completed by F.F.Cruz Co., Inc., and survey expert of the Study Team supervised observation and computation of leveling.

(3) *Field Classification*

Field classification to verify necessary information based o% 3 on the map legend of Philippines for the preparation of photogrammetric mapping was carried out by F.F.Cruz Co., Inc., and all information collected in the field was definitely described on the 2 times enlargement photographs.

(4) Uncontrolled Mosaic

Uncontrolled photo mosaic at a scale of 1:30,000 was completed by F.F. Cruz Co., Inc., and consisted of following aerial photographs.

- 1:30,000 new aerial photography
- 1:8,000 new aerial photography
- 1:60,000 existing photography, 1981.

3.2 Photogrammetric Mapping

(1) Aerial triangulation

Aerial triangulation based on the result of ground control survey was conducted adopting the analytical method of independent models block adjustment.

(2) Photogrammetric mapping

Photogrammetric mapping at a scale of 1:25,000 with 5 meter contour interval for 1,000 km^2 basin area covered the Agno river and main tributaries and photogrammetric mapping with 1 meter contour interval at a scale of 1:5,000 for 30 km^2 area in the Poponto swamp were prepared according to the following procedures:

- Stereo plotting
- Compilation
- Fair drawing

(3) Inspection

Immediately after completion of above works the Survey Technique Center *of Japanese Association of Surveyors inspected the final results of* photogrammetric mapping.

(4) Dispatch of security officers

Two security officers accompanied aerial photography involving negatives, diapositives and prints to Japan in the period of three months from August to November, 1989.

Photogrammetric works using aerial photographs had been carried out up to the middle of November under the control of security officers.

The coverage of aerial photography with various scales utilized for photogrammetric mapping is defined in Figs.3 .1 to 3.4.

3.3 River Survey

River Survey including the following works was undertaken by ACRE Survey and Development and field works were completed in the end of June, 1989.

- Installation of BPMS 874 pts
- Traversing 275 km
- River Cross Section 437 sections
- Longitudinal profile 275 km

Work items of river survey were amended for urgent requirement of Allied Rivers Survey. The location of cross section survey of the Allied Rivers is shown in Fig.3.5 and the survey area of the Agno River is shown in Fig. 3.6. Amendment of specification for additional survey works of Allied Rivers are as follows :

(1) Additional survey of Allied Rivers

- Leveling to connect bridge sites
  120 linear kilometers
- Cross section survey
  3 sections

(2) Reduction of the Agno and the Tarlac Rivers for additional survey of the Allied Rivers.

- Cross section interval from the irrigation intake weir of ARIS to the Binga Dam 2 km
- Cross section interval in the Tarlac River 1.5 km
- Cross section interval of adjoining stream of the confluence of the main Agno and Tarlac Rivers 1 km

4. SURVEY MATERIALS TO BE SUBMITTED

The following survey materials are to be submitted to JICA up to the end of February, 1990.

(1) Photogrammetric mapping

- Topographic maps (original)	1 set
- Topographic maps (secondary original)	1 set
- Calculation data of the aerial triangulation	1 set
- Summary of ground control survey	1 set

(2) River Survey

- River cross sections (original)	1 set
- River longitudinal profile (original)	1 set
- Observation and computation data	1 set

(3) Uncontrolled mosaic

Reprinted photo mosaic	3 sets

(4) Aerial photography

All aerial photography including original negatives were submitted to the Government of the Philippines through General Headquarters, AFP Intelligence J2 after the completion of Photogrammetric works.

TABLES

Table 1.1 QUANTITIES OF SURVEY WORKS

Work Item	Survey Works
Preliminary Works in Japan	(1) Formulation of the plan of operation (2) Preparation of contract documents with local survey contractors
Survey Works in the Philippines	
Preparatory Works	(1) Contracts of Aerial photography, levelings, field classification, uncontrolled mosaic and river survey (2) Permission of using aerial photography and taking it out of Philippines (3) Collection of existing survey results
Aerial photography	(1) Scale 1:30,000 1,564 km^2 (2) Scale 1:8,000 377 km^2 (Area with no 1:30,000 scaled photography in river channel)
Leveling	(1) Agno river and main tributaries 275 km (Installation of PBM on both bank at 1km interval)
Field classification	Investigation of place names and planimetric features 1,000km^2
Additional field classification of existing aerial photography	Modification of photographic features which have been changed after taking photography 213 km^2
Uncontrolled mosaic	Preparation of 1:30,000 scaled photo mosaic 3 sheets
GPS positioning	Selection, Monumentation, observation, analysis and pricking 15 points
River Survey	(1) Cross section in Agno river and main tributaries including traversing and drawing of longitudinal profile 275 km (2) Leveling and cross section in Allied river 120 km
Photogrammetric mapping in Japan	
Aerial triangulation	Analytical method 120 models
Mapping	Stereo plotting, Compilation and fair drawing 1:25,000 1,000km^2 1:5,000 30 km^2
Inspection	Inspection of the survey results by Survey Technique Center of Japanese Association of Surveyors Scale 1:25,000 1,000km^2 Scale 1:5,000 30km^2

