

## 4-9 流域保全

### (1) 流域保全

対象流域の山間部は急峻な斜面を有し、植生が粗であるため山地崩壊による土砂流出が問題となっている。上流域における流域保全対策としては、UNDP/FAOと森林局(Bureau of Forest Development)との共同によるアグノ上流域植林事業が実施されているようであるが、詳細は不明である。また、近年大統領令収集資料(4)―⑱参照)により、アグノ川上流域の管理はDepartment of National ResourcesからNAPOCORに移管され、NAPOCORではDepartment of Watershed Managementを設けて業務に着手しているようであるが、組織が新しいため具体的な方針は明らかでない。図4-30に管轄区域を示す。

### (2) 砂防

流域における砂防事業は殆ど実施されていない状況である。土砂流出による堆砂はアグノ川本川が非常に激しくなっているが、その状況は次のとおりである。

#### 1) アンブクラオダム

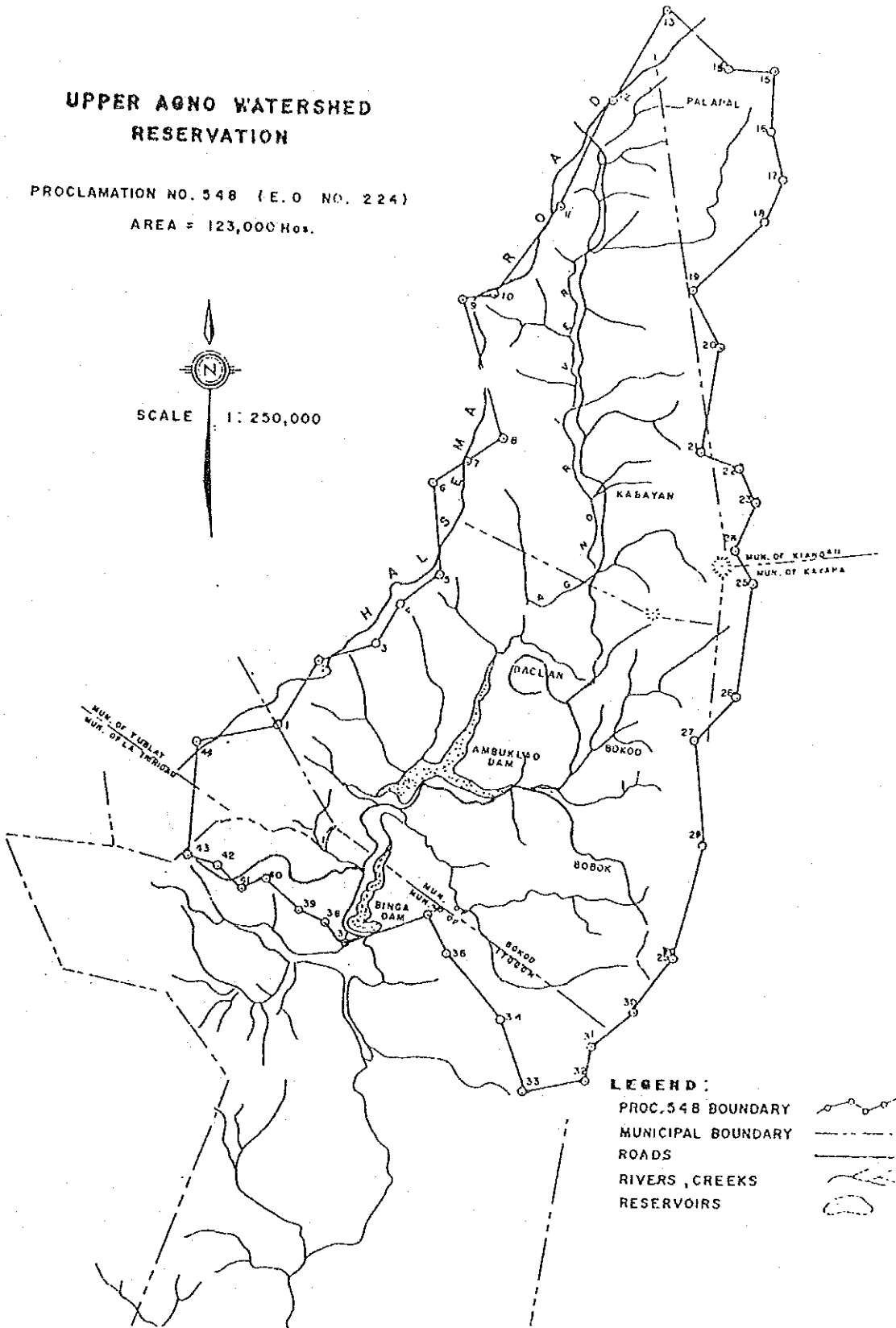
建設後30年余りの間に貯水池へ流入した土砂量から算出した年平均堆砂量は、約 $3.6 \times 10^6 \text{m}^3$ で東南アジアの各河川の実積と比較すると非常に多い値である。貯水池上流の河床縦断記録を図4-31に示す。貯水池内の堆砂は発電用取水塔の取水口敷まで達しており、発電に支障を来したこともあり、今後増々その頻度が多くなるため、「アンブクラオダム修復計画調査報告書」(昭和63年3月、JICA)ではその緊急対策を提案するとともに、取水塔に近い3支川の砂防ダムを提案している。また、放水口付近の堆砂も問題となっているが、これは本川の残流域からの流出土砂がビンガ貯水池の末端を堰上げているためであり、ビンガ貯水池の堆砂対策と併せて処理すべきであろう。

