC)	Develops electric power generation facilities including hydroelectric and geothermal power; constructs dams, reservoirs, diversion facilities and plants and watershed management.
	14. National Electrification Administration (NEA)	Promotes, encourages and assists public service entities to achieve service objectives, implements mini-hydro projects.
	15. Office of Energy Affairs (OEA)	Promotes development of indigenous energy resources such as mini-hydro projects.

Table 1-6-1 Government Agencies Related to Water Works (2/2)

5. Department of Environment & Natural Resources (DENR)	16. Environmental Management Bureau (EMB)	Formulates environment quality standards for water, air, land, noise & radiation; Approves environment impact statements and issues Environmental Clearance Certificates.
	17. Mines & Geo-Science Bureau (MGSB)	Manages, develops and conserves the country's mineral resources; monitors and maps groundwater resources.
	18. Forest Management Bureau (FMB)	Formulates and recommends policies and programs for the effective protection, development, management and conservation of forest lands and watersheds.
	19. Protected Areas & Wildlife Bureau (PAWD)	Undertakes the protection and conservation of natural wetlands such as lakes, marshes, swamps etc.
	20. National Mapping & Resources Management Authority (NAMRIA)	Responsible for integrated surveys, mapping, charting, oceanography, land classification, aerial photography, remote sensing etc.
	21. Laguna Lake Development Authority (LLDA)	Responsible for regional water resources development and management in the Laguna Lake catchment area.
6. Department of Health (DOH)	22. Environmental Heath Services (EHS)	Responsible for water supply & sanitation programs and strategies to forestall environment-related diseases.
	23. Bureau of Research Laboratories (BRL)	Monitors quality of drinking water.
7. Department of Science & Technology (DOST)	24. Philippine Atmospheric, Geophysical & Astron. Services Admin. (PAGASA)	Disseminates atmospheric, geophysical and astronomical data for use by economic sectors, the scientific and engineering community and the general public.
	25. Phil. Council for Agric. Forestry & Natural Resources Research & Develop. (PCAFNRRD)	Formulates national agricultural, forestry & natural resources research & development programs on a multi-disciplinary, inter-agency approach for the various commodities including water resources.
8. Department of Interior & Local Government (DILG)	26. PMO-Water Supply & Sanitation (PMO-WSS)	Supports the provision of WS&S Services by Local Government Units (LGUs)
	27. Provincial Governments	Coordinated with, and supported by, national line agencies and other entities, promote development of infrastructure including irrigation, water supply, electric power and roads.
	28. Municipal & Barangay Governments	Coordinated with, & supported by, national/agencies, promote municipal & barangay WS&S, watershed & other programs.
9. Department of National Defense (DND)	29. Office of Civil Defense (OCD)	Monitors safety of dams and other water resources projects; prepares and support the General public in emergencies.
	30. Philip. Air Force (PAF)	Undertakes rain enhancement through cloud seeding.
10. Dept. of Transportation & Comm. (DOTC)	31. Philippine Ports Authority (PPA)	Plans, develops, operates and maintains ports and port facilities.
11. Department of Tourism (DOT)	32. Philippine Tourism Authority (PTA)	Promotes and develops the recreational use of water resources.
12. Dept. of Trade & Industry (DTI)	33. Board of Investments (BOI)	Proponent of the Calabarzon integrated area study, covering water resources among, other aspects.

Source: Based on NWRB: "Situation Report on Water Resources", 1994

Part II : Major River Basins and Urban Centers

II.1 Major River Basins

(1) Laoag River Basin

The Laoag river basin has a drainage area of about 1,353 km^2. Located in the northwestern part of the Luzon Island, it lies within the province of Ilocos Norte.

River System

The Laoag river basin is bounded on the west by the South China Sea, on the east and north by the Central Cordillera Mountains, and on the south by the Abra river basin.

The basin, which originates in the northern wing of Cordillera Central, flows down on a northerly direction for about 30 km, collecting runoff from the tributaries originating in mountain ranges all around the Laoag river basin. Near Dingras, the river turns its course to the northwest and passes through the valley area and finally discharges to the South China Sea. The Laoag river is formed by the convergence of numerous small rivers originating in mountain ranges all around the basin.

Its major tributaries are the Papa, Madongan, Solsona, Cura and Guisit rivers. The major features of the Laoag river basin are summarized below.

River	Basin Area (km^2)	River Length (km)	Overall Slope
Whole Laoag River	1,353	73	1/55
Papa	103	19	1/15
Madongan	193	35	1/19
Solsona	163	31	1/21
Cura	289	38	1/21
Guisit	162	25	1/34

Source: Nationwide Flood Control Plan and River Dredging Program (1982)

Population

Description	Ilocos Norte			Laoag City		
	1980	1990	1995	1980	1990	1995
Population (thousands)	391	462	483	70	84	88
Population Density (person per sq. km)	114.9	135.9	142.1	647.9	779.1	821.7

Source: NSO

Land Uses

Category	Ilocos Norte		Laoag City	
	Area (ha)	Percentage	Area (ha)	Percentage
A. Agriculture				
Cropland	84,567	24.9%	7,110	66.1%
Tree Farm	10,957	3.2%	1	0%
Piggery/Poultry	268	0.1%	36	0.3%
Fisheries	966	0.3%	81	0.8%
B. Forest				
Timber/Woodland	151,799	44.7%	262	2.4%
Grass Land/Pasture	46,926	13.8%	0	0%
C. Built-up Areas	11,643	3.4%	858	8.0%
D. Other Land Use	32,634	9.6%	2403	22.4%
Total	339,760	100.0%	10,751	100.0%

Source: PPDO, Ilocos Norte (1994)

Inundation and Damages

The 1967 Typhoon Gening, 1986 Typhoon Meding and 1992 Typhoon Maring were the three (3) identified typhoons that caused the largest floods in the past. They caused big damages over the entire basin. The flooded area and affected population by these floods were estimated, based on interviews, as follows:

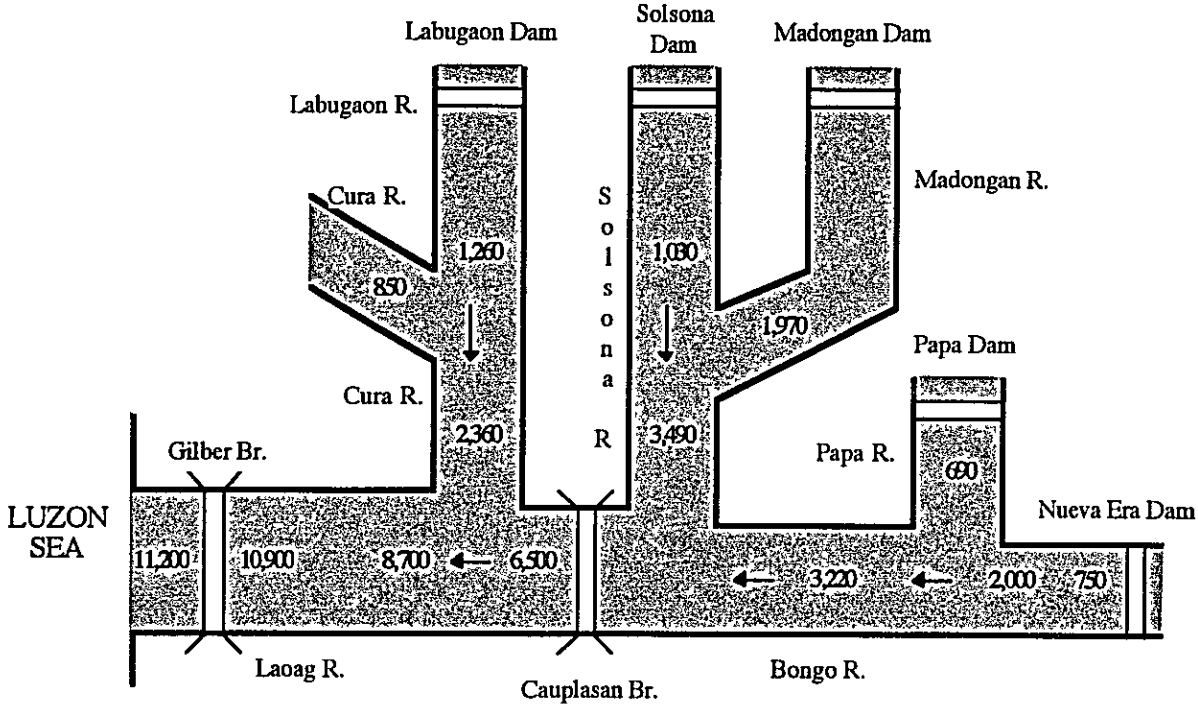
Year : 1967 Typhoon: Gening		Year : 1986 Typhoon : Meding		Year : 1992 Typhoon : Maring	
Flooded Area (ha)	Affected Population	Flooded Area (ha)	Affected Population	Flooded Area (ha)	Affected Population
11,991	39,092	7,531	52,513	5,351	36,399