FIGURES

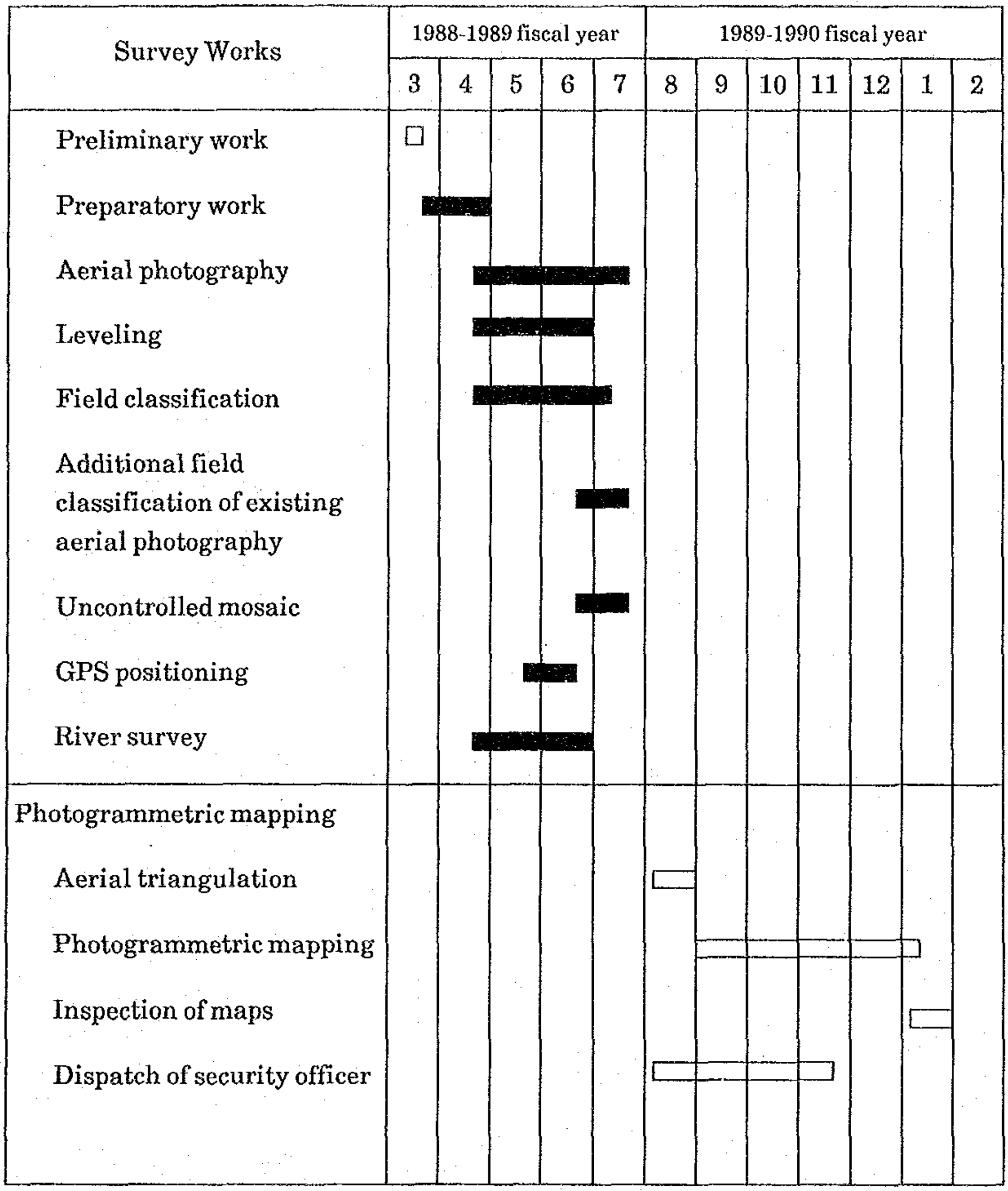

Fig. 1.1 WORKS SCHEDULE OF SURVEY

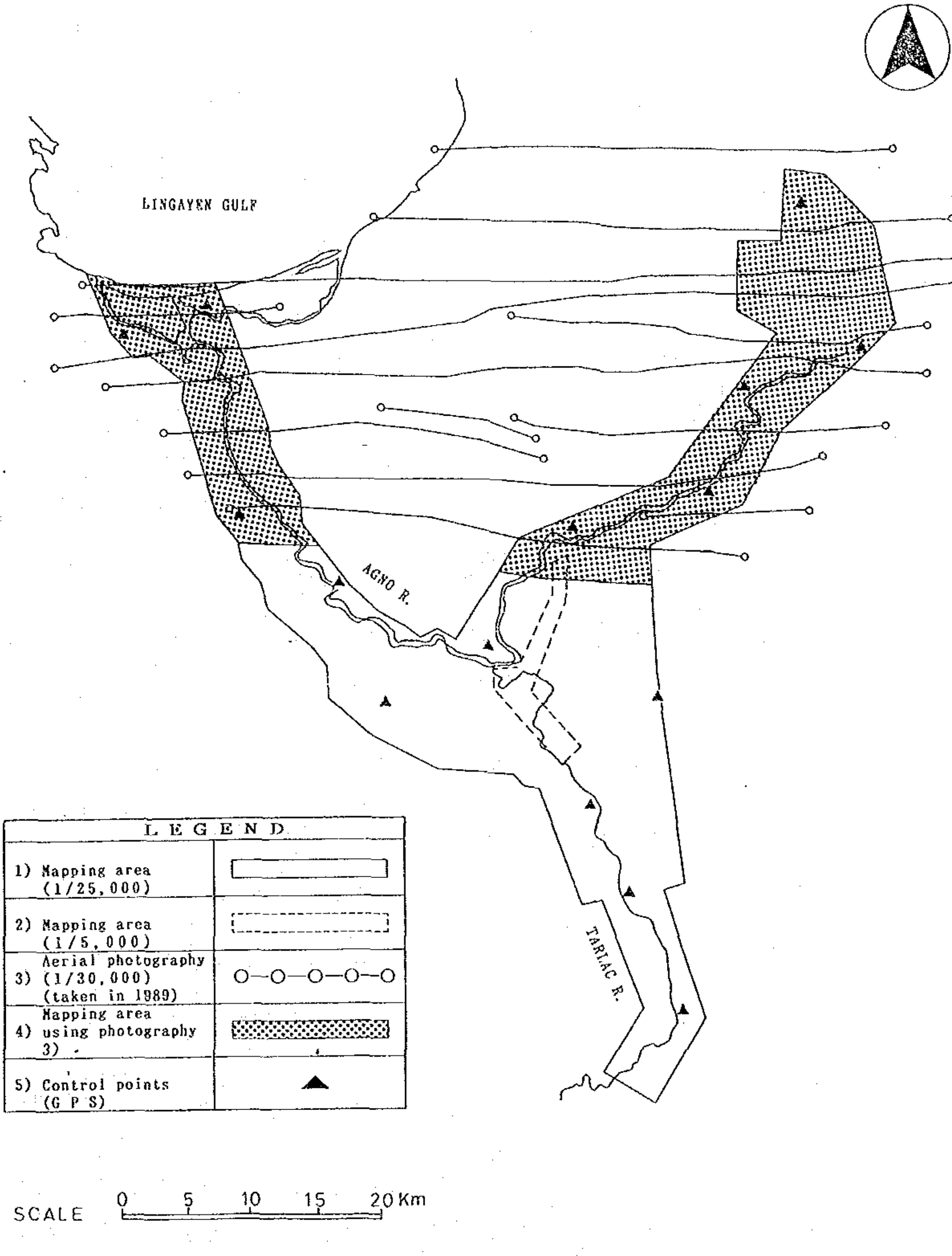

Fig. 3.1 MAPPING AREA BY AERIAL PHOTOGRAPHY WITH A SCALE OF 30,000

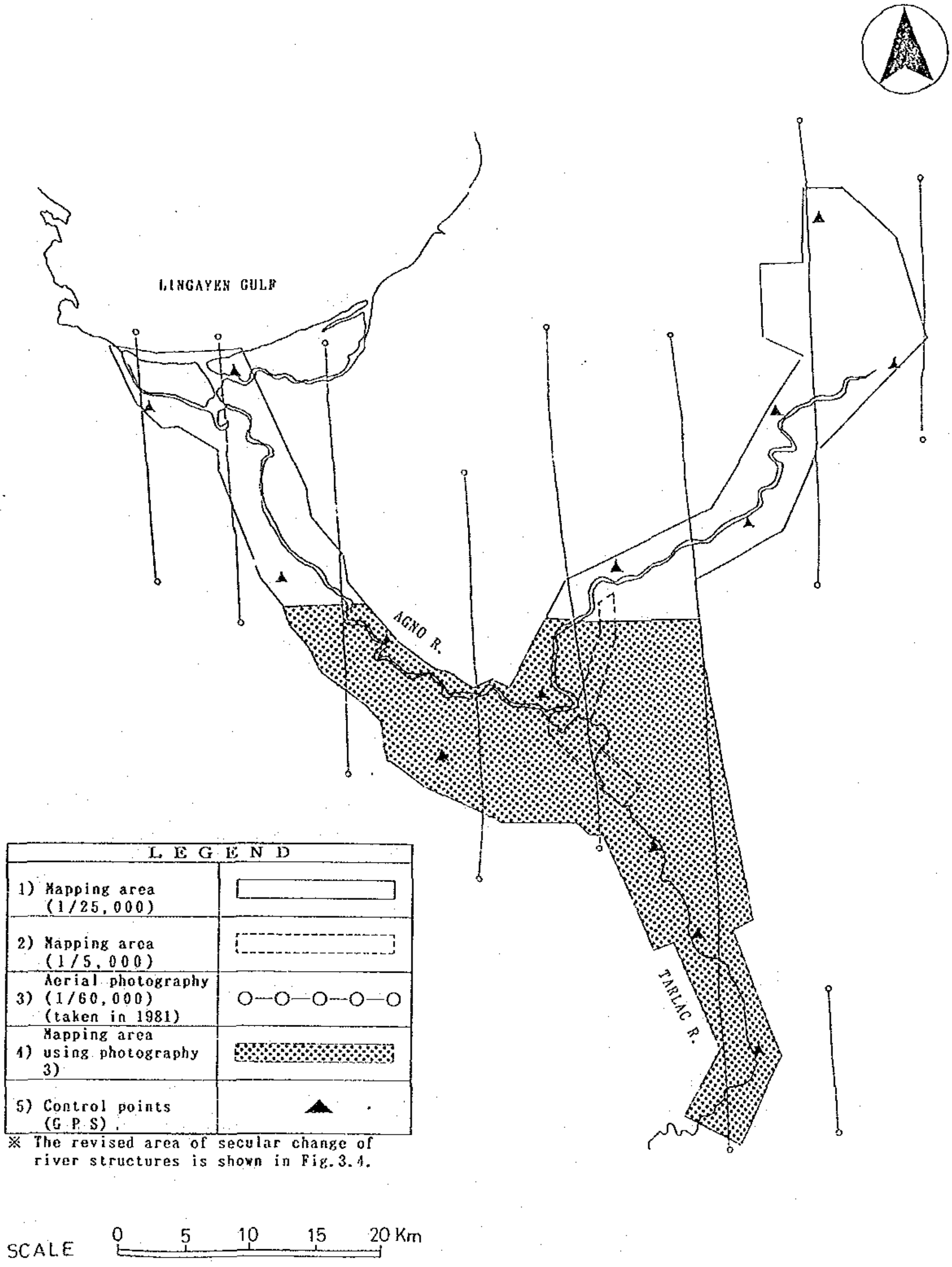

Fig. 3.2 MAPPING AREA BY AERIAL PHOTOGRAPHY WITH A SCALE OF 60,000

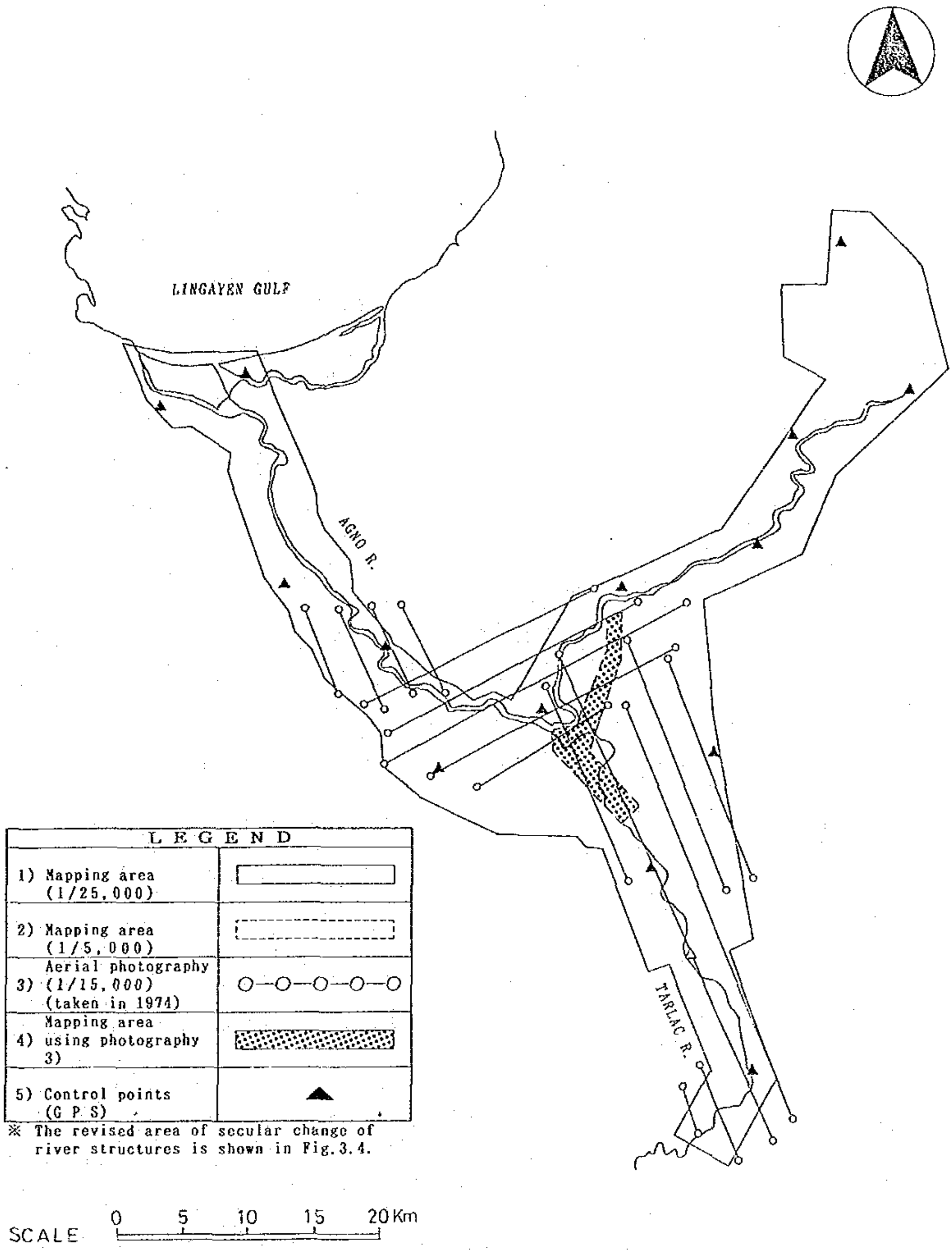

Fig. 3.3 MAPPING AREA BY AERIAL PHOTOGRAPHY WITH A SCALE OF 15,000

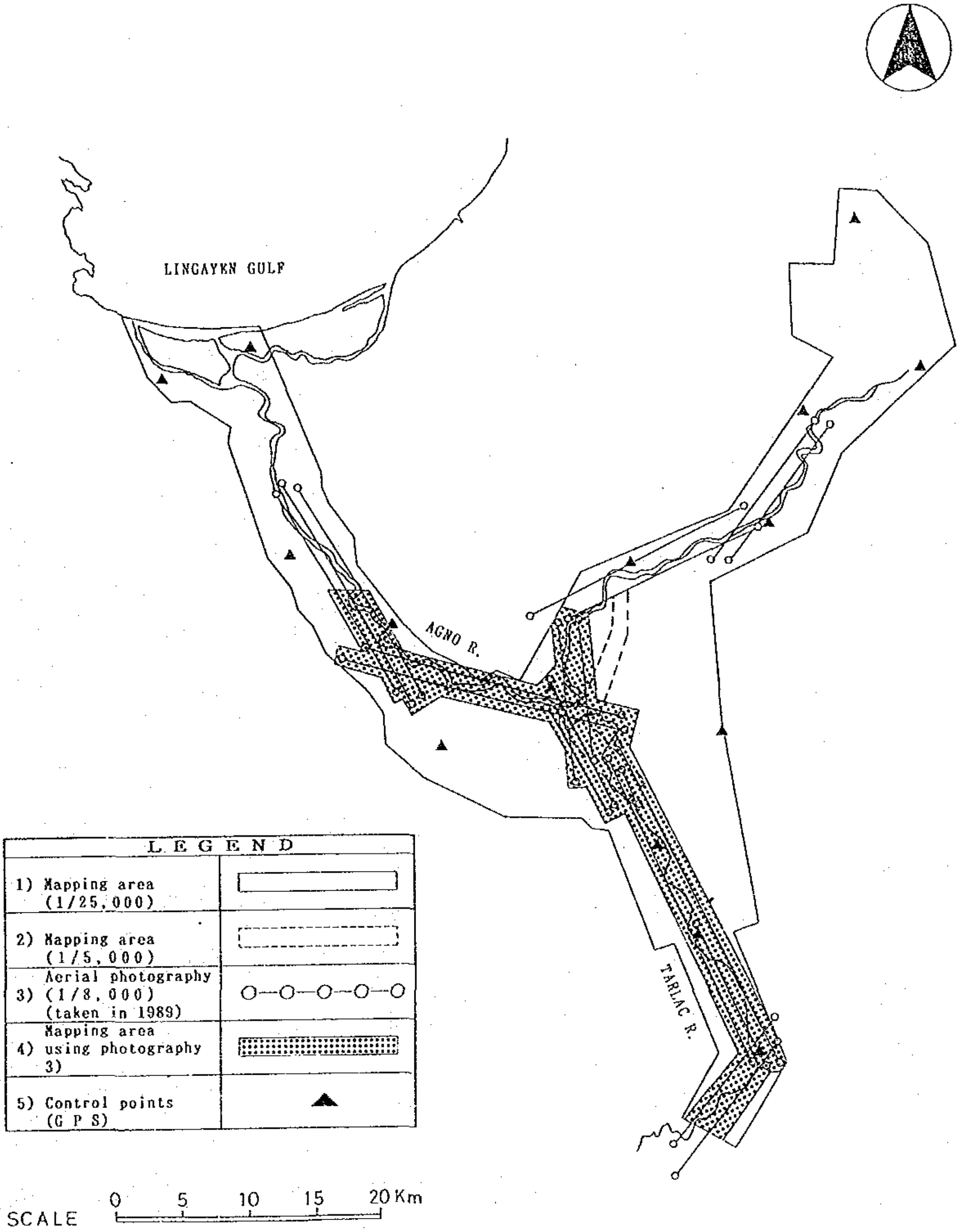

Fig. 3.4 MAPPING AREA BY AERIAL PHOTOGRAPHY WITH A SCALE OF 8,000

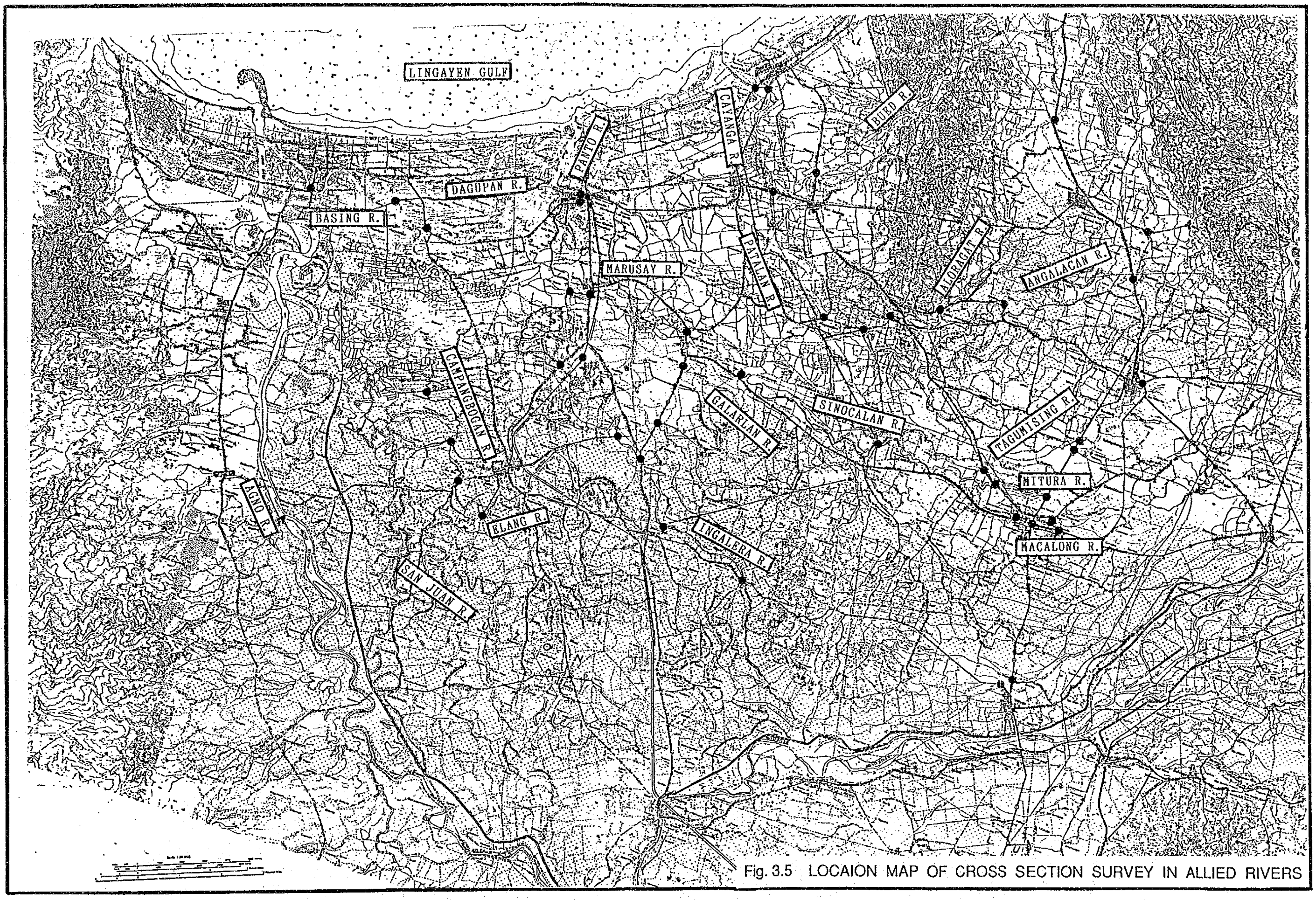

Fig. 3.5 LOCAION MAP OF CROSS SECTION SURVEY IN ALLIED RIVERS

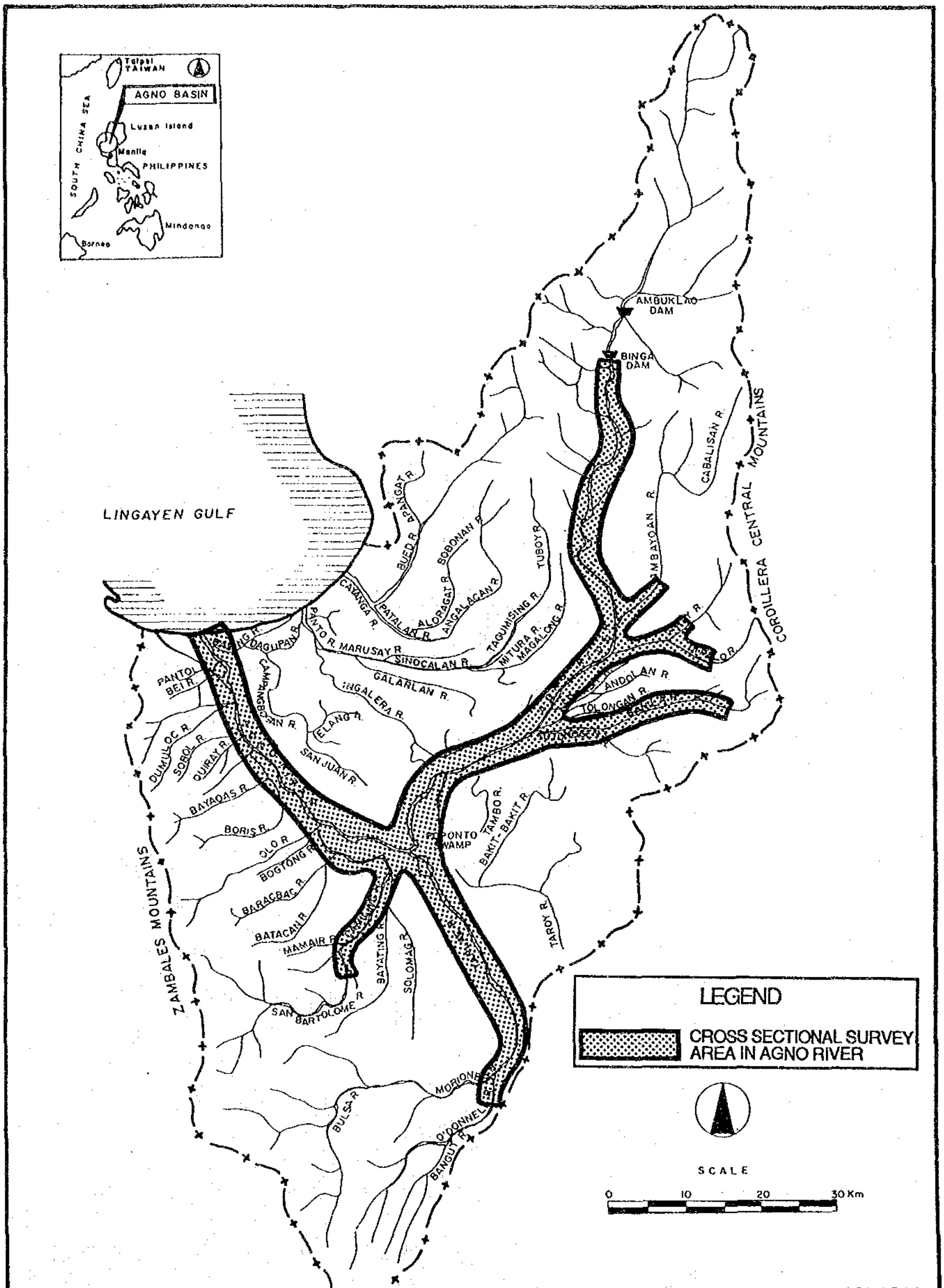

Fig. 3.6 LOCATION MAP OF CROSS SECTION SURVEY IN AGNO RIVER

5. FD

5. FD
FLOOD DAMAGE

FD : FLOOD DAMAGE

SUMMARY

The study on flood damage analysis aims at estimating the damages by probable floods based on the past floods with various scales in the probable inundation area. The damages due to flood and sediment in the inundation area have been estimated and the outline of the procedure for estimating damages by probable floods is summarized as follows, together with the results of the study.

(1) Flood records show that the 1972 flood which corresponds to a 10-year return period flood was the largest in the past two decades. Large floods occurred also in 1984 and 1986 with the recurrence probability of 4 and 7 years, respectively.

(2) The extent of the inundation area based on some past floods was verified and confirmed through the topographic maps and the results of the flood mark survey for the 1972, 1984 and 1986 floods.

(3) The probable inundation area lies in Regions I and III. Fifty-two (52) municipalities and two (2) cities in four (4) provinces are included in the probable inundation area.

(4) Damage to assets is classified into two: direct damage and indirect damage. Direct damage is the damage directly inflicted on vulnerable assets, while indirect damage is the loss due to the suspension of economic activities, additional transportation cost incurred in taking up alternative traffic routes, and costs for rescue and relief activities due to the flood.

(5) The distribution of assets for each mesh (1 km x 1 km) in the probable inundation area was estimated by counting the number and acreage of various assets using available maps. The number and acreage were updated based on the latest data available by the results of the socioeconomic study.

(6) The damage rate which shows the relationship between the degree of asset damage, depth and duration of flooding is mainly based on similar past studies in the country.

(7) Probable flood damage was assessed by multiplying the damage rate by the damageable values of assets in the inundation area with the flooding area-depth-durationship derived from the results of flood inundation analysis.

(8) The annual average flood damage including the indirect damage in the Study Area with the Allied River basins as a whole was estimated at about 1,300 million pesos based on the present economic condition at the price level of 1989.

(9) Damage by sediment was estimated at about 80 million pesos of rice yield reduction caused by sedimentation in the ricefield and desilting cost in the irrigation canal as the damage during flood-free time, while on maintenance cost of the Poponto Floodway as the damage during flood time.

FD: FLOOD DAMAGE

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ABBREVIATIONS

1. NAME OF PHILIPPINE GOVERNMENT AGENCIES

AFCS	Agno River Flood Control System
ARIS	Agno River Irrigation System
BAS	Bureau of Agricultural Statistics
BFAR	Bureau of Fishery and Aquatic Resources
BSWM	Bureau of Soils and Water Management
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DND	Department of National Defense
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
DPWH-PMO	DPWH Project Management Office
GOP	Government of the Philippines
LATRIS	Lower Agno and Totonogen River Irrigation System
LWUA	Local Water Utilities Administration
NAPOCOR	National Power Corporation
NAMRIA	National Mapping and Resource Information Authority
NEDA	National Economic Development Authority
NIA	National Irrigation Administration
OCD	Office of Civil Defense
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PENRO	Provincial Environment and Natural Resources Office
PNRC	Philippine National Red Cross
PNR	Philippine National Railways
SMORIS	San Miguel - O'Donnell River Irrigation System

2. NAME OF JAPANESE GOVERNMENT AND OTHER OFFICIAL AGENCIES AND ORGANIZATION

GOJ	Government of Japan
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction, Japan
OECF	Overseas Economic Cooperation Fund, Japan
UN	United Nations

3. MEASUREMENT UNITS

(Length)

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

(Weight)

gr(grs)	gramme(s)
kg(kgs)	kilogramme(s)
ton(s)	ton(s), eq'vt to 1,000 kg

(Area)

mm^2	square millimeter(s)
cm^2	square centimeter(s)
m^2	square meter(s)
km^2	square kilometer(s)
ha(has)	hectare(s)

(Time)

sec	second(s)
min	minute(s)
hr(hrs)	hour(s)
dy(dys)	day(s)
mth(mths)	month(s)
yr(yrs)	year(s)

(Volume)

cm^3	cubic centimeter(s)
m^3	cubic meter(s)
ltr	liter(s)

FLOOD DAMAGE ANALYSIS

1. INTRODUCTION

The Agno River basin is characterized as the basin with an ample rainfall at about 4,000 mm a year in the northern area, and about 2,000 mm a year in the southern area of the basin.

The occurrence of typhoons from the period of May to November brings more than 90% of the annual average rainfall. The downpour during this rainy season causes habitual flooding due to the overflow of the Agno River, Allied River and their tributaries in the Pangasinan Plain area, suffering from flood damages almost every year. On the other hand, major rivers in the basin such as Agno, Tarlac, Tuboy and Bued carry tremendous sediments to the downstream and causes damages to river facilities, irrigation systems and agricultural land.

The study of flood damage analysis aims at estimating the damages for probable floods based on the past floods with various scales. In this study, damages due to floods and sediment caused in the inundation area are estimated.

The outline of the procedure in estimating damages for probable floods is discussed as follows:

- The extent of the inundation area based on some past floods is confirmed and verified through topographic maps and site investigations. The study area in this flood damage study defined as the maximum probable inundation area is delineated based on the existing flood records and field investigation.