#### 2) ビンガダム

ビンガダムの貯水量は、流入土砂のため年々減少している。建設後、貯水池に流入した土砂量の年平均値は約 $1.2 \times 10^6 \text{m}^3$ であり、これを比堆砂量で他のダムと比較するとアンブクラオダム(流域面積 $690 \text{km}^2$ )  $5,340 \text{m}^3/\text{年}/\text{km}^2$ 、アンガットダム(流域面積 $568 \text{km}^2$ )  $5,720 \text{m}^3/\text{年}/\text{km}^2$ 、ビンガダム(残流域面積 $246 \text{km}^2$ )  $4,900 \text{m}^3/\text{年}/\text{km}^2$ でやや小さい値となっている。ビンガ貯水池の堆砂状況を図4-32に示す。

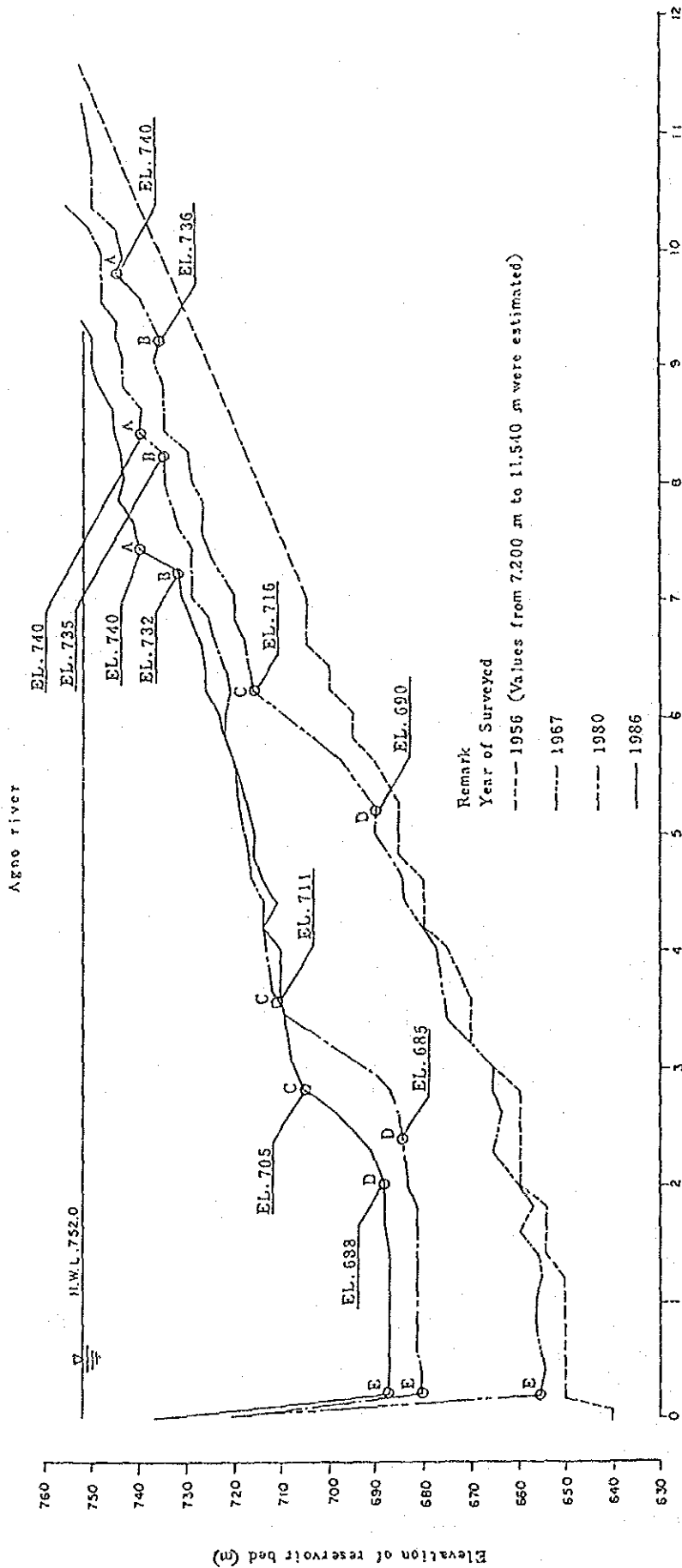
**UPPER AGNO WATERSHED  
RESERVATION**

PROCLAMATION NO. 348 (E.O. NO. 224)  
AREA = 123,000 Ha.