Source: OCD, Region 1

Main Project/Study

Title	Year	Agency	Status
Feasibility Report on Ilocos Norte Irrigation Project in the Philippines	1979	JICA	F/S
Nationwide Flood Control Plan and River Dredging Program	1982	MPWH/OECF	M/P
The Ilocos Norte National Irrigation Project Phase 1	1987	NIA/OECF	D/D & Construction
The Study on Sabo and Flood Control in the Laoag River Basin	1996-	JICA	F/S (Ongoing)

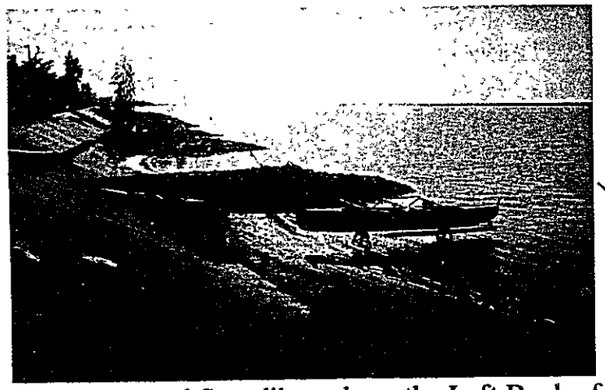
Proposed Design Discharge



Design Scale : 25-Year Recurrence

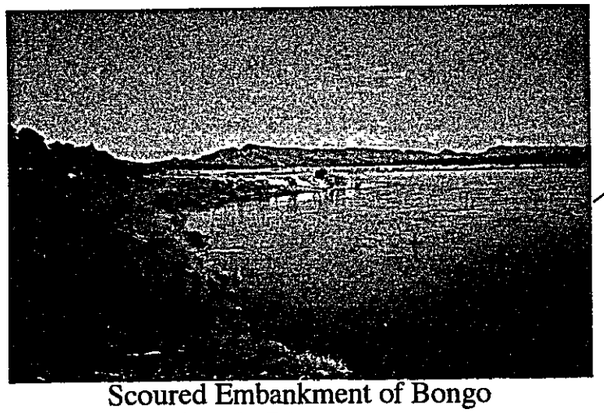
Source : The Study on Sabo and Flood Control in the Laoag River Basin, 1996, JICA

(1) Laoag River Basin



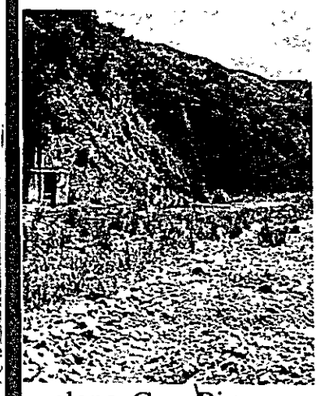
Revetment and Spurdikes along the Left Bank of Laoag River near the River Mouth

Spurdikes along Laoag River in San Nicolas Town

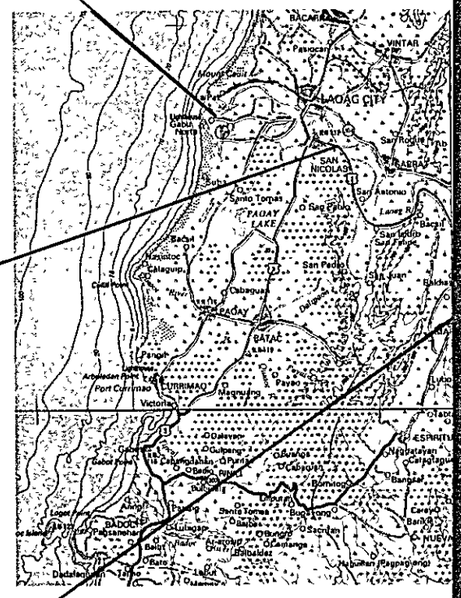


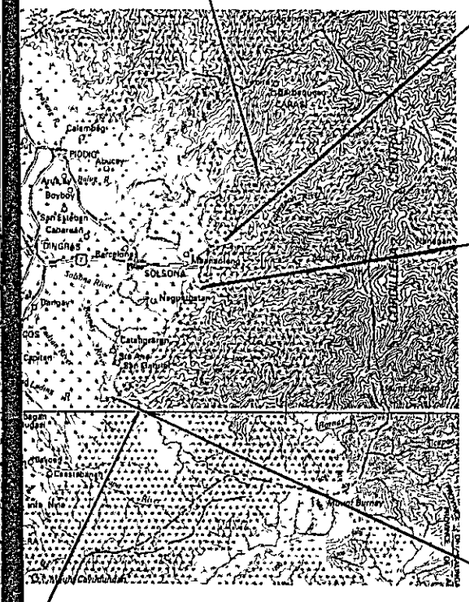
Scoured Embankment of Bongo River in Dingras Town