- The distribution of assets for each mesh in the probable inundation area are estimated by counting the number and acreage of various assets by using available maps. The number and acreage are updated based on the available latest data by the results of Socio-economic study.

- The damage rate, which shows a relationship between a degree of asset damage, depth and duration of flooding is mainly based on similar past studies in the country.

- Probable flood damages are assessed by multiplying the damage rate by the damageable values of assets in the inundation area with the flooding area-depth-duration relationship derived from the results of flood inundation analysis (refer to Hydrology Study.)

- The increase rate of various assets in the future are based on the results of Socio-economic study.

A general work flow of this flood damage study is depicted in Fig. 1.1.

2. EXISTING RECORDS ON PAST LARGE FLOODS

2.1 Flood Records

PAGASA and OCD have carried out the survey for each past large typhoon and flood in the basin since 1962. Table 2.1 shows a list of the past destructive typhoons as well as 4-day rainfall at the Agno River mouth and recurrence interval year. It shows that the severest flood with a recurrence interval of 10 years occurred in 1972 during the last two decades. As for current events, large floods occurred in August 1984 and July 1986 with the recurrence intervals of some 4 and 7 years, respectively.

According to the flood records of 1984, 1985 and 1986 prepared by AFCS Office, dikes on the right side of the Agno River, about 20 km of the river stretch between the downstream of San Roque and Asingan are frequently scoured and breached in several points during the floods, which results in serious flooding to the Allied River basins. The location of breaching and scouring caused by the floods of 1984, 1985 and 1986 is shown in Fig. 2.1.

Rainstorm that occurred in September, 1989 causes the overflow of the Sinocalan river and its tributary in the Allied River basins, and inundated the entire area of the Sinocalan river basin. The recurrence interval of this flood is estimated at some 5-year return period in the entire Allied River basins. Calasiao town and Dagupan City, which are located in the downstream coastal area of the Sinocalan river, were inundated with more than 1 m in water depth in lowlying places of the urban area.

As the example of major past flood maps, flood inundation maps of 1972 and 1984 by typhoon Maring are shown in Figs. 2.2, 2.3, respectively.

The following are flood year and its flood inundation area based on the available flood maps.

Calendar Year	Estimated Inundation Area (km^2)	Recurrence Interval Year
1935	2,100	No hydrological data
1972	2,040	10-year
1973	900	-
1980	1,550	-
1984	1,670	4-year

2.2 Flood Damage Records

The damage records on past large floods have been compiled by OCD since 1972, including the information on the number of affected people and houses, damages to crop, livestock, fishpond and infrastructures. The record of major past flood damages of 1972, 1984 and 1986 compiled by the provinces of Pangasinan and Tarlac are shown in the Table 2.2.

According to the available damage records in Pangasinan province, 1972 flood has the largest magnitude for the last two decades. Inhabitants of 530,000 or about 43% of the estimated population of 1,250,000 in 1972 suffered from flooding. This figure includes those evacuated from their places numbering 460,000 persons. According to a flood mark survey which will be discussed in the following chapter, the inundation depth during 1972 flood was generally 0.3 m to 1.0 m, and flooding durations were 5 to 10 days in the inundation area. In lowlying region the water depth was 2 to 3 m and the inundation lasted 30 to 40 days.

On the other hand, in the recent large magnitude floods of 1984 (Typhoon Maring) and 1986 (Typhoon Gading)in Pangasinan province, the reported number of affected peoples is about 300,000 and 160,000 which corresponds a share of about 20% and 11% of the estimated population of 1,500,000 in 1984, 1,550,000 in 1986, respectively. The damages by 1984 flood is about 107 million pesos and 141 million pesos for the 1986 flood at each year price levels.

The damages due to 1972, 1984 and 1986 floods, however, do not cover the full range of vulnerable assets damage as shown in Table 2.2. The damage to infrastructures is estimated only for river facility, telecommunication and railways, but others like irrigation and water supply facilities are not reported. Furthermore, damage to residential and non-residential buildings are not also reported.

The records of flood damages reported are used as a reference in estimating probable flood damages discussed in subsequent chapters.

3. ESTIMATION OF MAXIMUM PROBABLE INUNDATION AREA

The delineation of probable inundation areas for estimating the probable flood damages is based on the flood maps for the 1972 flood and 1984 flood referring to other available flood maps. Accuracy of 1972 and 1984 flood maps is confirmed using 1 to 50,000 scale topographic map and other any available maps and flood mark survey at sites. In the case of some discrepancies found on the flood maps, correction is given.

The reasons why the floods of 1972, 1984 and 1986 are selected for the inundation area are as follows;

- 1972 flood which corresponds to 10-year return period is reported as the largest in the past two decades.
- 1984 flood which corresponds to 4-year return period is the third largest in the past two decades with available hydrological data for flood inundation analysis.
- 1986 flood which corresponds to 7-year return period is the current largest.

The flood mark survey for confirming the extent of inundation area as well as water depth and duration of the above three floods was carried out at about 240 sites in the flood prone area. Major items interviewed are water depth, flood duration and flood water direction, sedimentation depth and damage. The results of the survey is used for flood inundation analysis in hydrological studies for estimating probable flood damages. The flood mark survey results from 1972, 1984 and 1986 floods are compiled in terms of inundation depth, flood duration, maximum flood water level and sediment depth.

Fig. 3.1 shows the maximum envelope of the inundation area which is prepared on the basis of the flood mark survey using available flood maps of past floods and topographic maps of 1 to 50,000 scale. The envelope delimits the maximum extent of flood inundation area in the Study Area; that is, the maximum extent of inundation area is defined as the probable maximum inundation area for the flood damage analysis. The maximum inundation area is estimated at 2,465 km^2.

4. ESTIMATION PROCEDURE OF DAMAGE BY FLOOD AND SEDIMENT

4.1 Classification of Damage by Flood and Sediment

The constitution of assets which are vulnerable to flood and sediment in the probable inundation area are prepared based on the past damage records and assets existing in the probable inundation area, and are shown in Fig. 4.1.

Damage to assets is mainly classified into two; direct damage and indirect damage. The direct damage is a damage directly imposed on assets, while indirect damage is a loss due to the suspension of economic activity, extra transportation cost incurred in taking up alternative and no other alternative traffic routes and costs for rescue and relief activities, due to flood and sediment.

The direct damage due to flood consists of agricultural damage to crops, livestocks and fish culture, and non-agricultural damage to houses, buildings and infrastructures. On the other hand, the direct damage due to sediment also consists of agricultural and non-agricultural damages.

4.2 Socio-economic and Agro-economic Conditions in the Probable Inundation Area

4.2.1 Basic Socio-economic condition

The administrative division of regions, provinces and municipalities with the probable inundation area is shown in Fig. 4.2. The probable inundation area lies in Region I (Ilocos) and Region III (Central Luzon). Among these regions, four (4) provinces, fifty two (52) municipalities and two (2) cities are included in the probable inundation area.

The administrative land area in the inundation area as well as population and number of houses in 1989 by municipality are estimated as shown in Table 4.1, while the total population in the probable inundation area is estimated at about 1.56 million inhabitants.

Probable Inundation Area

Province	Land Area (Km^2)	(%)	Population (person)	(%)
Pangasinan	1,824	74.0	1,289,060	82.7
Tarlac	506	20.5	213,864	13.7
Nueva Ecija	125	5.1	24,633	1.6
La Union	10	0.4	30,258	2.0
Total	2,465	100.0	1,557,821	100.0

The socio-economic activities in the probable inundation area in particular are in prosperity on major towns along the national highway road (Manila North Road) such as the towns of Tarlac, Gerona, Moncada, Villasis and Urdaneta, and also along the down stream area of the Allied Rivers like Dagupan City, Calasiao, Lingayen, San Carlos City and others.

Land use in the provinces of Pangasinan and Tarlac in 1989 is assumed because of no available latest data except agricultural land and fishpond areas and is tabulated in Table 4.2. Land use map of the probable inundation area is also shown in Fig. 4.3.

4.2.2 Agro-economic Condition

The agricultural land use by municipality in the probable inundation area as of 1988 is shown in Table 4.3. Judging from the total agricultural area of 1,325 km^2, the probable inundation area will be characterized as the basin with agricultural land use of about 54% of the total inundation area of 2,465 km^2.

The following shows the land area of major crops planted in the inundation area as of 1988.

Planted Area in the Inundation Area

Crops	Planted Area (km^2)	(%)
Paddy Irrigated	381	
Rainfed	722	
Sub-total	1,103	100.0
Corn	141	12.8
Sugarcane	6	0.5
Legume	84	7.4
Root crops	26	2.4
Tobacco	19	1.7
Others (Vegetable, fruits, etc.)	118	10.7

Source: DA, Pangasinan, Tarlac

The above table reveals that paddy planted area is dominant with a corresponding share of about 83% of the total agricultural planted area of 1,325 km^2.

As for the fish culture, in the inundation area, about 7,000 has. of fishpond or about 43% of the total area of 16,400 has. for freshwater and brackishwater fishponds in Pangasinan province, spreads over the coastal part of the inundation area. Most of the cultured fishes are milkfish, sharing more than 95% of the total fishpond area, followed by prawn and so forth.

4.3 Identification of Asset Items and Asset Distribution in the Probable Inundation Area

(1) Identification of Assets Items

As for agricultural damage, the damages to seven (7) major crops of paddy, corn, sugarcane, root crops, legume, tobacco and vegetables are estimated. The damage to livestocks such as poultry, carabao and so forth are also estimated. Fish culture damage is assessed on milkfishes which are major cultured fishes in the fishponds, and fishpond facility.

On the other hand, items classified as non-agricultural assets are residential houses including household effects, non-residential buildings such as commercial, school establishments and so on including inventory stocks and equipment. Furthermore, infrastructures such as roads, bridges, irrigation, river, water supply and telecommunication facilities are also estimated as the assets vulnerable to floods.

(2) Asset Distribution

The distribution of the assets in the inundation area are estimated by measuring and counting the acreage, number and distance of various assets using 1 to 50,000 scale topographic map with 1 km by 1 km mesh. The figures obtained are updated by the latest data so as to grasp the relationship between the area-depth-duration and distribution of assets in the inundation area.

The following are assumed for measuring and counting the distribution of assets:

- The topographic maps with a scale of 1 to 50,000 show the acreage of paddy, sugarcane and fishpond. Since the maps were prepared before 1977, the acreage of paddy, sugarcane and fishpond by each mesh in the present condition is estimated by updating total acreage given in a municipality from 1977 to present.

- Since the planted areas of other crops are not shown on the maps, the distribution of the planted area of the other crops by each mesh is assumed in proportion to that of paddy by mesh in a municipality.

- The distribution of residential houses by mesh is assumed to be proportional to the number of dots which shows the location of houses by mesh. The distribution of non-residential houses is also assumed to be proportional to the population or the number of residential houses measured from the maps by mesh in a municipality.

- The lengths or distances for roads, railway, river dike and irrigation canal by mesh are measured from the maps and any other available maps.

4.4 Estimation Method of Flood and Sediment Damages

4.4.1 Agricultural Damage by Flood

(1) Crop Damage

The damage to crops is estimated as follows;

crop damage = (planted area) x (damageable value per ha) x (damage rate)

As discussed in the preceding section, the major crops for estimating agricultural damage are irrigated and rainfed paddy, corn, root crop, legume, sugarcane, tobacco and vegetables.

The damageable value of crops per ha is estimated as the sum of expected net income and accumulated production cost spent at the time when a flood occurs. The damageable value calculated as the expected value is the sum of probable value of net income plus production cost through the year with the following parameters.

- planted area (ha)
- crop yield (ton/ha)
- seasonal frequency of flood
- cropping pattern
- price of crop product (peso/ton)
- production cost (peso/ha)

The damageable value with these parameters for each major crop is shown in Table 4.4.

The future damageable value of crops is estimated taking into consideration the growth rates of yield, growth rates of crop production cost and projected future crop prices. The growth rate of yield is determined by the nationwide trends while growth rate of crop production cost is assumed to be proportional to yield, and the future crop prices is based on the World Bank projection for international crops such as paddy, corn and sugarcane while for domestic crops the future crop prices is assumed to be constant.

The flood damage rate for crops which depends on inundation depth and duration is shown in Table 4.5. The inundation depth and duration hydrograph to be applied to each mesh cell is based on the flood inundation analysis.

(2) Livestock Damage

The livestock damage is estimated at 7% of the crop damage based on the damage records as shown below.

Records of Livestock Damage

Calendar year	Typhoon	Crop Damage (P.Million) (1)	Livestock Damage (P.Million) (2)	Ratio (%) (2)/(1)
1986	Miding	46.7	0.4	0.9
	Gading	51.2	1.9	3.7
1984	Maring	6.4	0.4	6.3
1976	Miding	6.0	0.1	1.7
1974	Susang	0.5	0.1	20.0
Source : OCD			Average	7 %

(3) Fishpond Damage

The flood damage to fishpond consists of damages to the fish stock and the facilities and it is calculated as follows;

fishpond damage = (fish stock damage) + (facility damage)

fish stock damage = (unit value of fish stock) x (fishpond area) x (damage rate)

facility damages = (damageable value of facility) x (fishpond area) x (damage rate)

The fishpond damage is estimated based on the following operation conditions and assumptions.

- The fishpond damage is made up of the damage to rearing ponds because of no seasonable in fishpond operation except nursery and transitory pond operations.

- The flood damage to nursery and transitory ponds are negligible because there is no ponds operation during flood free seasons in most cases.

- Total fishpond acreage in the inundation area is assumed to be rearing ponds for milkfish.

The unit value of milkfish per ha. with assumptions for estimation is shown in Table 4.6. The damageable value of fishpond facility per ha. is assumed on the basis of the maintenance cost of fishpond dikes as shown in the table.

Based on the interview with DA, BFAR and fishpond operator in Dagupan, the damage rate for fish stock is estimated at 90% of the total fish stocks if the flood water overflows the dikes of the fishpond with more than 10 cm of overflow water depth. While the damage rate for the facility is assumed based on the flood damage records of fishpond taking into considerations the probability of floods of 1.05 to 100-year. The damage rate is assumed to vary 0.5% to 40% with the recurrence years.

4.4.2 Non-agricultural Damage by Flood

(1) House and Building Damage

The flood damage to houses and buildings is estimated as follows;

residential building damage = (number of building) x (unit value of a house structure) x (damage rate)

household effects damage = (number of building) x (unit value of effects per dwelling) x (damage rate)

non-residential building damage = (number of building) x (unit value of building structure) x (damage rate)

inventory stock/equipment damage = (number of building) x (unit value of stock/equipment per building) x (damage rate)

The unit value for residential and non-residential building structures are evaluated based on the unit value of the building of each type, average floor size of the building by type percent distribution of building by type and its depreciated value.

The unit value of a building for residential and non-residential as well as for household effects, stocks and equipment are estimated as shown in Table 4.7.

The damage rate for buildings and contents which depends on inundation depth as well as ground slope is shown in Table 4.8.

(2) Infrastructure Damage

The flood damage to infrastructures is estimated as follows;

road/bridge damage	= (road length in km) x (unit value of road per km) x (damage rate)
railway damage	= (railway length in km) x (unit value of railway road per km) x (damage rate)
river facility damage	= (river dike length in km) x (unit value of dike per km) x (damage rate)
irrigation facility damage	= (irrigation canal length in km) x (unit value of canal per km) x (damage rate)
water supply facility damage	= (number of population) x (unit value of facility per capita) x (damage rate)
telecom. facility damage	= (number of population) x (unit value of facility per capita) x (damage rate)

The infrastructure damage is evaluated based on the following assumptions.

- For the estimation of damage to the main facility of each infrastructure, it is assumed that road classification by type of pavement are for roads, railway road for railway, river dike for river facilities and irrigation canal for irrigation facilities. The unit cost of infrastructures is estimated as shown in Table 4.7.

- The distribution of water supply and telecommunications facilities is assumed to be proportional to the number of population each mesh.

- The damage rate for the infrastructure facilities is assumed for this flood damage study based on the flood damage records of each infrastructure facility taking into consideration the probability of flood. The assumed damage rates for the infrastructure facilities varies with the recurrence years of 1.05 to 100 as follows;

road/bridge	1	to	20%
railway	2	to	50%
irrigation	3	to	23%
river	2	to	50%
water supply	1	to	40%
telecommunication	2	to	50%

4.4.3 Indirect Damage

The indirect damage is estimated on the following three (3) items.

Indirect damage = (Loss on economic activity)
+ (Extra transportation cost)
+ (Rescue and relief activity cost)

Loss on economic activity in the inundation area is a loss due to suspension of economic activity such as industrial production, trade, transportation, communications and so forth. The extra transportation cost is the cost due to the changing of traffic routes caused by flooding.

These losses are evaluated using GRDP per capita in the inundation area, number of suspension days which is based on the results of interview with AFCS of the DPWH and annual average daily traffic data on major traffic routes in the inundation area.

The rescue and relief activity cost is estimated at 5% of the total direct damage based on the damage records as follows;

Records of Rescue and Relief Cost

Calendar Year	Typhoon	Direct Damage (P.Million) (1)	Cost (P.Million) (2)	Ratio (%) (2)/(1)
1988	Unsang	321.7	1.2	0.4
1986	Gading	32.5	0.2	0.6
1980	Aring	20.3	0.1	0.5
1980		64.2	0.3	0.5
1974		60.8	1.0	1.6
1973	Luming	0.5	0.1	20.0
1972		1.7	0.2	11.7
Source : OCD			Average	5 %

4.4.4 Sediment Damage

The damage due to sediment in the inundation area also consists of agricultural and non-agricultural damages the same as the damage by flood. It is made up of two (2) situations, i.e., sidement damages during flood and during flood-free time.

The damage by sediment in this study is estimated based on the following items only because of the reasons mentioned below.

Sediment damage caused during flood-free time.

- rice yield reduction caused by sedimentation in the rice field

- desilting cost in the irrigation canal

Sediment damage caused during flood time.

- Maintenance cost of the Poponto floodway

- As shown in the sedimentation map (Fig. 4.4) in Pangasinan prepared by

DA, Pangasinan in 1988, the accumulated sedimentation depth are measured since 1960. The map reveals that in most places of Pangasinan the annual average sedimentation depth is too small.

- The crop and building damages by sedimentation are estimated using damage rate shown in Tables 4.5, 4.9, respectively. However, as revealed in the above-mentioned sedimentation map, the damage by sediment estimated is negligible.

- It is understood that the areas subject to damage due to sediment during flood time are identified only on the right side of the Agno River on the downstream portion from San Roque and at the downstream end of the river dikes in the Tarlac river near the Poponto Swamp based on the site-interview results. These areas are mostly a non-agricultural as well as non-urbanized areas.