- LEGEND :**
- PROC. 348 BOUNDARY
  - MUNICIPAL BOUNDARY
  - ROADS
  - RIVERS, CREEKS
  - RESERVOIRS

図4-30 アグノ川上流域 NAPOCOR 管轄区域



出典：参考資料③

図 4-31 アンブクラオ貯水池（アグノ川）の河床縦断形記録

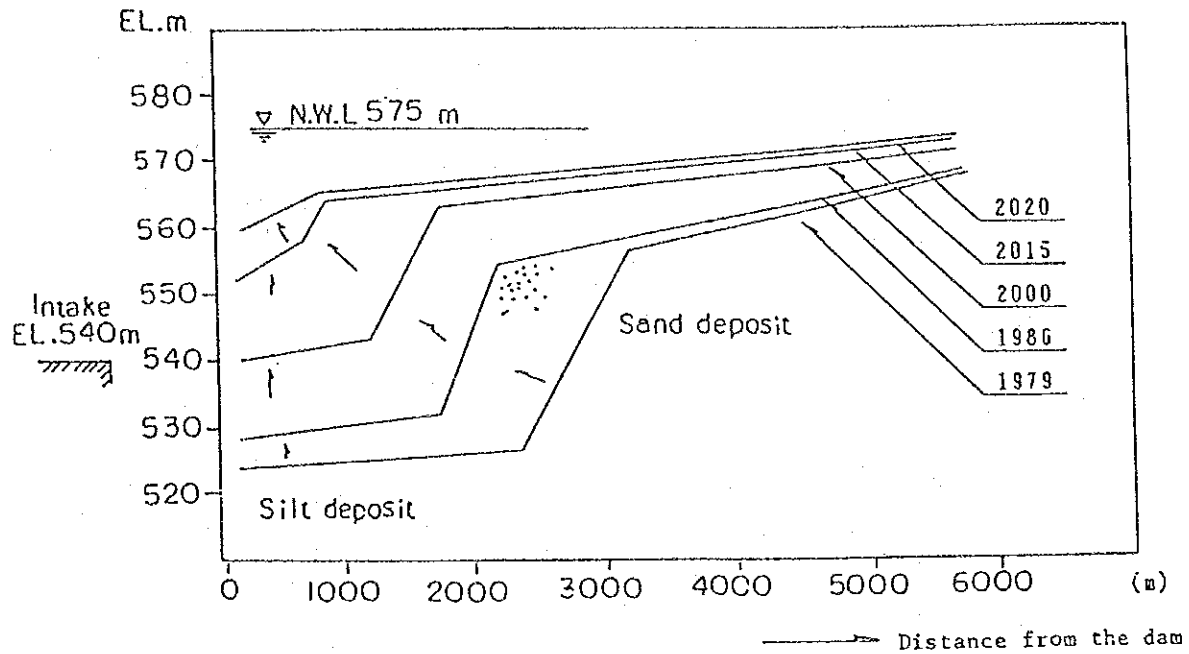


図4-32 ビンガ貯水池堆砂状況 出典：参考資料④

### 3) 河道および河川構造物

上流域の自然崩壊地の他、鉱山開発による崩壊地も多く、流出土砂の増大の要因になっており、河道湾曲部、河床などに堆積し河床上昇をひき起こしている。また、アグノ川河口部では堆砂のため年々河口が海側に伸びている状況である。

橋梁などの河川構造物も河床上昇による洪水流過能力の減少を来たしている。



## 第5章 本格調査の内容

### 5-1 調査の基本方針

#### (1) 概要

パンガシナン平野は、フィリピン国を代表する大穀倉地帯であり、アグノ川およびその近傍関連河川の氾濫原によって形成された沖積平野であるが、雨期になると毎年のように河川が氾濫し、1972年をはじめとしてたびたび大きな被害を受けてきた。

洪水被害の軽減のため、アグノ川については従来より堤防、水制工、遊水地、およびその分流放水路等の河川改修工事が進められてきた。しかし、それらは局部的な対策にとどまっており、水系全体の一貫した治水計画が立案されていない。今後、アグノ川とその関連河川を一体的に捕らえた洪水防御計画を早急に立案する必要がある。