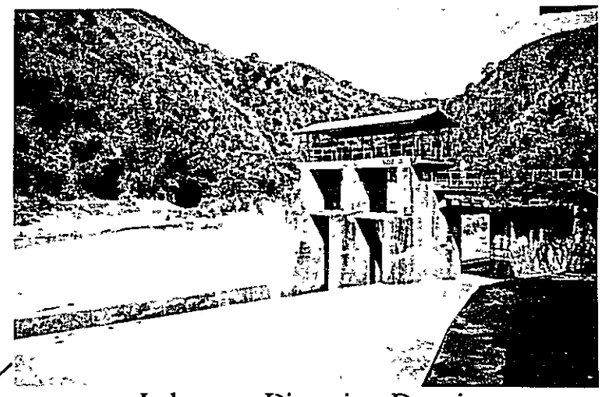
Cura Intake Canal



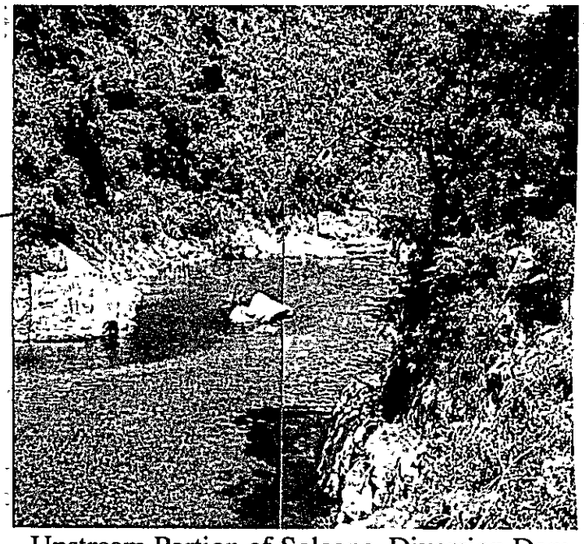
along Cura River



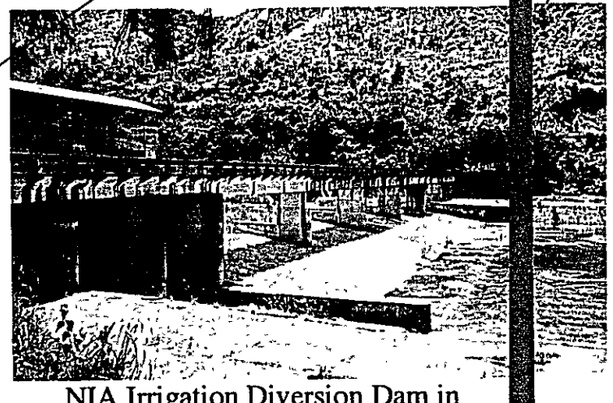




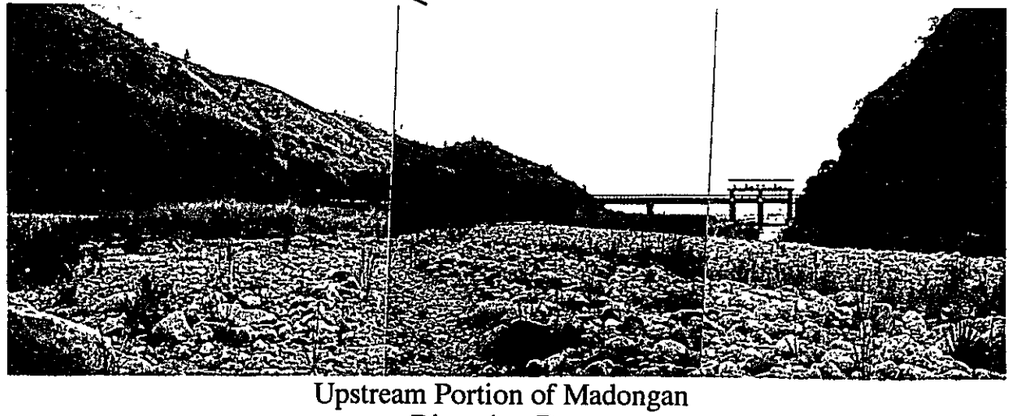
Labugaon Diversion Dam in Lagugaon River



Upstream Portion of Solsona Diversion Dam (Karingking Resort)



NIA Irrigation Diversion Dam in Madongan River



Upstream Portion of Madongan Diversion Dam

(2) Cagayan River Basin

The Cagayan river basin, located in the northern part of Luzon Island, is the largest basin in the Philippines. It occupies the major part of Cagayan, Isabela, Quirino, Kalinga-Apayao, Mountain Province, Ifugao and Nueva Vizcaya provinces and a small portion of Aurora province. The basin is bounded by Sierra Madre Mountains in the east, by Caraballo Mountains in the south, by Cordillera mountains in the west and by the coastal line of Babuyan channel in the north.

River System

The Cagayan river originates in the Caraballo Mountains near the Nueva Vizcaya - Nueva Ecija provincial boundary. The river, which flows down to the north, is joined by the Magat, Ilagan, Siffu-Mallig and Chico rivers. The river drains into the Babuyan channel in the northern extremity of Luzon Island.

The Cagayan river basin, also called the Cagayan Valley, is a feather-shaped one surrounded by the Sierra Madre Mountains in the east and the Cordillera Central Mountains in the west. Tributaries on the right side of the river are relatively steep with smaller basin areas, since the Cagayan river takes its route closer to the Sierra Madre Mountains. The flat plains extend mainly to the left side of the river. The Cagayan river has a drainage area of 27,280 km^2. Physical basin features are summarized as follows:

River	Basin Area (km^2)	River Length (km)	Overall Slope
Whole Cagayan River	27,280	505	1/9,300 to 1/3,200
Magat	4,638	178	1/640
Ilagan	2,926	170	1/1,900
Siffu-Mallig	2,321	133	1/4,300
Chico	4,551	210	1/1,900

Source: Nationwide Flood Control Plan and River Dredging Program (1982)

Population

Description	Cagayan		Isabela		Quirino		Ifugao		Mountain Province		Nueva Vizcaya	
	1980	1995	1980	1995	1980	1995	1980	1995	1980	1995	1980	1995
Population (thousands)	711	895	871	1,161	83	131	111	150	103	131	242	335
Population Density (person per sq. km)	79.0	99.4	81.6	108.9	27.22	42.8	39.4	59.6	49.1	62.5	61.9	85.8

Source: NSO

Land Uses (ha.)

Category	Cagayan Area	Isabela Area	Quiriono Area	Ifugao Area	Mountain Province	Nueva Vizcaya Area
A. Agriculture	569,025	397,195				
1. Cropland	392,662	235,108	62,941	19,391	21,853	40,145
Permanent	248,460	154,155				
Temporary	150,830	80,953				
2. Pasture	176,363	152,735	16,491	2,245	107,107	28,215
3. Fisheries		9,352				
B. Forest	474,329	489,392	167,838	65,862	98,292	301,469
C. Buit-up Areas	22,922	13,588	7,600		1,330	
D. Other Land Use	180	92	50,850	160,744	646	34

Source: Department of Agriculture, Region 2

Inundation and Damages

The 1973 Typhoon Openg, 1980 Typhoon Aring and 1982 Typhoon Weling are the three (3) identified typhoons that caused largest floods in the past. Unfortunately the damage data for 1973 Typhoon Openg are not available. Recently, there were many other typhoons which caused serious damages. These were the 1993 Typhoon Kadiang, 1994 Typhoon Weling and 1995 Typhoon Mameng.

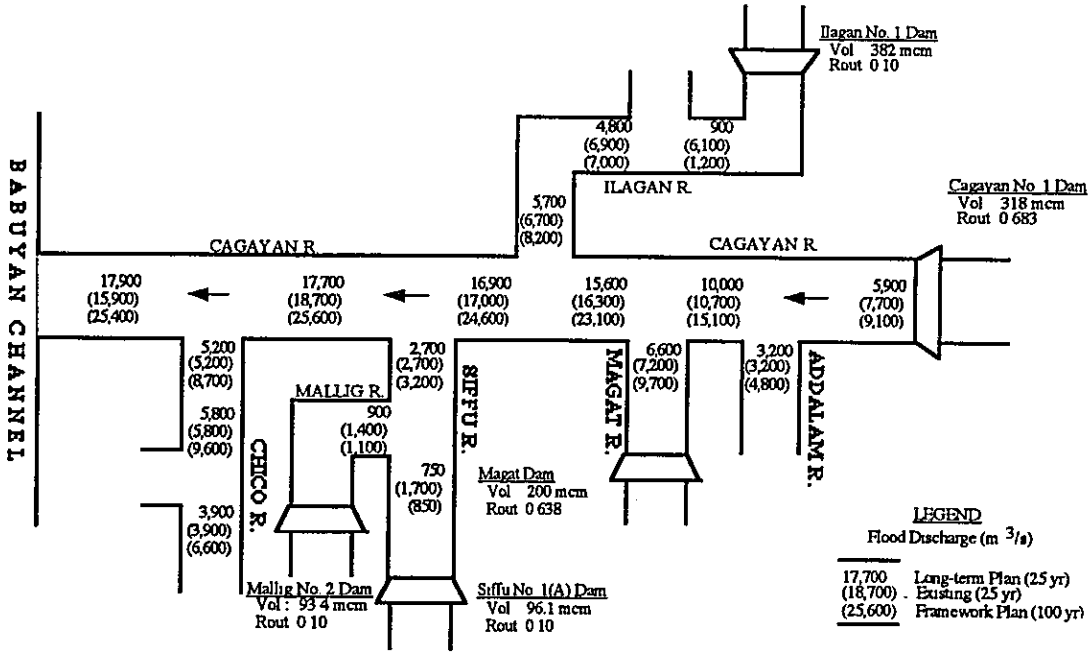
Description of Damages	Year : 1980 Typhoon: Aring	Year : 1982 Typhoon: Weling	Year : 1980 Typhoon: Maring	Year : 1995 Typhoon: Mameng
Casualties Dead/Missing	96	126	35	18

Source: OCD, Region 2

Main Project/Study

Title	Year	Agency	Status
Nationwide Flood Control Plan and River Dredging Program	1982	MPWH /OECF	M/P
M/P on the Cagayan River Basin Water Resources Dev't.	1985-87	JICA	M/P
Magat Dam	-84	NIA	DD/Const.