- It is also evaluated that the damage to buildings by flood in the identified areas mentioned above is more serious than the damage by sediment, considering the damage rates for flood and sediment.

- Therefore the damage due to sediment in the inundation area during flood is assumed to be included in the damage by flood, except the maintenance cost of the Poponto floodway.

5. PROBABLE FLOOD AND SEDIMENT DAMAGES

5.1 Probable Flood Damage

Annual average flood damages under the without the project condition is estimated for each of the mesh blocks by the use of the inundation water depth and duration for the flood frequencies of 1.05, 2, 5, 10, 25, 50 and 100 year computed by the flood inundation simulation model (See Hydrology Study).

The probable flood damage by the flood frequency is estimated and is tabulated in Table 5.1. The estimated indirect damage is shown in Table 5.2. The ratio of indirect damage to direct damage is estimated varying about 10% to 35% with the recurrence years.

Figs. 5.1, 5.2, illustrate regional distribution of probable direct flood damage in the probable inundation area in events of 25 year and 100 year flood.

The inundation area and affected inhabitants by return period are estimated as follows:

Return Period (Year)	2	5	10	50	100
Inundation Area (km^2)	1,448	1,665	2,038	2,183	2,465
Affected Inhabitant (Million person)	1.05	1.17	1.37	1.44	1.56

The probable flood damages of each mesh block are summed up in 18 sub-basins shown in Fig. 5.3.

The annual average flood damage including the indirect damage in the Study Area with the Allied River basins as a whole is estimated at about 1,262 million pesos based on the economic condition in 1989. The annual average flood damage by the sub-basins are tabulated and shown in Fig. 5.4 as well as the annual average damage of probable flood in the entire inundation area.

It is considered, however, that the big difference in flood damage amount between the recorded and the estimated flood damages is attributed to the high percentage of unreported damages. As mentioned in the Section 2.2, most of the recorded damage does not include buildings and other infrastructure damages.

Furthermore it is also understood that the accumulated damage of a great acreage of crop fields and a great number of buildings reaches a huge amount as shown in this study even if the damage for each acreage and for each building is insignificant.

5.2 Sediment Damage

(1) Sediment Damage to Irrigation System

NIA, Region I has eight (8) irrigation systems such as ARIS, LATRIS and so on in the probable inundation area. These irrigation systems suffers from sedimentation problem due to the siltation of its irrigation canal, carried by the irrigation water and reducing the amount of the original design irrigation water during flood free period.

For this sedimentation problem, NIA estimates the annual average damage due to sediment of about 81 million pesos as follows;

		Estimated Damage
- Rice yield reduction	Affected Area: 17,900 has	77.7 million pesos
- Desilting cost	Desilting volume: 355,000 m^3	5.7 million pesos
	Total annual average damage	83.4 million pesos

The details are shown in Table 5.3.

(2) Sediment Damage to Poponto Floodway

Since 1982, extension and maintenance work in the Poponto floodway has been made by excavating the floodway channels, repairing dikes and so on. The annual average maintenance cost is assumed at about 1 million pesos based on the records of the maintenance cost prepared by AFCS, DPWH.

Totally, the annual average damage by sediment is estimated at about 84 million pesos.

TABLES

Table 2.1 LIST OF DESTRUCTIVE TYPHOON RECORDS IN THE AGNO RIVER BASIN (1962-1988)

No.	Calender Year	Name of Tyhoon	Date	4-day Rainfall at Agno River Mouth (mm)	Remarks/ Return Period (year)
1	1962	KATE	Jul.18-27		
2		WANDA	Aug.25-Sept.3		
3		AMY	Sept.3-Sept.8		
4	1963	DIDING	Jun.24-30		
5	1964	SENIANG	Aug.2-11		
6		ARING	Sept.3-13		
7	1965	MILING	Jul.10-18		
8	1966				No Flood
9	1967	TRINING	Oct.14-20		
10	1968	DIDANG	Jul.23-29		
11		HUANING	Aug.18-25		
12		LUCING	Sept.2-8		
13		NITANG	Sept.26-Oct.2		
14	1969				No Flood
15	1970				No Flood
16	1971	ROSING	Jul.18-21	175	1.2-year return period
17		KRISING	Oct.9-12	261	1.8-year return period
18	1972	KORDING	Jun.26-27	27	
19			July 17-20	601	10-year Return Period
20	1973	LUMING	Oct.2-9		
21	1974	ILING	Jul.18-21		
22		SUSANG	Oct.8-12		
23		TERING	Oct.14-17		
24		WENING	Oct.25-29		
25		ANING	Nov.4-8		
26		BIDING	Nov.24-29		
27	1975	AURING	Jun.22-26		
28	1976	HUANING	Jun.27-Jul.30	370	4-year return period
29	1977	UNDING	Nov.10-17		
30	1978	MIDING	Aug.18-26		
31		KADING	Oct.25-27	152 (3-day)	1.1-year return period
32	1979	MAMANG	Aug.9-15		
33	1980	GLORING	May 22-26		
34		MITING	Jul.18-21	178	1.1-year return period
35		ARING	Nov.1-7		
36	1981	ANDING	Nov.22-25	168	1.1-year return period
37	1982	EMANG	Jul.12-16		
38		NORMING	Aug.30-Sept.3	82	1.01-year return period
39	1983	BEBENG	Jul.12-16		
40	1984	MARING	Aug.27-30	400	4-year return period
41	1985	KURING	Jun.20-23	389	4-year return period
42		DALING	Jun.26-29	195	1.2-year return period
43		SALING	Oct.15-20	-	
44	1986	GADING	Jul.7-10	479	7-year return period
45		MIDING	Aug.24-Sept.4		
46	1987	ISING	Aug.12-19		
47	1988	UNSANG	Oct.21-24		

Source: OCD, PAGASA

Table 2.2 DAMAGE RECORDS BY TYPHOONS OF 1972, 1984 AND 1986 IN PROVINCES OF PANGASINAN, TARLAC AND NUEVA ECIJA

Unit : Million Pesos

Items	1972 Tyhpoon			1984 Tyhpoon-Haring			1986 Typhoon-Gading		
	Pangasinan	Tarlac	Nueva Ecija	Pangasinan	Tarlac	Nueva Ecija	Pangasinan	Tarlac	Nueva Ecija
Casualities (number of habitants)									
Affected	524,391	273,448	173,905	296,628	34,175	44,630	152,041	58,057	68,248
Evacuated	461,971	232,430	94,488	12,512	-	10,156	-	-	-
Dead	-	-	-	21	-	-	7	-	-
Injured	-	-	-	3	-	-	2	-	-
Missing	-	-	-	6	-	-	5	-	-
Affected house/building (number of bldg.)									
Totally	-	-	-	173	-	-	336	-	-
Partially	-	-	-	379	-	-	1076	-	-
Direct Damage									
Agriculture									
Crops	0.6	-	-	6.4	27.3	18.1	51.2	7.1	0.6
Padday									
Corn	-	-	-	-	-	-	-	-	-
Sugarcane	-	-	-	-	-	-	-	-	-
Legume	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-
Livestocks	-	-	-	0.4	-	-	1.9	-	0.1
Fishpond	-	-	-	21.3	-	-	24.1	-	21.6
Sub-total	0.6	-	-	28.1	27.3	18.1	77.2	7.1	22.3
Non-agriculture									
House/Building									
Residential	-	-	-	-	-	-	-	-	-
Non-residential	-	-	-	-	-	-	-	-	-
Infrastructures									
Road/Bridge	-	-	-	3.5	-	-	2.5	-	-
Railways	2.8	-	-	5.0	-	-	-	-	-
Irrigation facility	-	-	-	-	-	-	-	-	-
River facility	-	-	-	65.7	-	-	54.8	-	-
Water supply facility	-	-	-	-	-	-	-	-	-
Telecom. facility	-	-	-	4.3	-	-	4.3	-	-
Sub-total	2.8	-	-	78.5	5.0	3.7	61.6	15.2	9.9
Total	3.4	-	-	106.6	32.3	21.8	138.7	22.3	32.2
Indirect Damage									
Rescue & Relief Services	0.2	-	0.3	-	-	-	2.1	2.4	-
Total	0.2	-	0.3	-	-	-	2.1	2.4	-
Grand Total	3.6	-	0.3	106.6	32.3	21.8	140.8	24.7	32.2

Sources: DND, Ocd, Quezon City
DA, Central Office, Pangasinan, Tarlac
PNRC, National Headquaters, Tarlac, Manila,
BFAR, DAF, Pangasinan
PMO-AFCS, DPWH

Notes: Damage Values shown in the above table are indicated at the price level of each year.

Table 4.1 LAND AREA, POPULATION AND NUMBER OF HOUSES BY MUNICIPALITY IN THE INUNDATION AREA (1/2)

No.	Province Municipality /City	Land Area by Mesh (km2)	Population in 1989 (persons)	Number of Residential Houses (Nos.)
	Pangasinan			
1	Aguilar	24	13,979	2,330
2	Alcala	36	29,055	4,843
3	Asingan	67	41,103	6,851
4	Balungao	38	10,189	1,698
5	Basista	16	19,984	3,331
6	Bautista	87	21,097	3,516
7	Bayambang	70	68,743	11,457
8	Binalonan	61	34,643	5,774
9	Binmaley	62	54,312	9,052
10	Bugallon	29	15,400	2,567
11	Calasiao	54	58,175	9,696
12	Labrador	2	131	22
13	Laoac	41	23,634	3,939
14	Lingayen	58	75,264	12,544
15	Malasiqui	92	57,714	9,619
16	Manaoag	19	39,831	6,639
17	Mangaldan	45	56,114	9,352
18	Mangatarem	58	11,510	1,918
19	Mapandan	30	23,360	3,893
20	Natividad	15	10,531	1,755
21	Pozzorubio	32	19,826	3,304
22	Rosales	48	32,666	5,444
23	San Fabian	12	1,368	228
24	San Jacinto	28	19,362	3,227
25	San Manuel	52	22,082	3,680
26	San Nicolas	20	8,496	1,416
27	San Quintin	24	13,103	2,184
28	Sta. Barbara	69	39,151	6,525
29	Sta. Maria	69	22,109	3,685
30	Sto. Tomas	8	10,093	1,682
31	Sison	12	6,909	1,152
32	Tayug	51	29,924	4,987
33	Umingan	37	19,670	3,278
34	Urbiztondo	82	33,329	5,555
35	Urdaneta	111	79,200	13,200
36	Villasis	60	38,111	6,352
37	Dagupan City	38	111,196	18,533
38	San Carlos City	167	117,696	19,616
	Sub-total	1,824	1,289,060	214,843

Source: National Statistics Office

Note : The number of residential houses is assumed by divided the number of population shown above by 6 of average number of occupants per house. One mesh cell is 1 km by 1 km.

Table 4.1 LAND AREA, POPULATION AND NUMBER OF HOUSES BY MUNICIPALITY IN THE INUNDATION AREA (2/2)

No.	Province Municipality /City	Land Area by Mesh (km2)	Population in 1989 (persons)	Number of Residential Houses (Nos.)
	Tarlac			
39	Anao	24	7,650	1,275
40	Camiling	90	37,381	6,230
41	Gerona	76	42,641	7,107
42	Moncada	86	40,452	6,742
43	Paniqui	87	14,187	2,365
44	Pura	23	14,454	2,409
45	Ramos	25	12,958	2,160
46	San Clemente	13	3,509	585
47	San Manuel	42	15,899	2,650
48	Sta. Ignacia	4	1,486	248
49	Tarlac	35	23,134	3,856
50	Victoria	1	119	20
	Sub-total	506	213,869	35,645
	Nueva Ecija			
51	Cuyapo	51	14,559	2,427
52	Guimba	21	989	165
53	Nampicuan	53	9,085	1,514
	Sub-total	125	24,633	4,106
	La Union			
54	Rosario	10	30,258	5,043
	Sub-total	10	30,258	5,043
	Total	2,465	1,557,821	259,637

Source: National Statistics Office

Note : The number of residential houses is assumed by divided the number of population shown above by 6 of average number of occupants per house. One mesh cell is 1 km by 1 km.

Table 4.2 LAND USE IN THE PROVINCES OF PANGASINAN AND TARLAC

Land Use	Pangasinan				Tarlac			
	1983		1992		1980		1992	
	(km2)	(%)	(km2)	(%)	(km2)	(%)	(km2)	(%)
1 Agricultural Land	2,518	46.9	2,665	49.6	1,048	34.3	-	-
Irrigated Paddy	561				245			
Rainfed Paddy	1,152				378			
Others	805				425			
2 Grass Land	1,308	24.4	1,199	22.3	47	1.5	-	-
3 Forest Land	765	14.3	765	14.3	1,237	40.5	-	-
4 Fishpond	164	3.1	218	4.1	9	0.3	-	-
5 Swamps	63	1.2	116	2.2	7	0.2	-	-
6 Bare Land	116	2.2	59	1.1	-	-	-	-
7 Mining	116	2.2	-	-	-	-	-	-
8 Built-up Area /Others	318	5.9	346	6.4	705	23.1	-	-
Total	5,368	100.0	5,368	100.0	3,053	100.0	-	-

Source: Multi-Year Human Settlement Plan Region I 1983-1987
Medium-Term Ilocos Region Development Plan 1987-1992
Regional Development Council, Region I
Socio Economic Profile, 1985

Note : Land use for others in Tarlac province includes grass land, forest, fishpond, swamps, bare land and built-up area. Agricultural land and fishpond area in Pangasinan Agricultural land and fishpond area in Pangasinan and Tarlac are in 1988-1989. (Souce: DA, Pangacinan, Tarlac)

Table 4.3 AGRICULTURAL LAND USE BY MUNICIPALITY IN THE INUNDATION AREA (1/2)

No.	Province Municipality /City	Agricultural Land Area Irri. Paddy (ha)	Rainfed Paddy (ha)	Other (ha)	Sub-total (ha)	Other Land (km2)	Total Land Area (km2)
	Pangasinan						
1	Aguilar	324	121	2	447	20	24
2	Alcala	1,040	2,560	0	3,600	0	36
3	Asingan	2,538	150	75	2,763	39	67
4	Balungao	945	837	68	1,850	20	38
5	Basista	0	1,110	0	1,110	5	16
6	Bautista	242	2,180	633	3,055	57	87
7	Bayambang	233	4,650	488	5,371	16	70
8	Binalonan	1,161	1,751	223	3,135	30	61
9	Binmaley	0	875	0	875	53	62
10	Bugallon	222	458	22	702	21	28
11	Calasiao	446	2,917	1,923	5,286	0	53
12	Labrador	8	8	11	28	2	2
13	Laoac	73	1,385	401	1,859	22	41
14	Lingayen	0	1,068	0	1,068	50	60
15	Malasiqui	288	3,851	71	4,210	50	92
16	Manaoag	671	1,092	117	1,880	0	19
17	Mangaldan	300	2,501	95	2,896	16	45
18	Mangatarem	1,505	966	2,352	4,822	10	58
19	Mapandan	165	954	1,272	2,391	6	30
20	Natividad	368	62	0	430	11	15
21	Pozzorubio	432	348	180	960	23	32
22	Rosales	2,680	848	315	3,843	9	48
23	San Fabian	0	0	0	0	12	12
24	San Jacinto	662	883	184	1,729	11	28
25	San Manuel	1,796	280	36	2,112	31	52
26	San Nicolas	310	0	10	320	17	20
27	San Quintin	231	679	0	910	15	24
28	Sta. Barbara	553	3,563	170	4,285	26	69
29	Sta. Maria	1,485	2,401	0	3,886	30	69
30	Sto. Tomas	601	167	0	768	0	8
31	Sison	195	151	12	359	8	12
32	Tayug	1,821	1,623	0	3,443	16	51
33	Umingan	480	932	19	1,432	23	37
34	Urbiztondo	0	3,069	1,458	4,527	37	82
35	Urdaneta	1,656	1,932	1,012	4,600	65	111
36	Villasis	1,679	2,524	160	4,362	16	60
37	Dagupan City	0	405	0	405	34	38
38	San Carlos City	0	7,465	1,555	9,020	77	167
	Sub-total	25,108	56,765	12,863	94,737	877	1,824

Source: DA, BAS, Pangasinan, Tarlac

Table 4.3 AGRICULTURAL LAND USE BY MUNICIPALITY IN THE INUNDATION AREA (2/2)

No.	Province / Municipality /City	Agricultural Land Area: Irri. Paddy (ha)	Rainfed Paddy (ha)	Other (ha)	Sub-total (ha)	Other Land (km2)	Total Land Area (km2)
	Tarlac						
39	Anao	25	1,339	507	1,871	5	24
40	Camiling	3,026	932	353	4,311	47	90
41	Gerona	419	2,346	689	3,453	42	76
42	Moncada	1,650	1,710	2,865	6,225	23	86
43	Paniqui	166	2,399	2,719	5,284	34	87
44	Pura	6	1,343	945	2,294	0	23
45	Ramos	7	1,620	780	2,407	1	25
46	San Clemente	312	21	7	340	10	13
47	San Manuel	952	684	127	1,763	24	42
48	Sta. Ignacia	61	204	6	271	1	4
49	Tarlac	311	76	275	662	28	35
50	Victoria	11	34	14	59	0	1
	Sub-total	6,946	12,706	9,287	28,939	217	506
	Nueva Ecija						
51	Cuyapo	2,552	1,276	0	3,828	13	51
52	Guimba	896	448	0	1,344	8	21
53	Nampicuan	2,107	1,054	0	3,161	21	53
	Sub-total	5,555	2,777	0	8,332	41	125
	La Union						
54	Rosario	500	0	0	500	5	10
	Sub-total	500	0	0	500	5	10
	Total	38,109	72,249	22,150	132,508	1,140	2,465

Source: DA, BAS, Pangasinan, Tarlac

Table 4.4 DAMAGEABLE VALUE OF CROPS (1/8)

Name of Crops : Irrigated Paddy

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender			2nd						1st				
B. Planted Area (%)	1st Crop						25	75	100	100	75	25	
	2nd Crop	100	100	75	25							25	75
C. Accumulated Cost (%)	1st Crop						16	38	54	74	85	98	
	2nd Crop	54	74	85	98							16	38
D. Flood Frequency (%)		0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0

Year		1989	1995	2000	2005	2010
E. Yield	(ton/ha)	4.5	4.6	4.6	4.7	4.7
F. Price	(P/ton)	3,780	3,294	3,170	3,170	3,170
G. Production Cost	(P/ha)	8,215	8,323	8,430	8,538	8,646
H. Net Income	(P/ha)	8,795	6,697	6,207	6,288	6,367
I. Damageable Cost	(P/ha)	6,115	6,195	6,275	6,356	6,436
J. Damageable Value	(P/ha)	9,452	7,891	7,554	7,653	7,749