以上のような背景のもとに1988年6月フィリピン国政府よりわが国に対して、アグノ川流域にかかる洪水防御計画のマスタープラン策定および緊急治水計画のフィージビリティ調査について要請したものである。

本調査の目的は、以上のような状況を踏まえて、アグノ川およびその近傍の関連河川の一貫した治水計画のマスタープランの策定とその計画の中で緊急事業のフィージビリティ調査を行うことにある。また、これらの調査過程をとおしてフィリピン側カウンターパートに技術移転を行う。

#### (2) 課題

アグノ川および関連河川の治水に関する課題の概観は次のとおりである。

- 1) アグノ川は堤防、水制工が部分的に整備され、ポポント・スワンプ（計画的遊水地）、およびその分流放水路が設置されており、また低水路の一部で浚渫が行われている。しかし河道の流下能力は小さく、治水施設の中には災害を受け復旧されずに放置されているものもあるため、中小洪水においても氾濫をおこしており、さらに大洪水時にはパンガシナン平野に越水し大被害をもたらす可能性が高い。このため、アグノ川では既存の治水施設を有効に活用するとともに、水系一貫となった整合性のある治水計画をたて、効率的な治水施設の整備を進めて行くことが必要である。
- 2) 現在アグノ川の有している遊水機能を十分に考慮した治水計画とすることが必要である。
- 3) 関連河川はほとんど治水施設が整備されておらず、流下能力が非常に小さいため中小洪水に対しても対応できない状況にあり、抜本的洪水対策の検討が必要である。
- 4) 山岳部は樹林が伐採されている箇所が多いため平野部への土砂供給が多く、河床の上昇、河積の阻害による流下能力の低下がみられるので、治水計画に当たっては