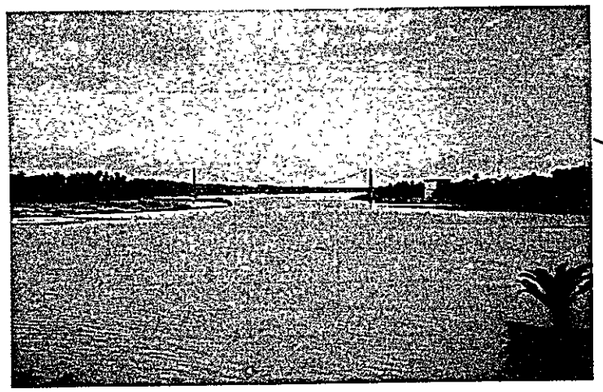
Proposed Design Discharge



DESIGN DISCHARGE FOR LONG TERM PLAN

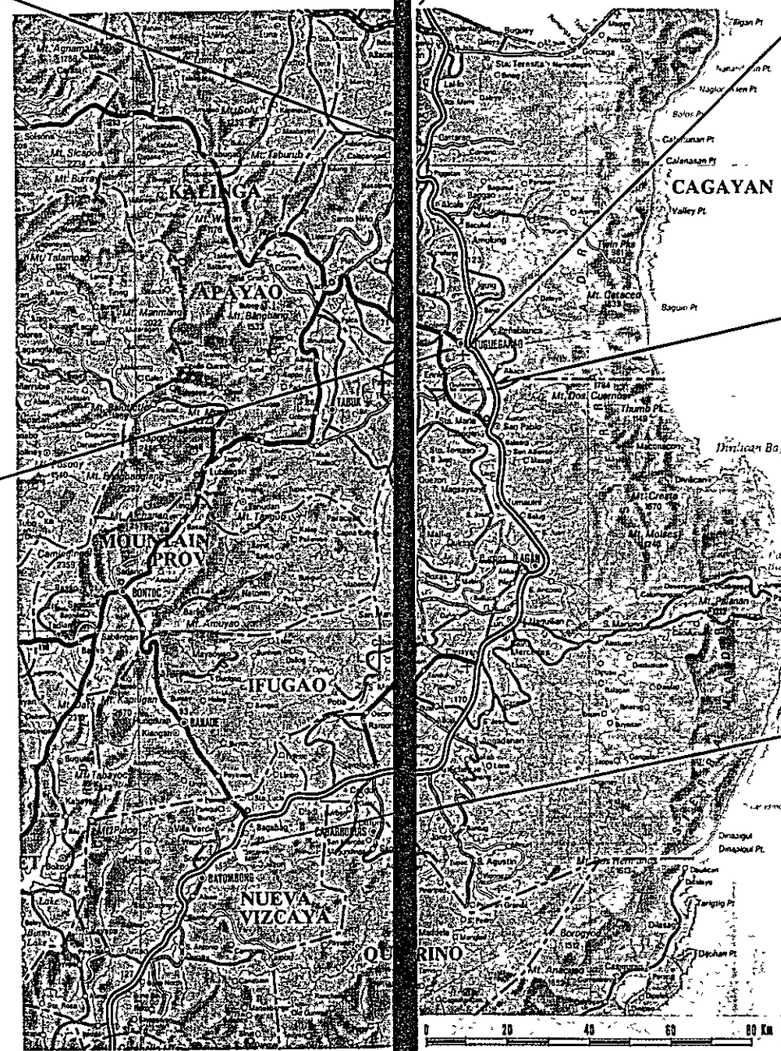
Source : M/P on the Cagayan River Basin Water Resources Development, 1987, JICA

(2) Cagayan River Basin



Magapit Bridge

River Mouth



Cataggaman Dike, Tuguegarao

Namabbalan Bank Protection

Spurdike near Tuguegarao

Magat River - Dadap Spurdike

(3) Agno River Basin

The Agno river, the fifth largest river in the Philippines, flows in Benguet, Pangasinan and Tarlac provinces.

River System

The Agno river originates in the Cordillera Central Mountains, and flows southward in the mountainous area. After passing the mountainous area, the Agno river flows out to a vast alluvial plain and then flows down towards Bayambang thereby collecting runoff from the left tributaries and joins the Tarlac river, a major tributary of the Agno river. At the confluence of these 2 rivers is the Poponto swamp which have an approximate area of 30 km^2 spread over during the wet season and functions as a natural retarding basin, thus aiding in the reduction of flood peak in the downstream. During summer the Poponto swamp dries up. After joining the Tarlac river, the Agno river turns northwestward collecting runoff from the northern slope of the Zambales Mountains and finally discharges into the Lingayen Gulf.

A vast alluvial plain and a delta known to be formed by the Agno river is the Pangasinan plain, which has been developed agriculturally for a long time. Main features of the Agno basin are summarized below.

River	Basin Area (km^2)	River Length (km)	Overall Slope
Whole Agno River	5,697	206	1/91
Tarlac	1,740	93	1/58
Ambayaoan	421	39	1/33
Viray-Depalo	140	30	1/21
Camiling	709	60	1/100

Source: Nationwide Flood Control Plan and River Dredging Program (1982)

Population

Description	Pangasinan			Benguet			Tarlac		
	1980	1990	1995	1980	1990	1995	1980	1990	1995
Population (thousands)	1,636	2,020	2,178	355	486	541	689	860	946
Population Density (person per sq. km)	304.8	376.3	405.7	113.6	183.0	203.7	225.2	281.7	309.8

Source: NSO

Land Uses (Pangasinan Province)

Category	Area (ha)	Percentage of Area
A. Agriculture	373,720	
1. Cropland	238,070	44.4%
2. Pasture	122,608	22.8%
3. Fisheries	13,042	2.4%
B. Forest	130,423	24.3%
C. Built-up Areas	19,375	3.6%
D. Other Land Use	13,300	2.5%
Total	536,818	100.0%

Source: Provincial Planning Development Office, Pangasinan

Inundation and Damages

The Agno river basin has experienced large floods in 1935, 1936, 1937, 1938, 1943, 1950, 1960, 1968, 1972, 1980, 1984, 1986 and 1992. The flood in 1972, the largest ever recorded, inundated almost the entire flood prone area.