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

$$\text{Damageable Value} = \sum_{Jan.}^{Dec.} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (2/8)

Name of Crops : Rainfeded Paddy

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender												
B. Planted Area (%)						25	75	100	100	75	25	
C. Accumulated Cost (%)						16	38	54	74	85	98	
D. Flood Frequency (%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0

Year		1989	1995	2000	2005	2010
E. Yield	(ton/ha)	2.8	2.9	2.9	3.0	3.0
F. Price	(P/ton)	3,780	3,294	3,170	3,170	3,170
G. Production Cost	(P/ha)	7,650	7,811	7,972	8,134	8,295
H. Net Income	(P/ha)	2,934	1,608	1,276	1,304	1,329
I. Damageable Cost	(P/ha)	5,910	6,035	6,159	6,284	6,408
J. Damageable Value	(P/ha)	4,726	3,791	3,598	3,671	3,744

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

$$\text{Damageable Value} = \sum_{Jan.}^{Dec.} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (3/8)

Name of Crops : Corn

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender												
B. Planted Area (%)	100	95	55	7							25	75
C. Accumulated Cost (%)	64	89	96	100							18	39
D. Flood Frequency (%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0

Year		1989	1995	2000	2005	2010	
E. Yield	(ton/ha)	3.0	3.0	3.0	3.0	3.0	
F. Price	(P/ton)	4,080	3,789	4,080	4,080	4,080	
G. Production Cost	(P/ha)	7,731	7,777	7,777	7,777	7,777	
H. Net Income	(P/ha)	4,509	3,659	4,536	4,536	4,536	
I. Damageable Cost	(P/ha)	6,921	6,963	6,921	6,921	6,921	
J. Damageable Value	(P/ha)	115	98	116	116	116	Negligibly small

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

$$\text{Damageable Value} = \sum_{\text{Jan.}}^{\text{Dec.}} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (4/8)

Name of Crops : Sugarcane

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender												
B. Planted Area (%)	40	55	65	75	95	100	100	100	100	93	75	60
C. Accumulated Cost (%)	8	16	20	29	38	47	62	70	77	92	95	100
D. Flood Frequency (%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.03	0

Year		1989	1995	2000	2005	2010
E. Yield	(ton/ha)	60	60	60	60	60
F. Price	(P/ton)	235	236	225	225	215
G. Production Cost	(P/ha)	11,400	11,400	11,400	11,400	11,400
H. Net Income	(P/ha)	2,700	2,731	2,089	2,119	1,504
I. Damageable Cost	(P/ha)	6,600	6,600	6,600	6,600	6,600
J. Damageable Value	(P/ha)	7,093	7,124	6,501	6,530	5,934

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

$$\text{Damageable Value} = \sum_{\text{Jan.}}^{\text{Dec.}} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (5/8)

Name of Crops : Tobacco

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender													
B. Planted Area	(%)	100	100	100	95	8						8	95
C. Accumulated Cost	(%)	45	60	75	90	100						15	30
D. Flood Frequency	(%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0
Year		1989	1995	2000	2005	2010							
E. Yield	(ton/ha)	1.2	1.2	1.2	1.3	1.3							
F. Price	(P/ton)	20,000	20,000	20,000	20,000	20,000							
G. Production Cost	(P/ha)	18,660	18,971	19,282	19,593	19,904							
H. Net Income	(P/ha)	5,340	5,429	5,518	5,607	5,696							
I. Damageable Cost	(P/ha)	2,400	2,440	2,480	2,520	2,560							
J. Damageable Value	(P/ha)	61	62	63	64	65	Negligibly small						

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA
Oct.,1988

Note :

$$\text{Damageable Value} = \sum_{Jan.}^{Dec.} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (6/8)

rops : Root Crop (peanut)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
ng Calender							No Seasonable						
d Area	(%)	100	100	100	100	100					100	100	100
lated Cost	(%)	50	50	50	50	50					50	50	50
Frequency	(%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0
Year		1989	1995	2000	2005	2010							
	(ton/ha)	1.5	1.6	1.6	1.7	1.7							
	(P/ton)	9,600	9,600	9,600	9,600	9,600							
tion Cost	(P/ha)	6,800	7,072	7,344	7,616	7,888							
come	(P/ha)	7,600	7,904	8,208	8,512	8,816							
able Cost	(P/ha)	6,200	6,448	6,696	6,944	7,192							
able Value	(P/ha)	2,675	2,782	2,889	2,996	3,103							

A, BAS
he Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA
Oct.,1988

$$\text{Damageable Value} = \sum_{Jan.}^{Dec.} (B*D*(C*I+H))$$

Table 4.4 DAMAGEABLE VALUE OF CROPS (7/8)

Name of Crops : Legume

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender													
B. Planted Area	(%)	100	100	50								50	100
C. Accumulated Cost	(%)	60	80	100								20	40
D. Flood Frequency	(%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0

Year		1989	1995	2000	2005	2010
E. Yield	(ton/ha)	1.5	1.5	1.5	1.5	1.6
F. Price	(P/ton)	14,650	14,650	14,650	14,650	14,650
G. Production Cost	(P/ha)	12,050	12,162	12,275	12,387	12,500
H. Net Income	(P/ha)	9,925	10,018	10,110	10,203	10,296
I. Damageable Cost	(P/ha)	10890	10,992	11,093	11,195	11,297
J. Damageable Value	(P/ha)	484	489	493	498	502

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

Damageable Value = $\sum_{Jan.}^{Dec.} (B*D*(C*I+H))$

Table 4.4 DAMAGEABLE VALUE OF CROPS (8/8)

Name of Crops : Vegetables (Eggplant)

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A. Cropping Calender													
B. Planted Area	(%)	100	100	50								8	95
C. Accumulated Cost	(%)	60	80	100								20	40
D. Flood Frequency	(%)	0	0	0	0	0.04	0.08	0.25	0.29	0.13	0.13	0.08	0

Year		1989	1995	2000	2005	2010
E. Yield	(ton/ha)	8.0	8.2	8.4	8.6	8.8
F. Price	(P/ton)	4,900	4,900	4,900	4,900	4,900
G. Production Cost	(P/ha)	11,050	11,318	11,312	11,306	11,300
H. Net Income	(P/ha)	28,150	28,833	29,790	30,746	31,703
I. Damageable Cost	(P/ha)	10,210	10,458	10,705	10,953	11,200
J. Damageable Value	(P/ha)	193	198	204	211	217

Source: DA, BAS
The Report on Feasibility Study on the Improvement of Operation Maintenance in Pumping Irri. System, JICA Oct.,1988

Note :

Damageable Value = $\sum_{Jan.}^{Dec.} (B*D*(C*I+H))$

Table 4.5 DAMAGE RATES OF CROPS BY FLOOD AND SEDIMENT

Crops	Flood Duration (days)	Flood Damage Rate (%) Inundation Depth Above Ground Level (m) Less than 0.5	0.5 - 1.0	More than 1.0	Sediment Damage Rate (%) Sediment Depth Above Ground Level (m) Less than 0.5	0.5 - 1.0	More than 1.0
Paddy					68	81	100
	1 to 2	21	24	37			
	3 to 4	30	44	54			
	5 to 6	36	50	64			
	Longer than 7	50	71	74			
Upland Crops					68	81	100
	1 to 2	27	35	51			
	3 to 4	42	48	67			
	5 to 6	54	67	81			
	Longer than 7	67	74	91			
Tobacco					68	81	100
	1	50					
	2	75					
	Longer than 3	100					

Source : Master Plan Study on the Cagayan River Basin Water Resources Development, 1987, JICA
Panay River Basin-wide Flood Control Study, 1985, JICA
Nationwide Flood Control Plan and River Dredging Program, 1982, JICA
Technical Standard for River and Sabo Works, Ministry of Construction, Japan

Note : Damage rate for tobacco is based on the the study results of The Kelantan River Basin Flood Control Project, Malaysia, JICA, 1988

Table 4.6 UNIT VALUES OF FISH STOCKS AND FISHPOND FACILITY

Item	Unit Value
Fish Stocks	16,600 pesos/ha
Fishpond Facility	80,000 pesos/ha

Assumptions:

1. Unit value of fish stocks (milkfish)

- Average stocking rate of fries at the initial stage

Milkfish fries:	3,000 fries/ha

- Recovery rate of fish

Middle stage:	80 %
Last stage:	90 %

- Size of fish

Middle stage:	3 - 4 pieces/kg
Last stage:	6 - 8 pieces/kg

- Prices of fish

Fry:	0.6 peso/piece
Middle stage:	40 pesos/piece
Maketable size:	50 pesos/piece

2. Unit cost of fishpond dikes

Unit construction cost: (including values for other facilites)	40 pesos/m/foot
Average dike length:	400 m/ha

Source: Interview with DA, BFAR and fishpond operators, Dagupan

Table 4.7 ESTIMATED UNIT VALUE OF NON-AGRICULTURAL PROPERTIES

Item	Unit Cost
1. Houses and Buildings	
(1) Residential Building	
- House Structure	29,600 Pesos/Bldg.
- Household Effects	8,000 Pesos/Bldg.
(2) Non-residential Building	
- Building Structure	154,000 Pesos/Bldg.
- Stocks/Equipment	83,000 Pesos/Bldg.

Assumptions:

- Dwelling type by materials, distribution, unit cost and average floor size.

Dwelling type by materials	Distribution percent	Unit cost	Average floor size
- Concrete	4.2 %	3,900 pesos/unit	55 m2/unit
- Semi-concrete	0.1 %	3,000 pesos/unit	45 m2/unit
- G.I.sheet/wood	50.3 %	2,400 pesos/unit	35 m2/unit
- Bamboo/nipa	45.4 %	850 pesos/unit	20 m2/unit

- Distribution class and average value of household effects by class.

Class	Distribution percent	Average value
High	4.3 %	43,000 pesos/unit
Medium	50.3 %	19,000 pesos/unit
Low	45.4 %	6,500 pesos/unit

- Non-residential bldg. distribution and average floor size.

Bldg. type by materials	Distribution percent	Average floor size school bldg.	Average floor size commercial bldg.
- Concrete	8 %	144 m2/unit	60 m2/unit
- Semi-concrete	1 %	144 m2/unit	60 m2/unit
- G.I.sheet/wood	91 %	144 m2/unit	60 m2/unit

- Unit values of stocks and appliances are based on interview results with DPWH, insurance company and other agencies, and questionnaires carried out in site-interviews.
- Depreciation ratio: 50 %

Item	Unit Cost
2. Infrastructures	
- Road/Bridge	352,000 - 1,490,000 pesos/km
- Railway road	2,800,000 pesos/km
- River dikes	3,500,000 pesos/km
- Irrigation canal	638,000 pesos/km
- Water supply facility	350 pesos/person
- Telecommunication	10 pesos/person

Source: DPWH, PNR, NIA
1980 Census of Population and Housing,
National Cecsus and Statistics Office, Manila

Table 4.8 DAMAGE RATES OF BUILDING AND CONTENTS BY FLOOD AND SEDIMENT

Properties	Flood Damage Rate (%)				Sediment Damage Rate (%)	
	Flood Level Below Floor Level	Flood Level Above Floor Level (m)			Sediment Depth above Floor Level (m)	
		Less than 0.5	0.5 - 1.0	More than 1.0	0 - 0.5	More than 0.5
House/Building Structure						
Ground Slope						
Less than 0.1 %	3.0	5.3	7.2	11.7	43.0	57.0
0.1 - 0.2 %	3.0	8.3	12.6	19.2	43.0	57.0
More than 0.2 %	3.0	12.4	21.0	33.0	43.0	57.0
Indoor Movables						
Residential						
Household Effects	-	8.6	19.1	36.6	50.0	69.0
Non-residential						
Depreciable assets	-	18.0	31.4	44.3	54.0	63.0
Inventory Stock	-	12.7	27.6	39.8	48.0	56.0

Source: Master Plan Study on the Cagayan River Basin Water Resources Development, 1987, JICA
Panay River Basin-wide Flood Control Study, 1985, JICA
Nationwide Flood Control Plan and River Dredging Program, 1982, JICA
Technical Standard for River and Sabo Works, Ministry of Construction, Japan

Table 5.1 PROBABLE FLOOD DAMAGE

Unit : Million Pesos

Item	Return Period (Year)						
	1.05	2	5	10	25	50	100
1. Casualities							
Affected People(1000 person)	938	1,056	1,175	1,370	1,406	1,435	1,157
Affected Area (km2)	1,213	1,448	1,665	2,038	2,122	2,183	2,465
2. Direct Damage							
(1) Agricultural Damage							
- Crops	236	269	321	388	437	467	545
- Livestocks	17	19	22	27	31	33	38
- Fishpond	4	27	143	171	217	262	293
Sub-total	257	315	486	586	684	762	877
(2) Non-agricultural Damage							
- Residential Bldg.	317	433	598	731	946	1,086	1,220
- Non-residential Bldg.	49	83	141	177	251	296	338
Sub-total	366	516	739	908	1,197	1,382	1,558
-Infrastructures							
- Road/Bridge	6	35	93	175	245	334	419
- Railways	2	10	23	40	63	77	104
- Irrigation Facility	4	8	16	27	34	45	52
- River Facility	8	52	92	135	175	221	259
- Water Supply Facility	3	18	61	96	148	175	216
- Telecommunication	0	1	3	4	5	6	8
Sub-total	23	125	287	476	669	857	1,058
Total	646	956	1,512	1,970	2,550	3,001	3,492
3. Indirect Damage	63	114	299	489	750	966	1,208
Grand Total	709	1,070	1,811	2,458	3,299	3,968	4,700

Note: The probable flood damage shown above is estimated for the entire Agno River Basin.

Table 5.2 *PROBABLE INDIRECT FLOOD DAMAGE*

Probable Indirect Damage (1000 Pesos)								
Damage Item	Return period (year)	1.05	2	5	10	25	50	100
	Economic suspension period (days)	1	2	6	9	14	18	21
	Traffic suspension period (days)	1	2	6	9	14	18	21
1. Loss due to suspension of Economic Activity (GRDP in the Inundation Area)		29,609	66,676	222,780	389,344	622,014	816,228	1,033,225
2. *Extra Transportation Cost due to* Change of Traffic Routes		590	590	590	590	590	590	590
3. Cost due to Rescue Services (5% of Probable Direct Damage)		32,320	48,982	75,600	98,492	127,491	150,071	174,619
Total		*62,519*	*116,248*	*298,970*	*488,425*	*750,095*	*966,889*	*1,208,434*
Remarks:								
Total probable flood damage (1000 pesos)		708,913	1,095,895	1,810,967	2,458,259	3,299,915	3,968,310	4,700,814
GRDP per capita in 1989 (pesos)		9,480	9,480	9,480	9,480	9,480	9,480	9,480
Economic activity days a year		300	300	300	300	300	300	300
Inundation area (km2)		1,213	1,448	1,665	2,038	2,122	2,183	2,465
Affected peoples (1000 persons)		937	1,055	1,175	1,369	1,406	1,435	1,557
Probable direct damage (1000 pesos)		646,394	979,647	1,511,997	1,969,834	2,549,820	3,001,421	3,492,380
Indirect damage/Direct damage (%)		9.7	11.9	19.8	24.8	29.4	32.2	34.6

Note : The suspension days for economic activities and traffic are assumed based on the interview with AFCS, DPWH and site-interviews.

Table 5.3 ESTIMATED ANNUAL DAMAGE BY SEDIMENT IN NATIONAL IRRIGATION SYSTEMS

Irrigation System	Original Design Service Irrigation Area	Program Service Irrigation Area	Actual Irrigated Area		Loss on Crop Production									Desilting Cost of Irrigation Canal			Total Loss
					Wet Season				Dry Season				Sub-total	Desilting Volume	Unit Cost of Desilting	Sub-total	
			Wet Season	Dry Season	Affected Area	Different Unit Yield of Paddy	Unit Value	Loss	Affected Area	Different Unit Yield of Paddy	Unit Value	Loss					
	(ha)	(ha)	(ha)	(ha)	(ha)	(ton/ha)	(peso/ton)	(P.1000)	(ha)	(ton/ha)	(peso/ton)	(P.1000)	(P.1000/ year)	(m3/year)	(peso/m3)	(P.1000/ year)	(P.1000/ year)
Agno River Irri. System (ARIS)	18,509	12,130	6,007	3,483	6,123	1.0	3,500	21,432	3,483	1.6	3,500	19,747	41,178	69,000	16.1	1,111	42,289
Sinocalan-Ext. Irri. System	1,650	1,650	178	573	1,472	0.7	3,500	3,349	573	0.4	3,500	702	4,051	0	16.1	0	4,051
Lower Agno Rive (LATRIS) Irri. System	10,000	10,000	4,510	2,786	5,490	0.7	3,500	12,491	2,786	0.4	3,500	3,413	15,904	185,300	16.1	2,983	18,887
Ambayaoan River (AMRIS) Irri. System	4,050	4,050	3,004	647	1,046	0.7	3,500	2,380	647	0.4	3,500	792	3,173	1,400	16.1	23	3,195
Depalo River (DERIS) Irri. System	1,963	1,963	1,519	121	444	0.7	3,500	1,011	121	0.4	3,500	148	1,159	38,000	16.1	612	1,771
San Fabian (SFIS) Irri. System	2,765	2,765	1,740	1,361	1,025	0.7	3,500	2,333	1,361	0.4	3,500	1,667	3,999	10,844	16.1	175	4,174
Camiling River (CARIS) Irri. System	8,580	8,580	6,790	2,314	1,790	0.7	3,500	4,071	2,314	0.4	3,500	2,834	6,906	41,493	16.1	668	7,574
Dumoloc River (DURIS) Irri. System	1,500	1,500	987	143	513	0.7	3,500	1,168	143	0.4	3,500	175	1,343	9,055	16.1	146	1,488
Sub-total	49,017	42,638	24,733	11,427	17,905			48,234	11,427			29,478	77,712	355,092		5,717	83,429

Source: NIA, ARIS, Urdaneta, Pangasinan

Notes: Program service irrigation areas are based on the last three years program(1986-1988).

Actual irrigated areas are based on the last three years records(1986-1988).

ARIS, NIA estimates the loss on crop production due to sedimentation for ARIS and LATRIS. The loss values shown above for other RIS are based on the the same estimation procedure by ARIS.

The different unit yield is estimated based on the following production values.

FIGURES

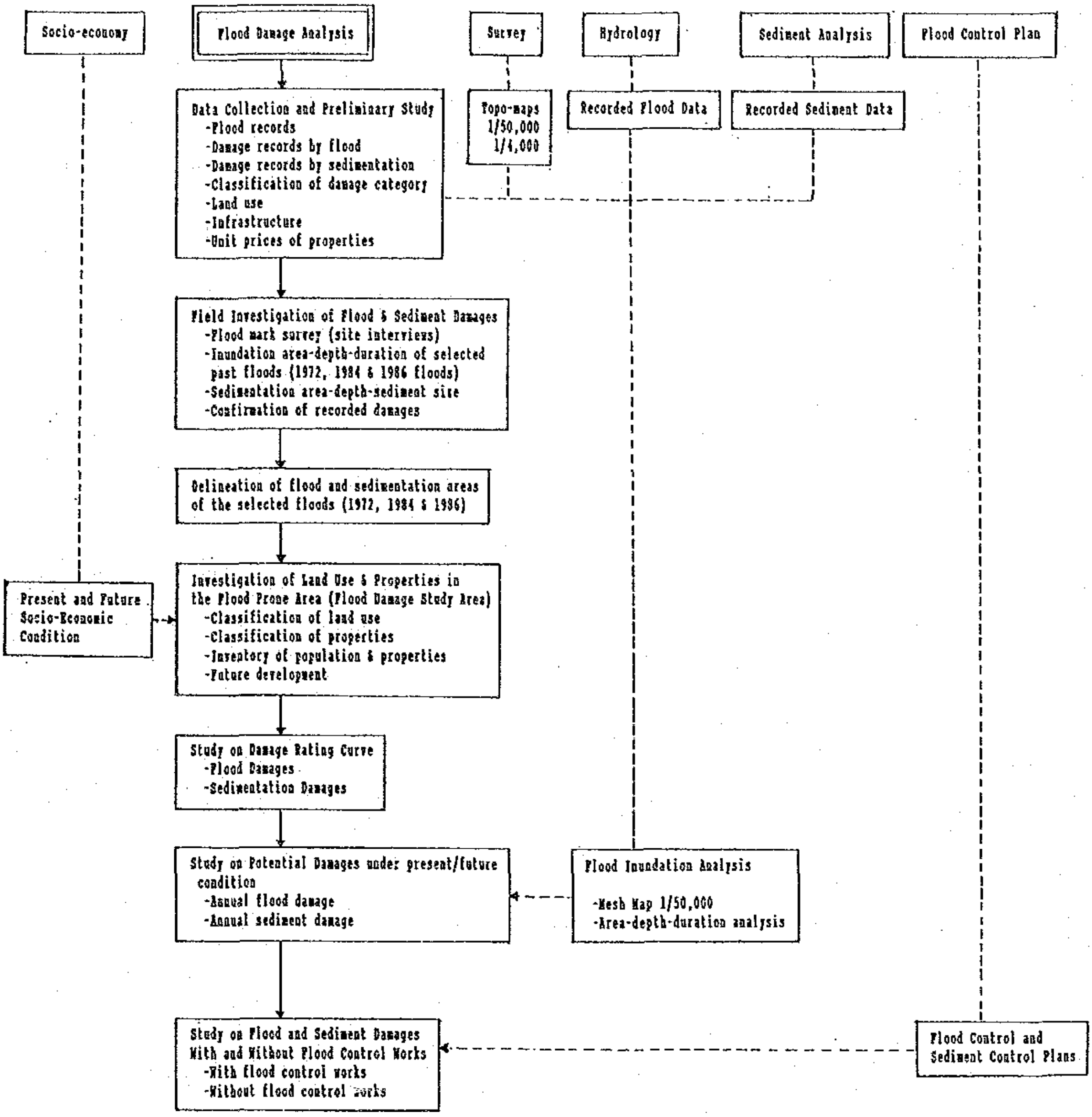


Fig. 1.1 FLOW CHART OF FLOOD DAMAGE ANALYSIS

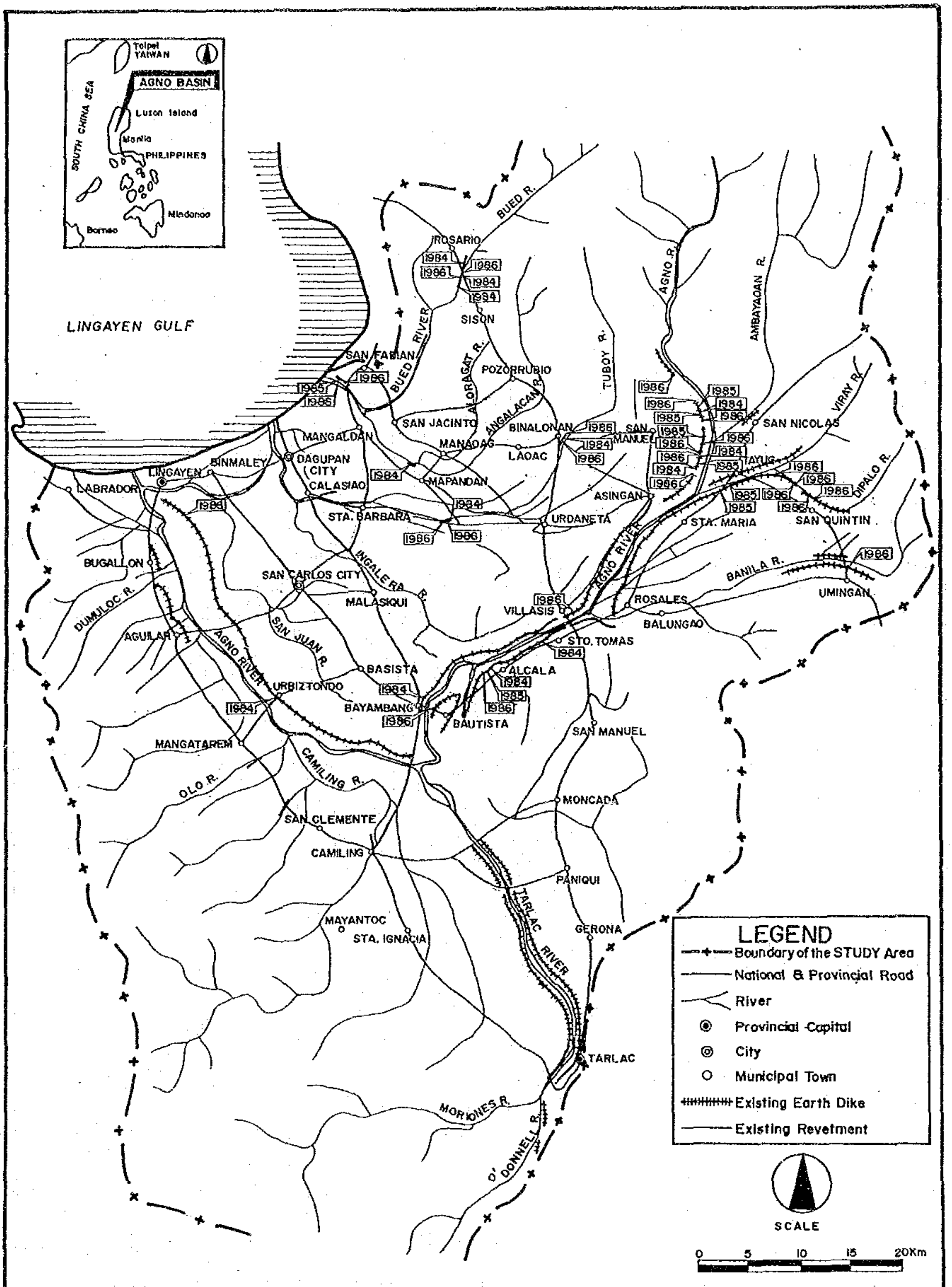
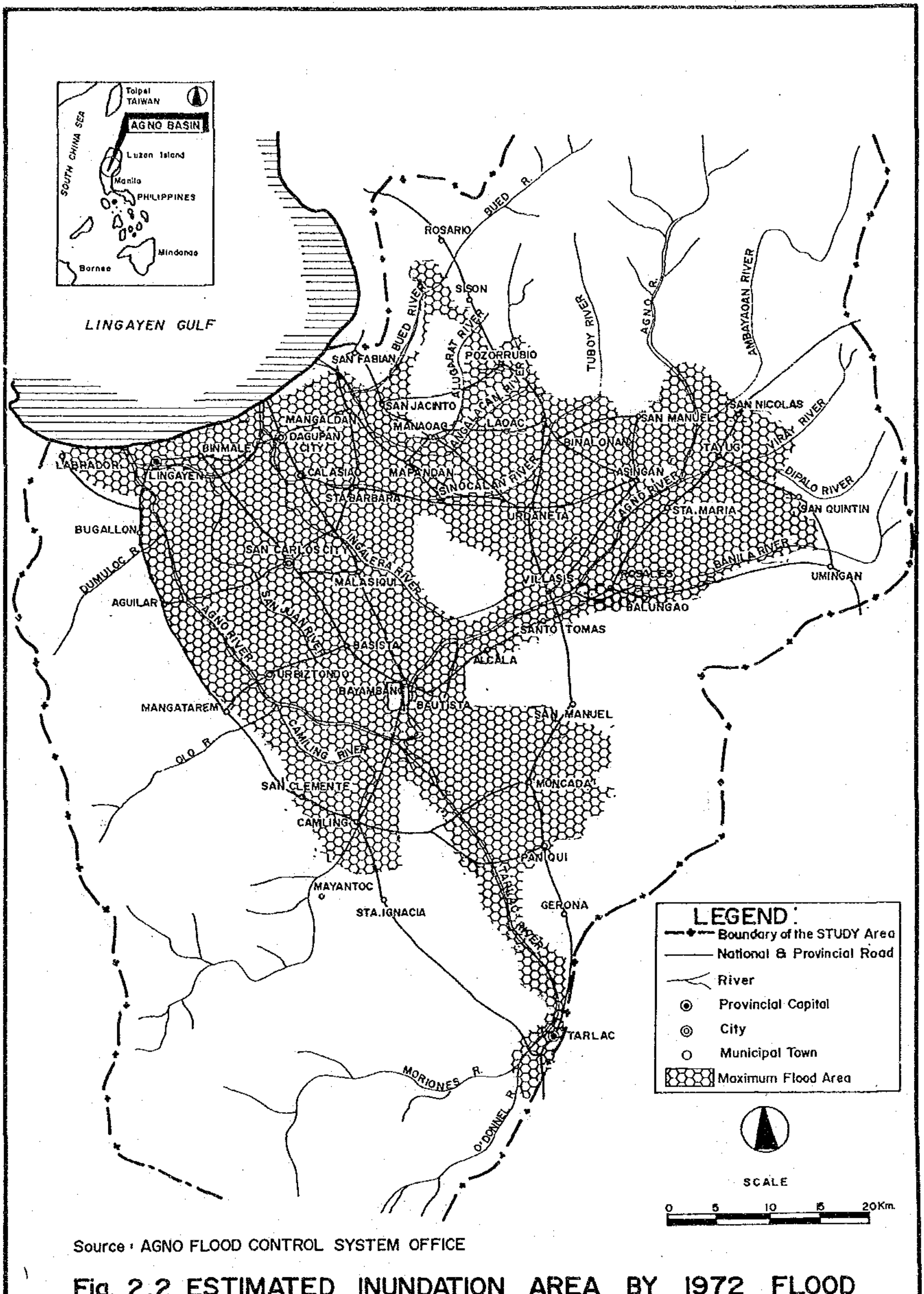
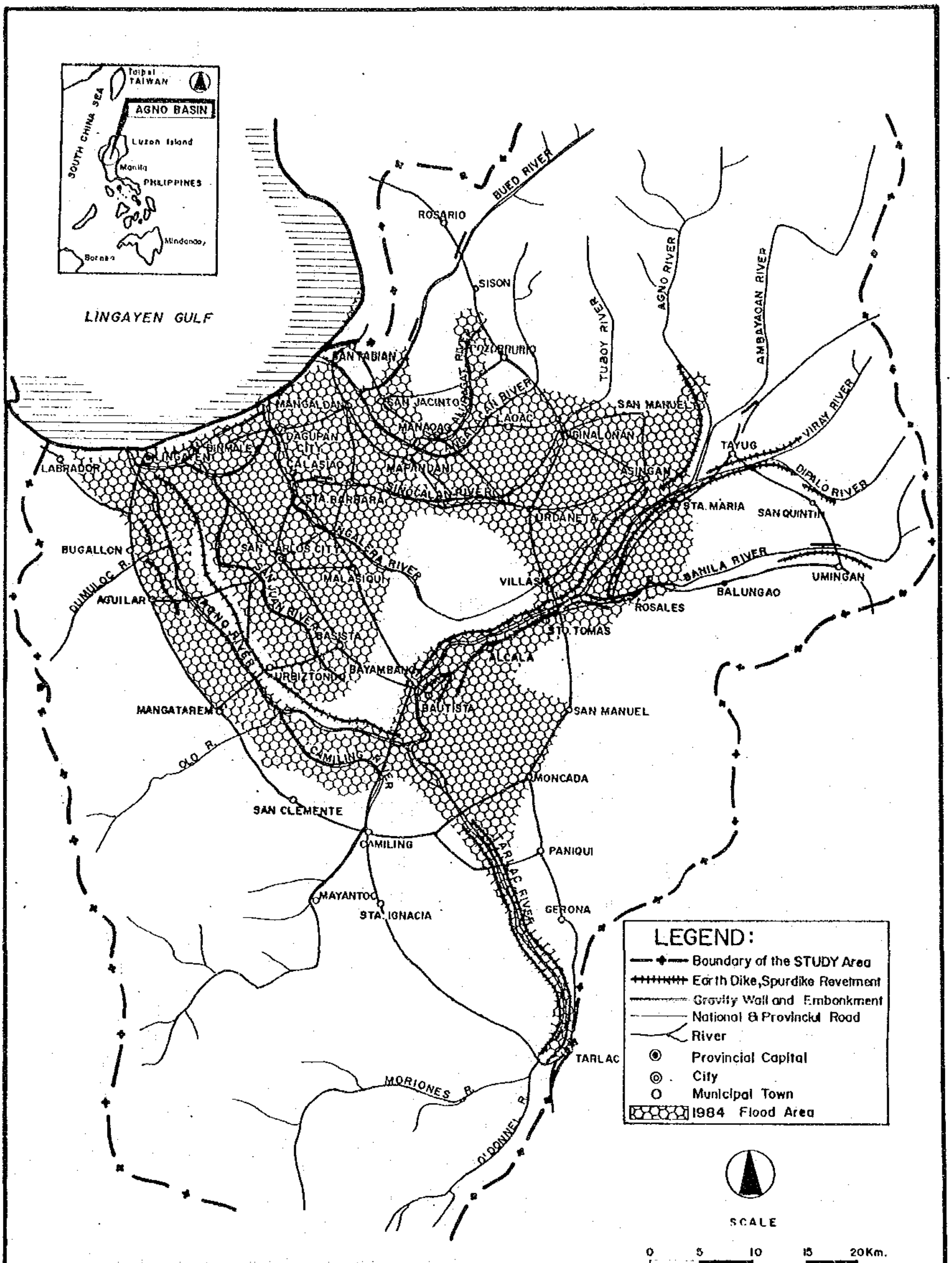