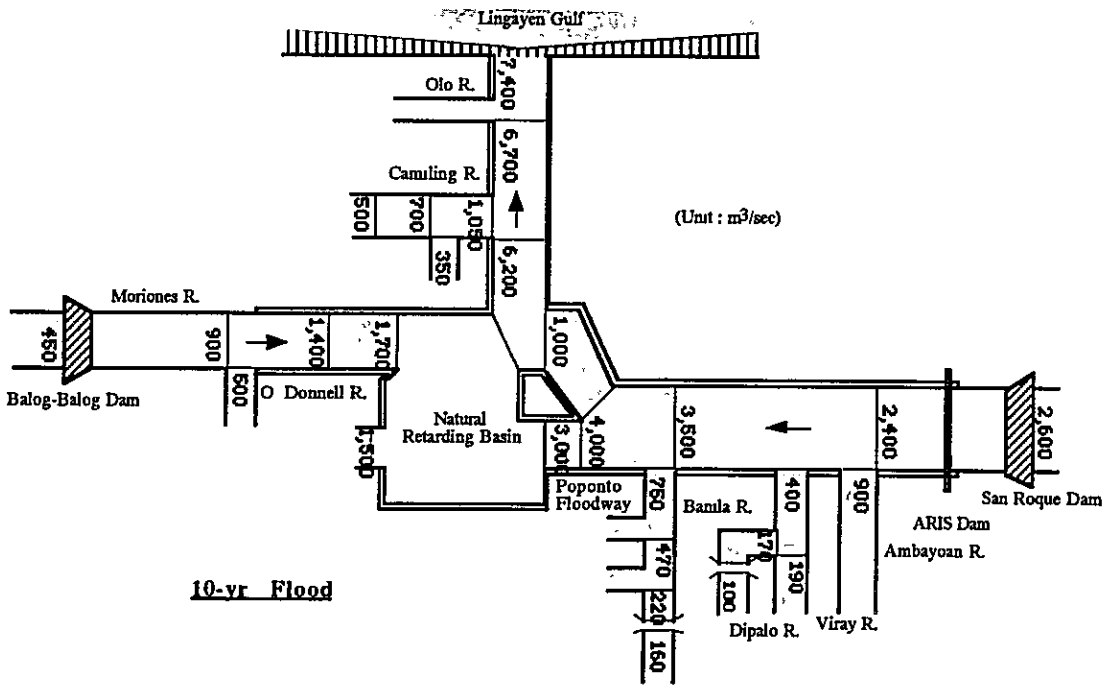
Description of Damages	Year: 1976 Typhoon	Year: 1980 Typhoon	Year: 1993 Typhoon
Casualties Dead/Missing	21	336	49
Houses and Buildings			
Totally Destroyed	3,917	16,510	164,174
Partially Destroyed	4,912	47,573	444,904
Damaged Cost	₱ 12.2 Mil.	₱ 366.3 Mil.	₱ 1,085 Mil.

Source: OCD

Main Project/Study

Title	Year	Agency	Status
Nationwide Flood Control Plan and River Dredging Program	1982	MPWH /OECF	M/P
Study of Agno River Basin Flood Control Project	1989-1991	JICA	M/P & F/S
Urgent Rehabilitation and Improvement Works for the Agno River Flood Control Project	1994	DPWH/ OECF	D/D
Agno and Allied Rivers Urgent Rehabilitation Project	1996-	DPWH/ OECF	Construction (On-going)
Ambuklao Dam	-1957	NPC	Construction
Binga Dam	-1960	NPC	Construction

Proposed Design Discharge

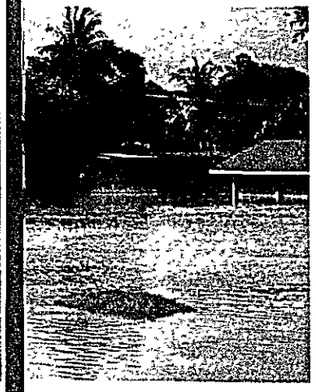


Source : Study of Agno River Basin Flood Control, 1994, JICA

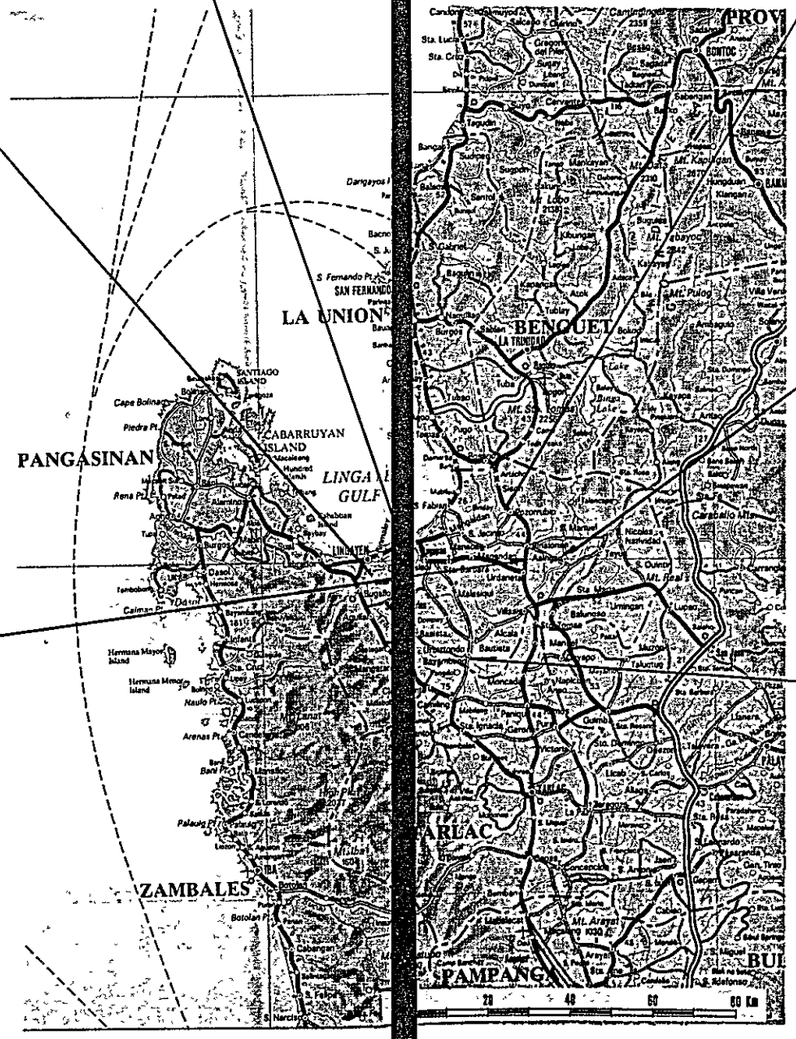
(3) Agno River Basin

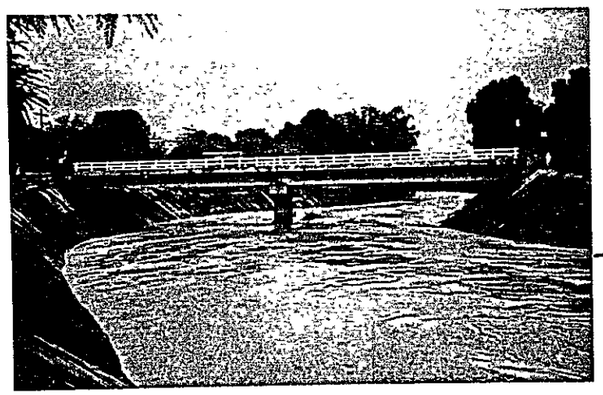
Lower Agno River

Inundation by Typhoon



Rosing - August 20, 1996





Revetment around
Tagamusing Bridge

Bued River in Sison

Newly completed Dike with Gabion
Mattress at Ambayaoan River

Poponto Floodway

(4) Pampanga River Basin

The Pampanga river basin, the 4th ranked river basin in the Philippines, is located in Central Luzon. The basin covers major portions of Pampanga, Bulacan and Nueva Ecija provinces and small portions of Zambales, Rizal, Quezon, Tarlac and Nueva Vizcaya provinces.

River System

The Pampanga river originates in the Caraballo Mountains and it flows in a southerly direction to its mouth in Manila Bay, joining its major tributaries: the Rio Chico Talavera river near Mt. Arayat and the Angat river at Sulipan. At Masantol, the Bebe-San Esteban diversion channel bifurcates from the Pampanga river and joins to the Pasig river, while the Angat river diverts its flow to the Labangan floodway at Calumpit.

In the middle reaches of the Pampanga river, there exist two (2) swamps, i.e., Candaba swamp (250 km^2) lying between the Angat and Pampanga rivers, and San Antonio swamp (120 km^2) between the Rio Chico and Pampanga rivers.

The total drainage area of the Pampanga river is 10,503 km^2 including the Pasag river basin.

River	Basin Area (km^2)	River Length (km)	Overall Slope
Whole Pampanga River	10,503	260	1/160
Pampanga River	8,907	260	1/160
Origin to Sapang Buho		91	1/60
Sapang Buho to Arayat		108	1/1,000 to 1/3,000
Arayat to Calumpit		35	1/7,000
Calumpit to rivermouth		26	1/20,000
Rio Chico River	3,020	80	1/3,600
Angat River	895	115	1/110
Pasag (or Guagua) River	1,596	75	1/110

Source: Nationwide Flood Control Plan and River Dredging Program (1982)

Population

Description	Pampanga			Nueva Ecija		
	1980	1990	1995	1980	1990	1995
Population (thousands)	1,182	1,533	1,636	1,069	1,313	1,506
Population Density (person per sq. km)	541.8	703.0	750.2	202.4	248.5	285.0

Source: NSO

Land Uses (Pampanga Province)

Category	Area (ha)		Percentage of Area	
	Before Eruption*	After Eruption*	Before Eruption*	After Eruption*
A. Agriculture				
1. Cropland	104,239	104,421	47.84%	48.10%
2. Pasture	19,579	18,579	8.98%	8.56%
3. Fisheries	42,341	42,341	19.43%	19.51%
B. Forest	15,884	15,884	7.30%	7.32%
C. Built-up Areas	29,123	28,296	13.37%	13.03%
D. Other Land Use	6,720	7,547	3.08%	3.48%
Total	217,886	217,068	100.00%	100.00%

Source: Provincial Planning & Development Office, Pampanga

* Mt. Pinatubo Eruption in June, 1991

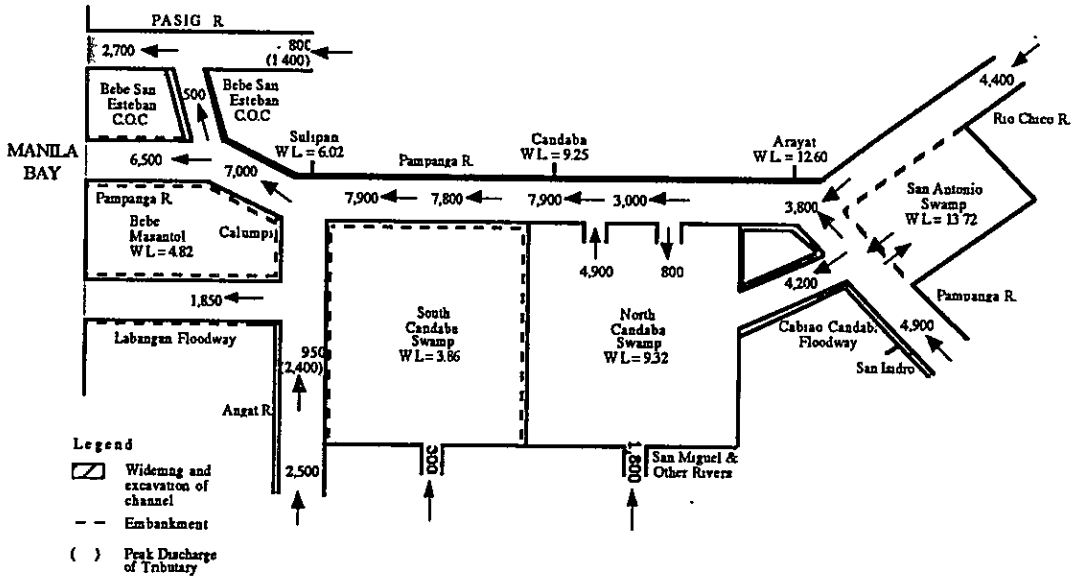
Inundation and Damages

The floods in 1960, 1972 and 1976 are the remarkable floods since 1960. These floods inundated 1,400 km^2 of lands. Since the eruption of Mt. Pinatubo in 1991, frequent floods were inflicting much damages on infrastructures, crops, fish ponds and residential/commercial establishments in the entire flood plain area of 2,200 km^2.

Main Project/Study

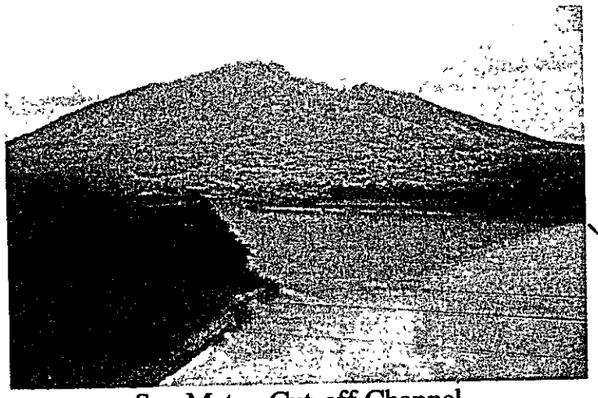
Title	Year	Agency	Status
Pampanga Delta Development Project	1980-1982	JICA	F/S
Nationwide Flood Control Plan and River Dredging Program	1982	MPWH/OECF	M/P
Pampanga Delta Development Project	1987-1989	DPWH/OECF	D/D
Pampanga Delta Development Project	1993-	DPWH/OECF	Construction (On-going)
Pantabangan Dam	1969-1976	NIA/IBRD	Construction
Angat Dam	-1968	NPC/ADB	Construction