Fig. 2.1 LOCATION OF BREACHES/GAPS AND SCOURS CAUSED BY FLOODS OF 1984, 1985 AND 1986



Source : AGNO FLOOD CONTROL SYSTEM OFFICE

Fig. 2.2 ESTIMATED INUNDATION AREA BY 1972 FLOOD



SOURCE: AGNO FLOOD CONTROL SYSTEM OFFICE

Fig. 2.3 ESTIMATED INUNDATION AREA BY 1984 FLOOD

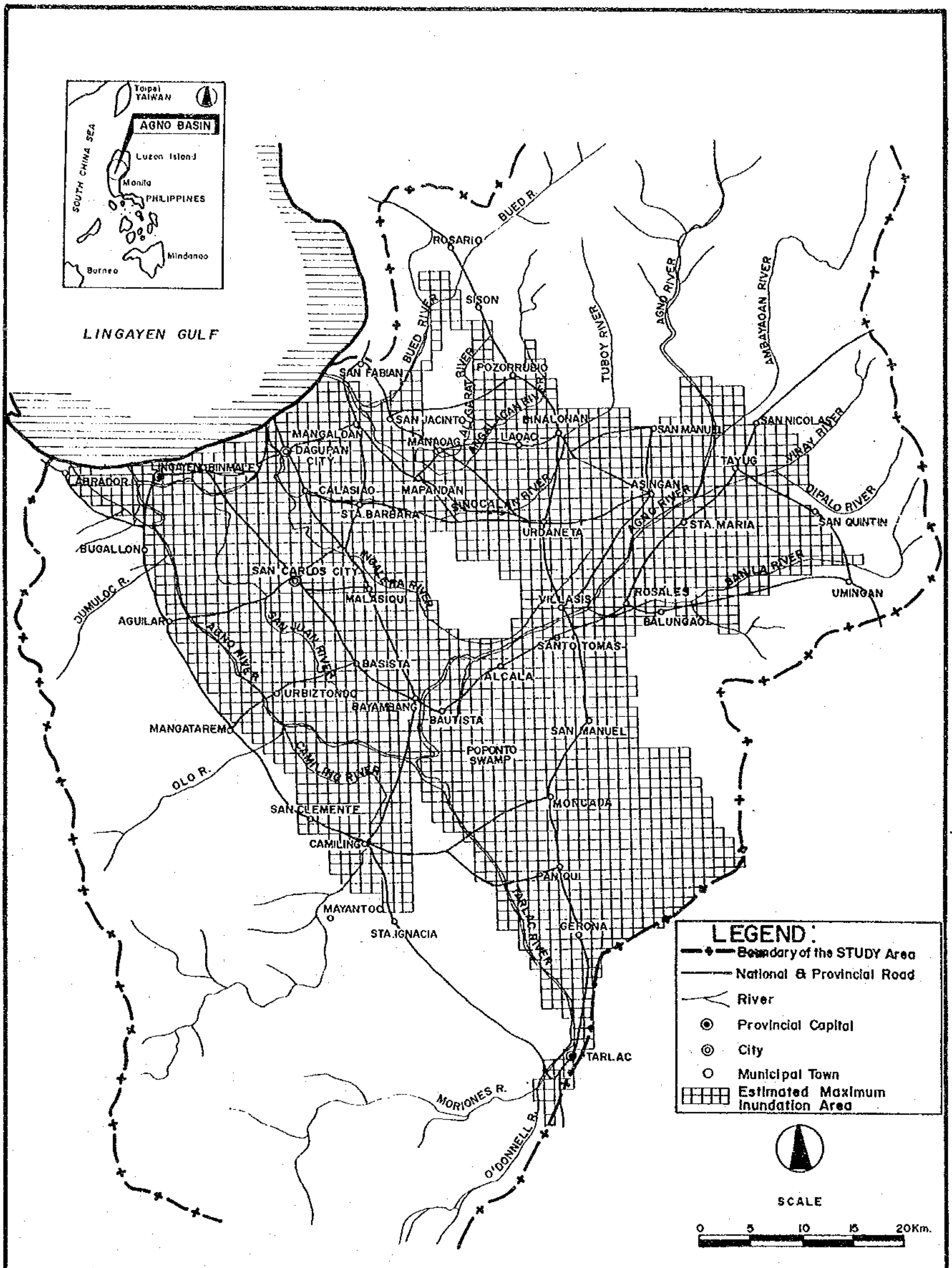


Fig. 3.1 ESTIMATED MAXIMUM INUNDATION AREA

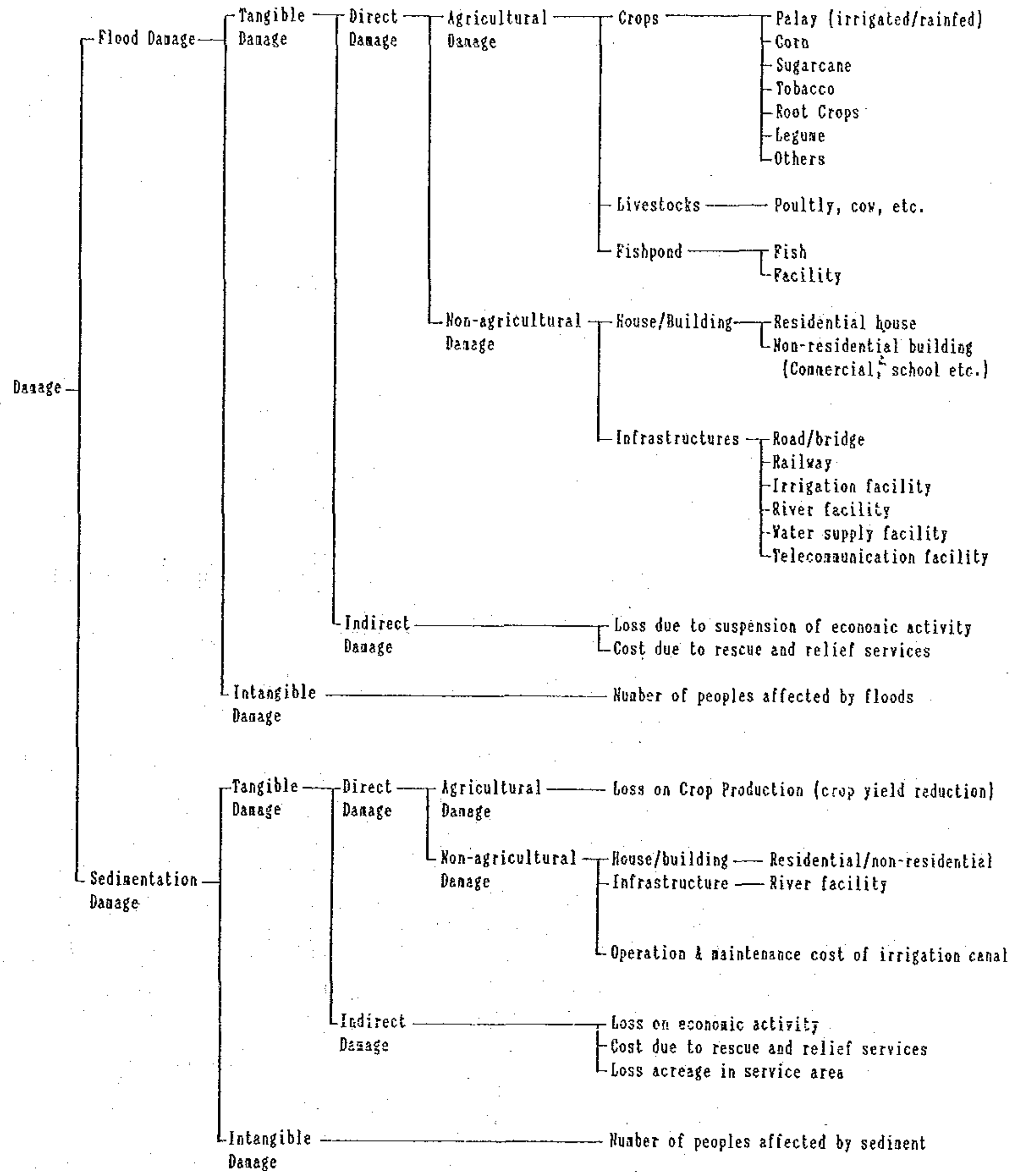


Fig. 4.1 CONSTITUTION OF DAMAGES DUE TO FLOOD AND SEDIMENT

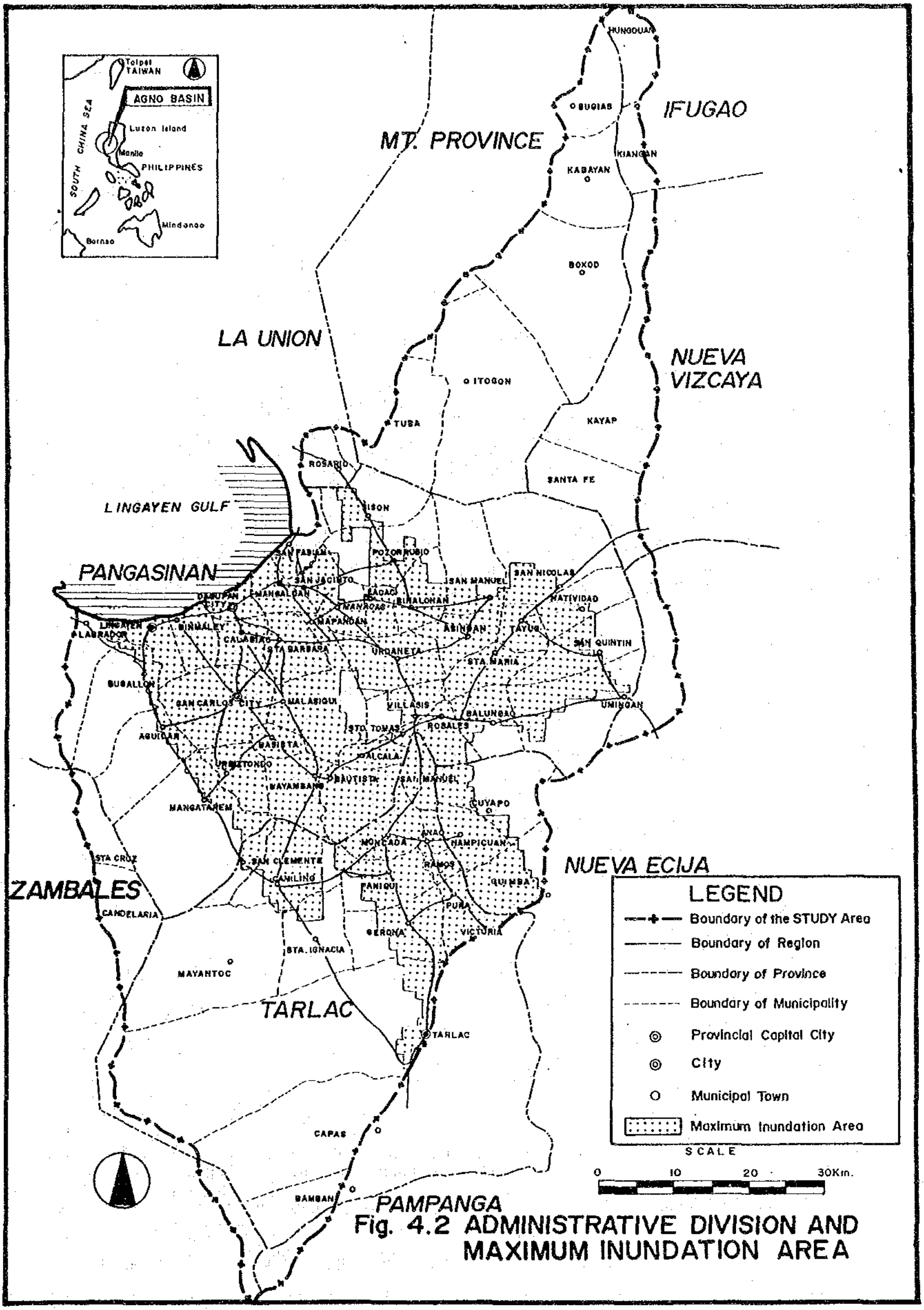
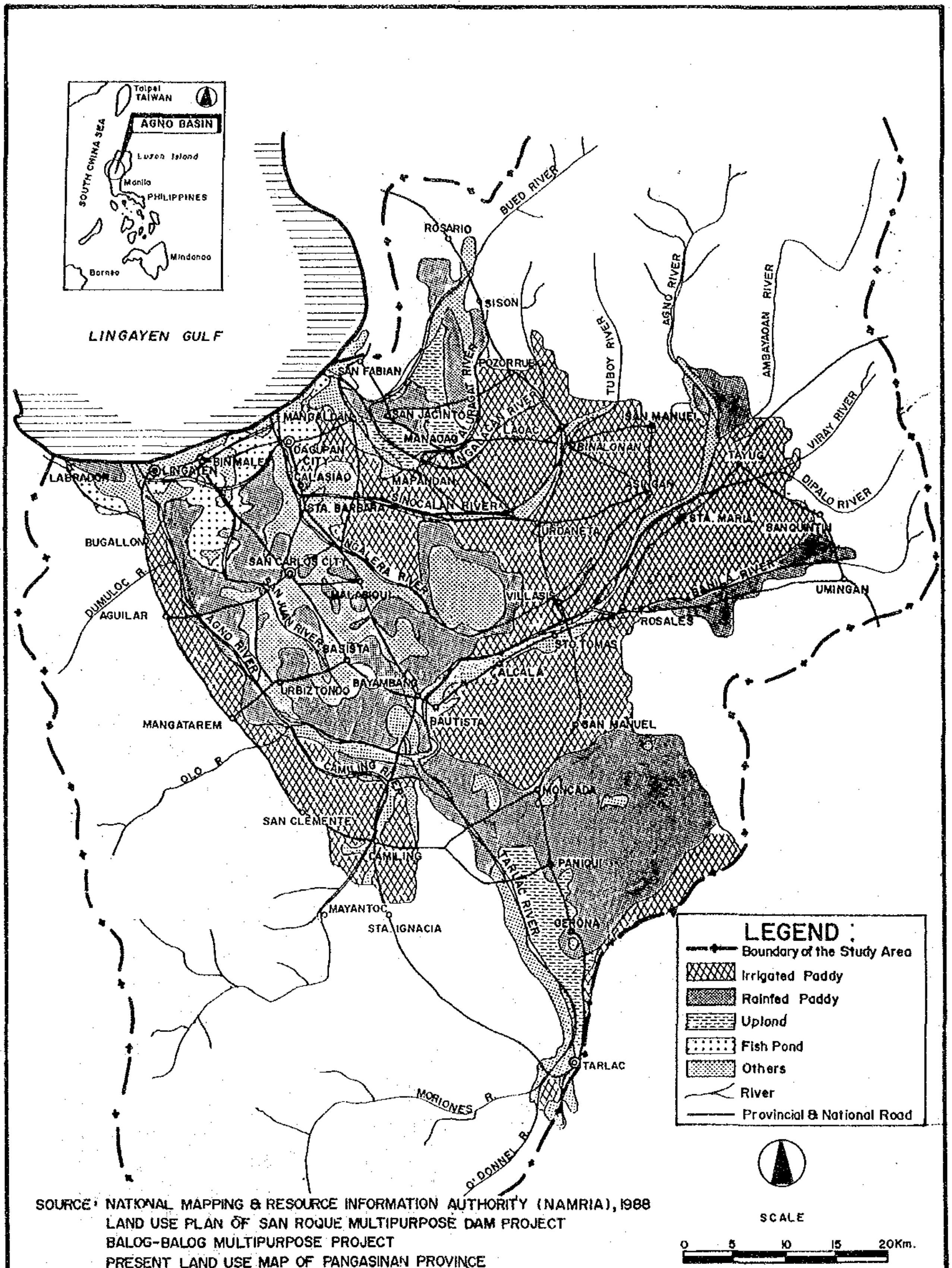


Fig. 4.2 ADMINISTRATIVE DIVISION AND MAXIMUM INUNDATION AREA



SOURCE : NATIONAL MAPPING & RESOURCE INFORMATION AUTHORITY (NAMRIA), 1988
LAND USE PLAN OF SAN ROQUE MULTIPURPOSE DAM PROJECT
BALOG-BALOG MULTIPURPOSE PROJECT
PRESENT LAND USE MAP OF PANGASINAN PROVINCE
BUREAU OF SOILS, 1982

Fig. 4.3 LAND USE MAP IN MAXIMUM INUNDATION AREA

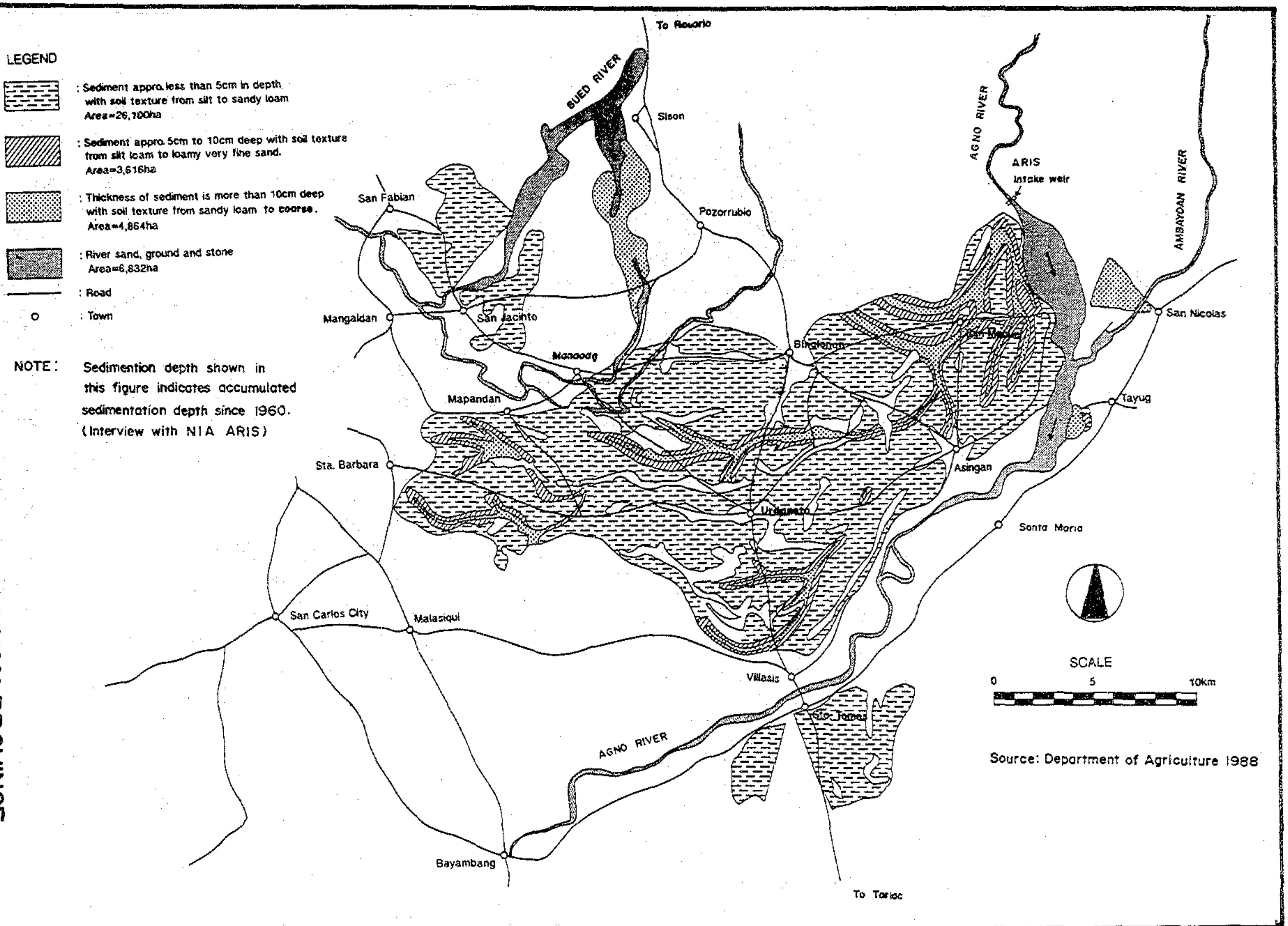


Fig. 4.4 SEDIMENTATION MAP IN PANGASINAN PROVINCE

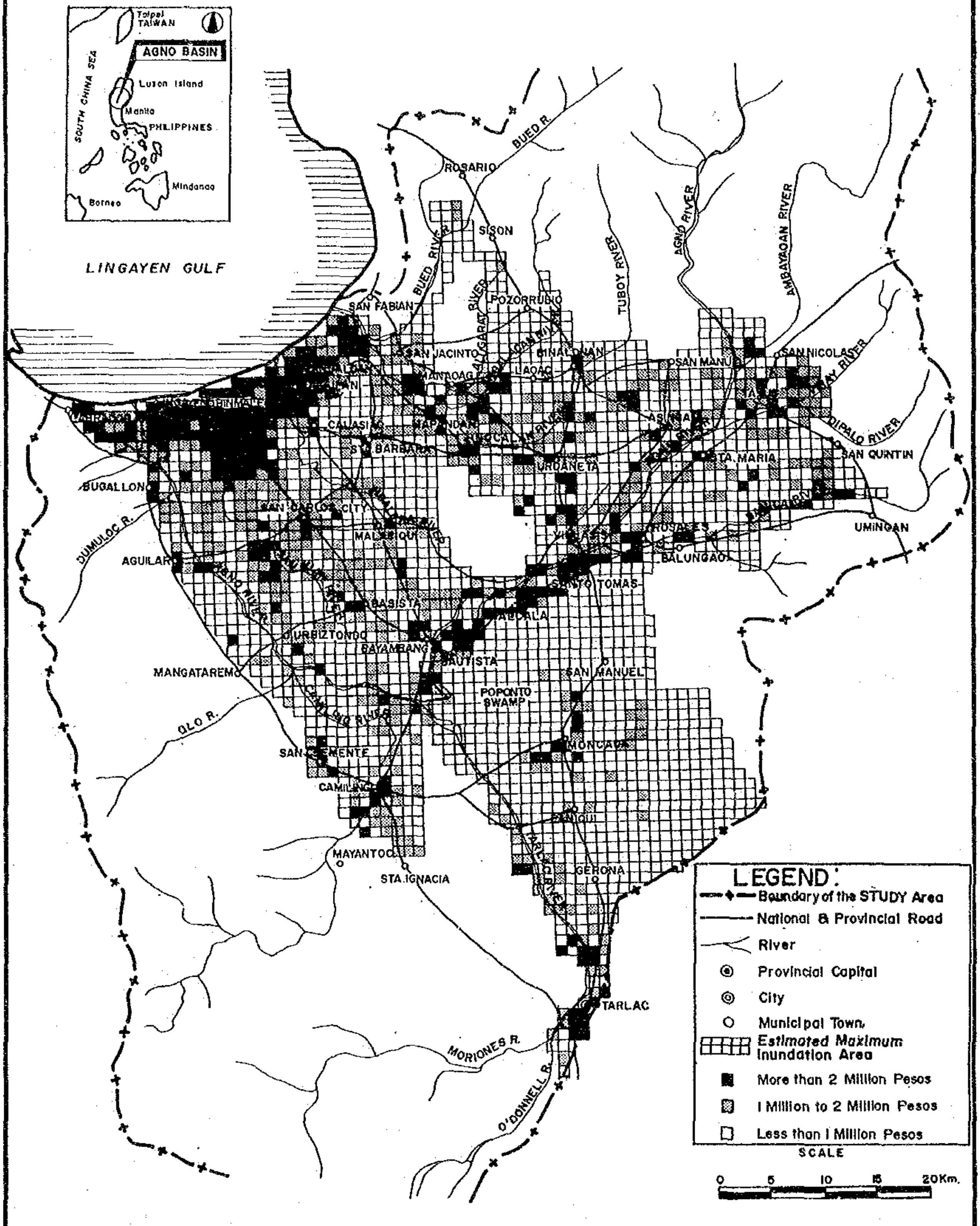


Fig. 5.1 DISTRIBUTION OF PROBABLE FLOOD DAMAGE BY 25-YEAR FLOOD (DIRECT DAMAGE)

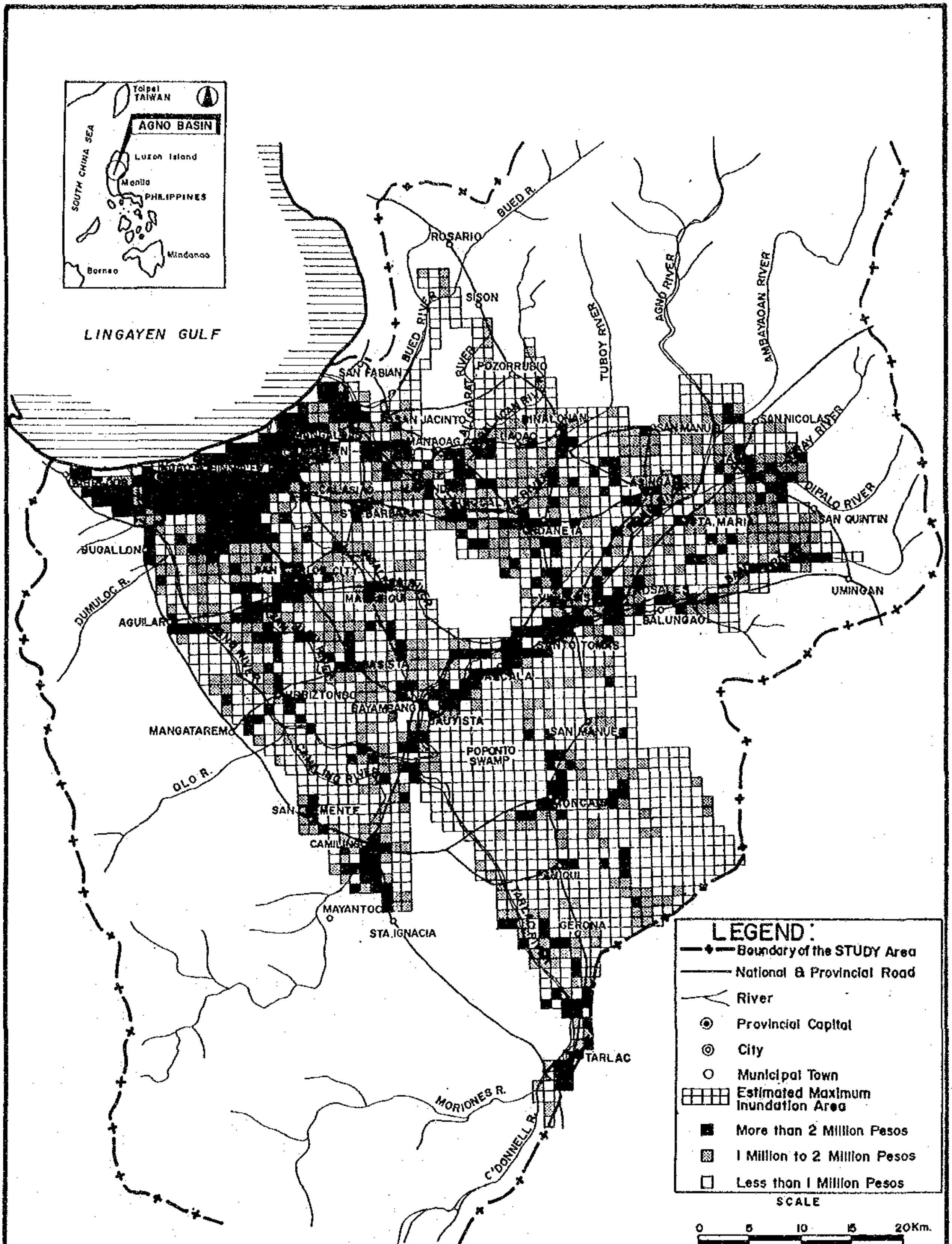


Fig. 5.2 DISTRIBUTION OF PROBABLE FLOOD DAMAGE BY 100-YEAR FLOOD (DIRECT DAMAGE)

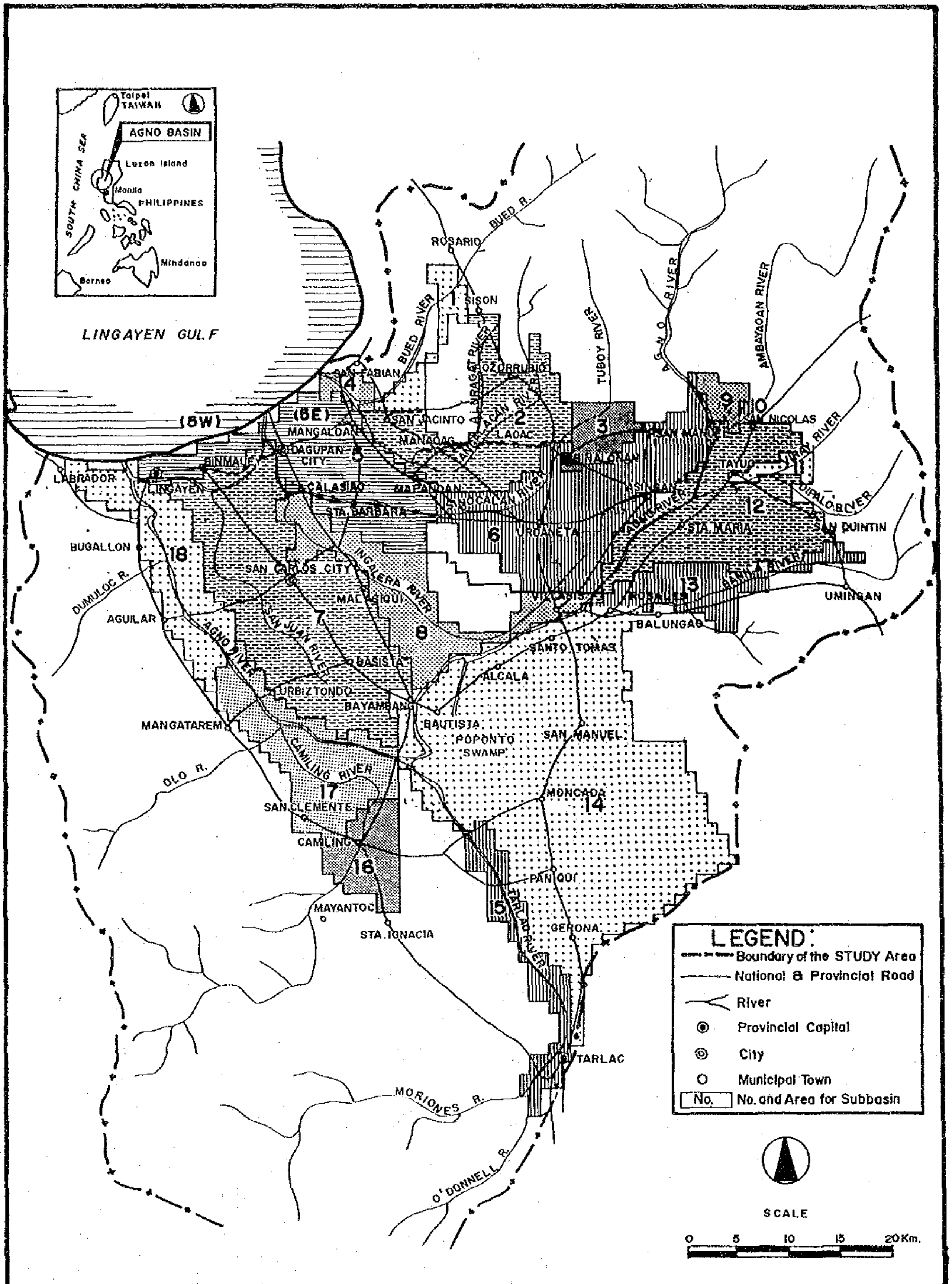


Fig. 5.3 DIVISION OF SUBBASIN FOR ESTIMATION OF PROBABLE FLOOD DAMAGE

ANNUAL AVERAGE FLOOD DAMAGE

Unit : Million Pesos

Sub-basin No.	Return Period (year)						
	1.05	2	5	10	25	50	100
1	-	1.8	4.1	5.6	6.8	7.2	7.5
2	-	31.7	62.0	75.7	86.1	90.3	92.8
3	-	5.5	10.8	13.3	15.1	15.9	16.4
4	-	8.2	15.5	18.7	21.0	21.9	22.5
5	-	51.2	111.4	141.0	164.2	174.1	180.0
6	-	43.5	84.4	103.2	117.9	124.2	127.7
7	-	69.9	158.9	203.8	239.1	253.6	261.9
8	-	34.8	67.2	81.6	93.0	97.7	100.3
9	-	3.5	7.2	8.6	9.5	9.9	10.1
10	-	0.7	1.6	2.0	2.2	2.3	2.4
11	-	4.0	7.2	8.7	10.0	10.5	10.8
12	-	28.1	54.7	68.8	81.3	86.6	89.7
13	-	13.1	25.6	31.3	36.0	37.9	39.1
14	-	42.8	88.5	111.5	132.3	142.0	148.9
15	-	0.0	0.0	6.3	14.2	17.0	18.5
16	-	1.3	5.3	9.3	14.0	16.4	17.8
17	-	13.7	33.1	43.8	52.6	56.1	58.1
18	-	7.7	27.5	39.7	50.4	54.9	57.4
Total		361.8	765.0	973.0	1,145.8	1,218.4	1,261.8

Note : The entire Agno River Basin

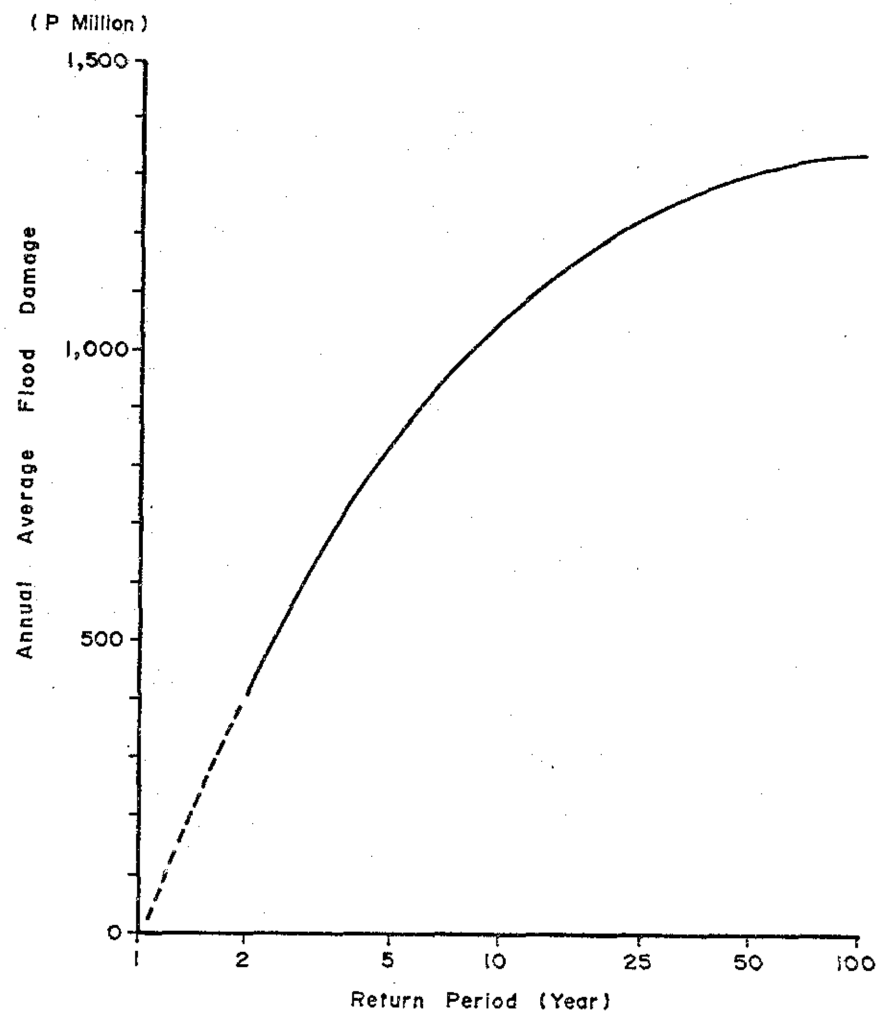
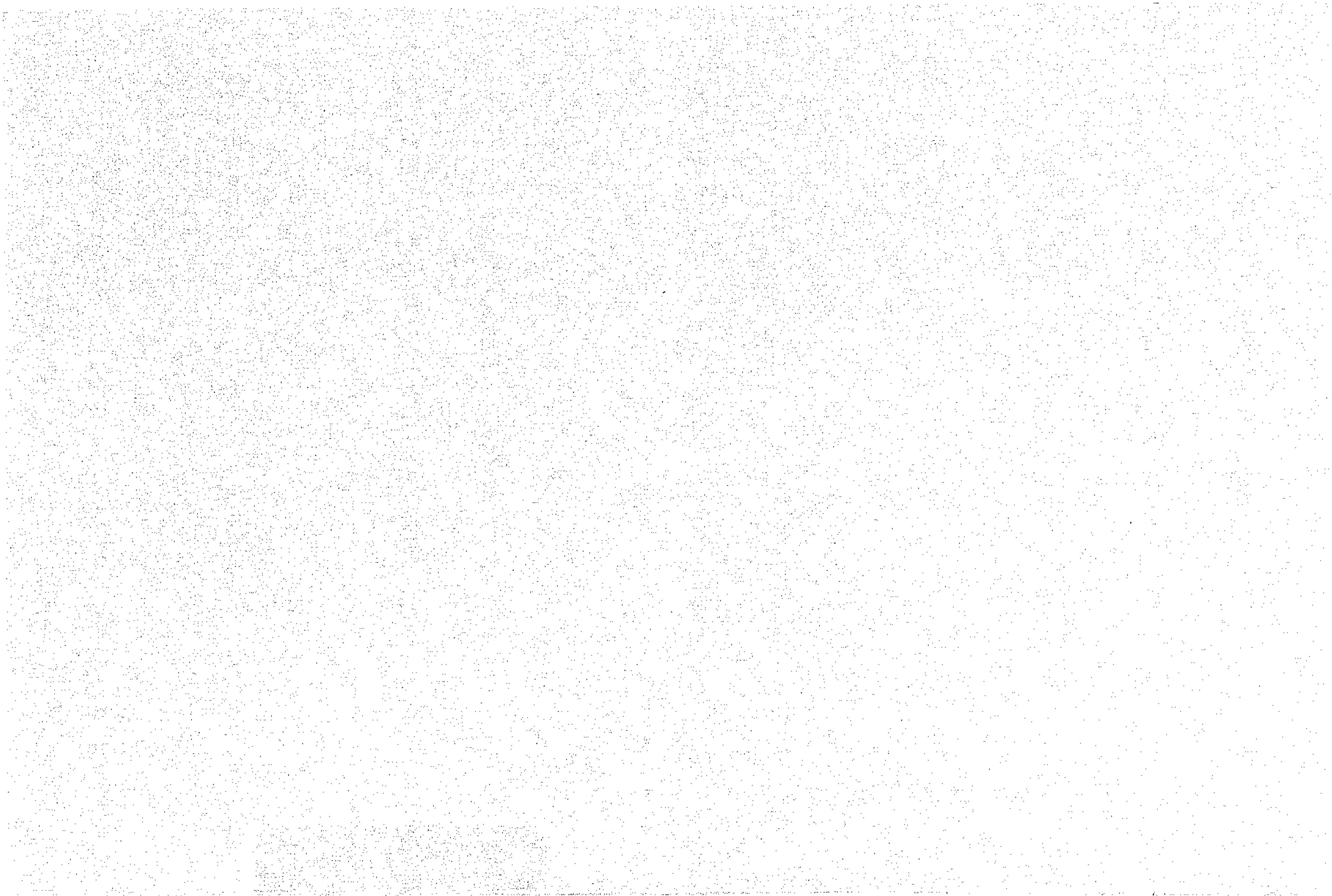


Fig. 5.4 PROBABLE ANNUAL FLOOD DAMAGE CURVE



6. SD

6. SD

SEDIMENT CONTROL PLAN

SD : SEDIMENT

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