Proposed Design Discharge

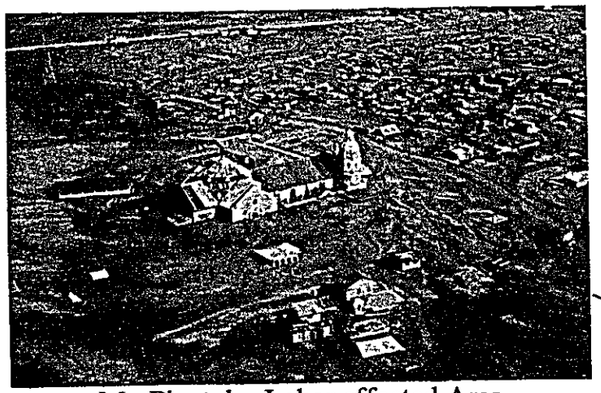


Source : Design Report (Flood Control Component), PDDP, 1989, DPWH/OECF

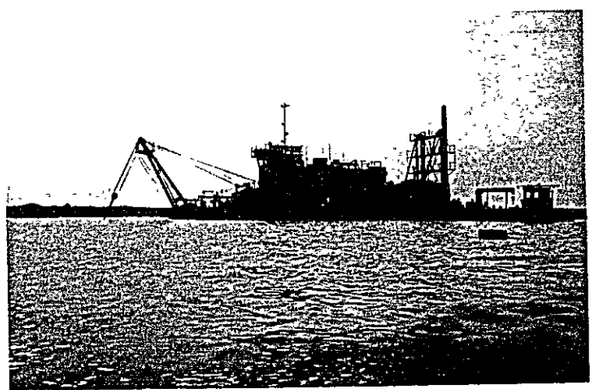
(4) Pampanga River Basin



San Mateo Cut-off Channel
at Mt. Arayat



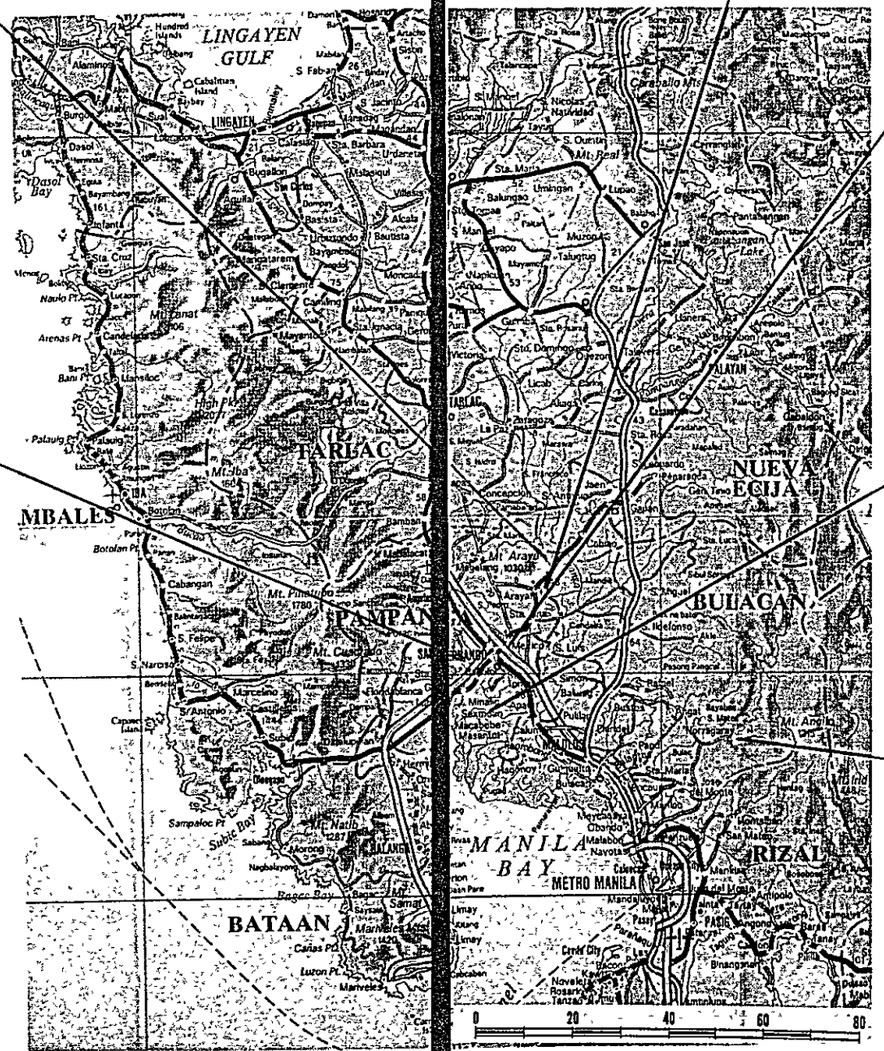
Mt. Pinatubo Lahar affected Area,
Bacolor, 1995



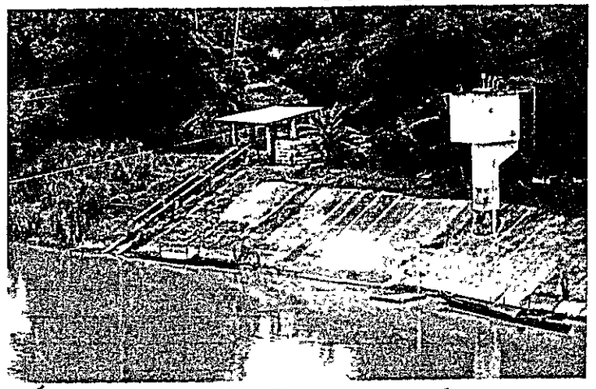
Dredging Machine for Pampanga
Delta Development Project

Apalit - Arayat

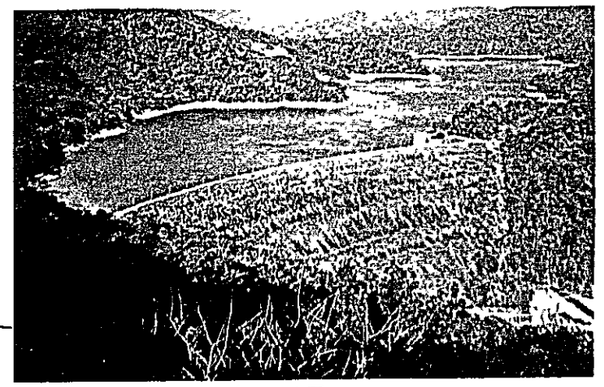
Set Back Levee



Pampanga River showing scoured
Section at Barangay Cupang



Mancatian Revetment and
Rain Gauge Station



Angat Dam

(5) Pasig-Marikina (Laguna Bay) River Basin

The Pasig-Marikina River and Laguna Bay are located in the central part of Luzon Island. The basin occupies the major part of NCR and of Rizal and Laguna provinces, which are the most populated areas in the Philippines.

River System

The Pasig River, which flows from east to west through the center of Metro Manila, extends about 17.0 km from the confluence of the Marikina River and the Napidan Channel to the Manila Bay. It has a fairly direct course, except for its double-loop meander at the Punta-Santa Ana area. One of its principal tributaries is the San Juan River, which enters the Pasig River at the lower river meander about 6.0 km upstream of the river mouth.

Upstream from the junction with the Napindan Channel, the Pasig River is named the Marikina River which originates in the western side of the Sierra Madre Mountain about 35.0 km northeast of Manila. At the town of Montalban, the river emerges from the foothills of the mountain range, turning and flowing southward through the Marikina Valley until it become the Pasig River.

River	Basin Area (km^2)	River Length (km)	Overall Slope
Pasig-Marikina	634	78	1/29,000 - 1/1,200
San Juan	91	14	
Buli-Baho-Mahaba	74	25	1/1,400 - 1/800(Baho) 1/1,000 - 1/400 (Buli)

Source: Study on Flood Control and Drainage Project in Metro Manila (1990, JICA)

Population

Description	NCR			Rizal			Laguna		
	1980	1990	1995	1980	1990	1995	1980	1990	1995
Population (thousands)	5,926	7,928	9,454	556	977	1,313	973	1,370	1,631
Population Density (person per sq. km)	9,317.4	12,465.4	14,864.8	424.4	746.4	1,003.1	553.0	778.7	926.9

Source: NSO

Land Uses (ha.)

Category	Pasig-Marikina	San Juan	Buli-Baho-Mahaba
A. Agriculture			
1. Cropland	2.6	0.0	0.0
2. Pasture	0.0	0.0	0.0
3. Fisheries	9.0	0.0	1.0
B. Forest	451.5	0.0	2.0
C. Built-up Areas	70.8	77.1	66.0
D. Other Land Use	9.0	14.3	5.3

Source: Department of Agriculture, Region 4

Inundation and Damages

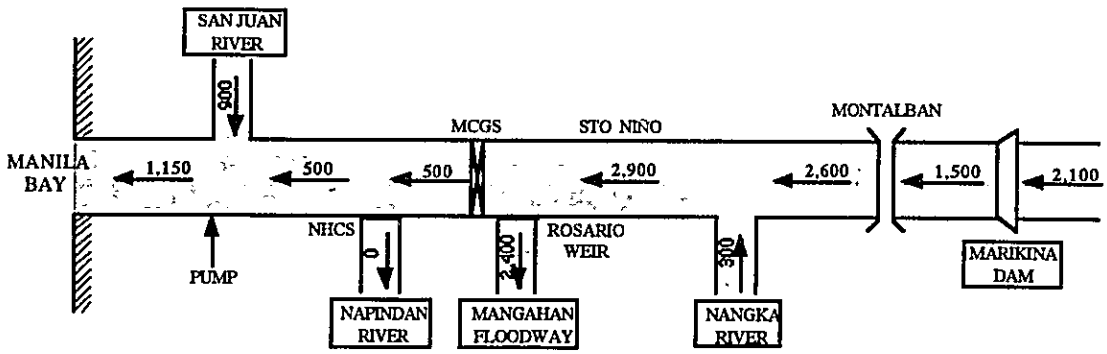
Flooding in 1986 caused by Typhoon Meding, inflicted the most serious damage in recent years to Metro Manila. The flooded area in Metro Manila reached 86.7 km^2 or 14.5% of Metro Manila. If the flooded area of Cainta and Taytay which are both located in the Marikina Valley, are included, the total flooded area was 103.6 km^2.

Flooding in 1988 caused by Typhoon Unsang also inflicted serious damage in the Marikina River Basin and in the low-lying shoreline area of the Laguna Lake because of the overflowing flood water of the Marikina River and the incremental high lake stage, respectively. The Provident Subdivision, which is located at the right bank side in the lower reach of Sto. Niño, suffered tremendous damage because of the destruction of the river wall by the flood flow.

Main Project/Study

Title	Year	Agency
Marikina River Multipurpose Project	1954	Marikina Proj. Coordinating Committee (MPCC)
Feasibility Study for the Hydraulic Control of the Laguna de Bay Complex and Related Development Activities	1970	UNDP, ADB
Laguna de Bay Water Resources Development	1973	LLDA/UNDP, ADB
A Feasibility Study on Mangahan Floodway	1975	DPWTC/USAID
Review and Evaluation, Marikina Multi-purpose Project	1978	
Metro-Manila Integrated Urban Drainage and Flood Control Master Plan	1983	MPWH/IBRD
Construction of Napindan Hydraulic Control Structure	1985	MPWH/ADB
Construction of Mangahan Floodway	1988	DPWH/OECF
Study on Flood Control and Drainage Project in Metro Manila	1990	JICA
Detailed Design of North Laguna Lakeshore Urgent Flood Control and Drainage Project	1992	DPWH/OECF
Construction of an Effective Flood Control Operation System including Telemetering and Flood Warning System in the Pasig-Marikina-Laguna Lake Complex	1993	DPWH/OECF

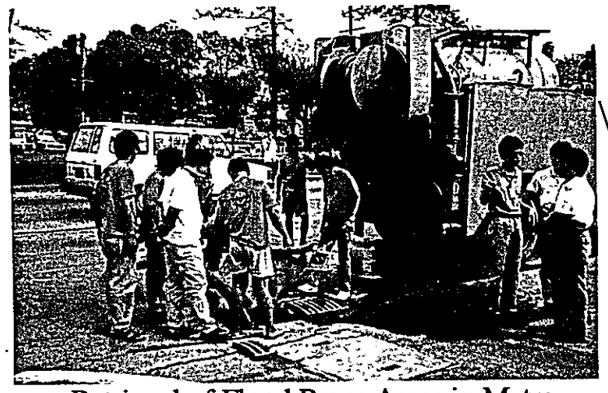
Proposed Design Discharge



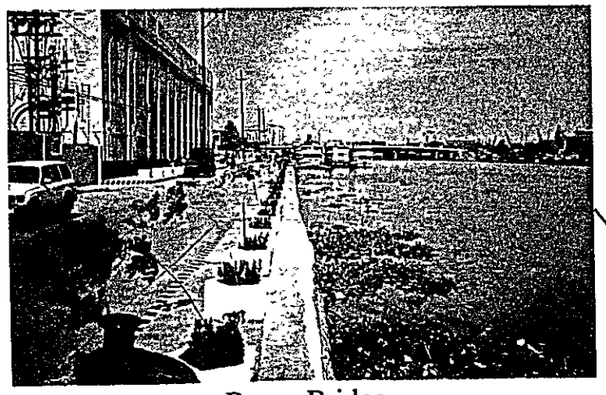
Design Discharge is of a 100-year return Period

Source: Study on Flood Control and Drainage Project in Metro Manila, 1990, JICA

(5) Pasig-Marikina River Basin

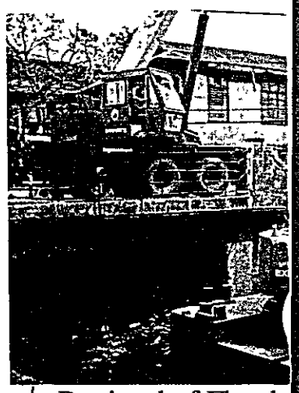


Retrieval of Flood Prone Areas in Metro Manila, JICA Grant Aid Program

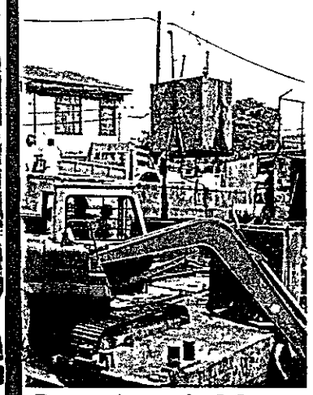


Roxas Bridge

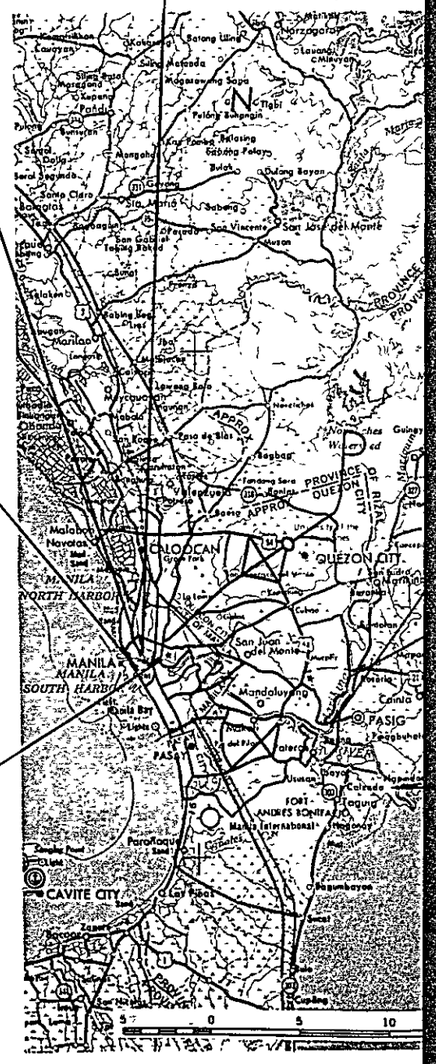
Mini-Forest Park (Between Quezon Bridge and Ayala Bridge

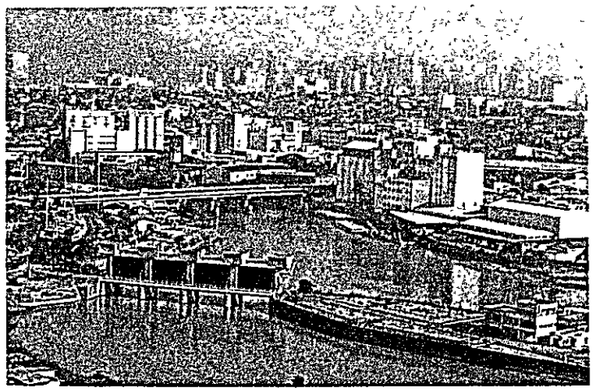


Retrieval of Flood Manila, JICA

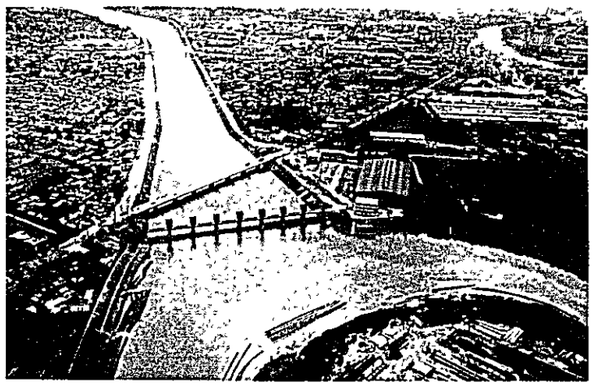


Prone Areas in Metro Grant Aid Program

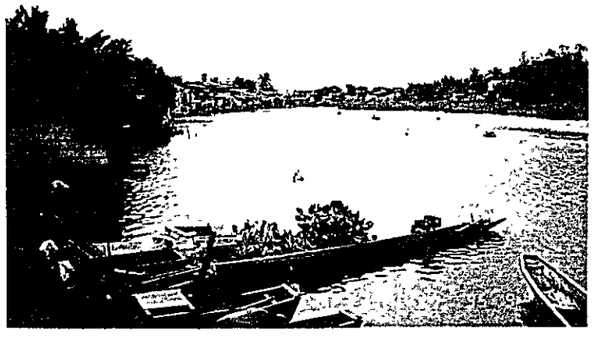




Napindan Gate



Mangahan Floodway



Napindan River