土砂の供給及び堆積を十分考慮する必要がある。さらに、アグノ川山岳部、ブエド川上流において鉱山から大量の鉱滓が流出しているが、十分な対策を講ずるには至っていない。

またアグノ川の灌漑施設 (ARIS) は、土砂堆積による機能マヒのために灌漑面積が年々減少している。

- 5) アグノ川は蛇行が発達し、流路が安定していないことから河道の安定化対策および水衝部対策が重要である。
- 6) アグノ川においては、河岸及び堤防の洗掘、欠壊、並びに堤体や基盤の漏水による被害が多いので十分な対策が必要である。
- 7) 下流には多くの養魚池が存在し、河口部の流下能力を低下させていると考えられる。また土砂の供給により河口部が延進しており、土砂堆積と合わせ河口部の流下能力の低下が懸念される。
- 8) 橋梁における被害 (アバットの流失等) が多く見られるが、既設橋梁の位置、構造が河岸の洗掘を助長している可能性があり、これらの工作物設置に対する技術的検討が必要である。

## 5-2 調査対象地域および範囲

### (1) 調査対象地域 (7,500km<sup>2</sup>)

#### 1) アグノ川本支川流域 (5,700km<sup>2</sup>)

アグノ川本川および主要支川アンバイオアン川、ヴィラ・デ・パロ川、タルラック川、カミリング川

#### 2) 関連河川流域 (1,800km<sup>2</sup>)

シノコラン川、パタラン川等

### (2) 調査範囲

- 1) アグノ川本支川および関連河川流域の治水計画のマスタープランを策定する。
- 2) マスタープランに基づく緊急事業を選定し、そのフィージビリティ調査を行う。

## 5-3 調査項目および内容

本格調査は治水計画のマスタープラン策定と緊急事業のフィージビリティ調査からなる。

### (1) アグノ川流域の治水計画のマスタープラン調査

適切な治水計画規模を設定し、それに基づいてアグノ川本支川および関連河川流域を一体とした治水計画のマスタープランを策定する。

## 1) 現地調査

### (a) 平面図作成およびモザイク写真作成

平面図は、戦後すぐに作成された5万分の1の図面があるのみで、河道形状はもちろん堤内地の地形についても大きく変化している可能性がある。そのため、平野部およびアグノ川とその主要支川および関連河川について航空写真撮影を実施する。それによって以下のように平面図、モザイク写真を作成する。

なお航空写真撮影に当たっては、乾期をのがすことなく、すみやかに撮影することが重要である。

#### 平面図作成（2万5千分の1）

アグノ川本川（サンロケダム予定地～河口）

主要支川 アンバイオアン川、ヴィラ・デ・パロ川、タルラック川、カミリング川（合流部～山地部入口）

関連河川（ただし、調査費用の面からの制約も考慮し、可能であれば既存の5万分の1を修正して使用することもやむを得ない）

#### モザイク写真作成

関連河川を含む平野部全体

### (b) 縦横断図作成

#### a) アグノ川本支川

アグノ川本川（河口～ピンガダムサイト） 1 km 毎

アグノ川主要4支川（合流部～山地部入口） 1 km 毎

ポポント・スワンプ、分流放水路 500m 毎

・アグノ川の堤内側は引堤の可能性を考慮して十分な距離をとるものとする。  
（堤内地100m程度）

・構造物の必要な箇所、合流点付近は補足測量を行う。

#### b) 関連河川

I/Aにも記述されているとおりフィリピン側で行うが、代表的な地点の流下能力を把握し、改修の基本的方針を検討したのち必要箇所について縦横断測量を追加する。

・構造物の必要な箇所は補足測量を行う。

### (c) 水理水文観測（13箇所）

必要箇所は図5-1に示す。



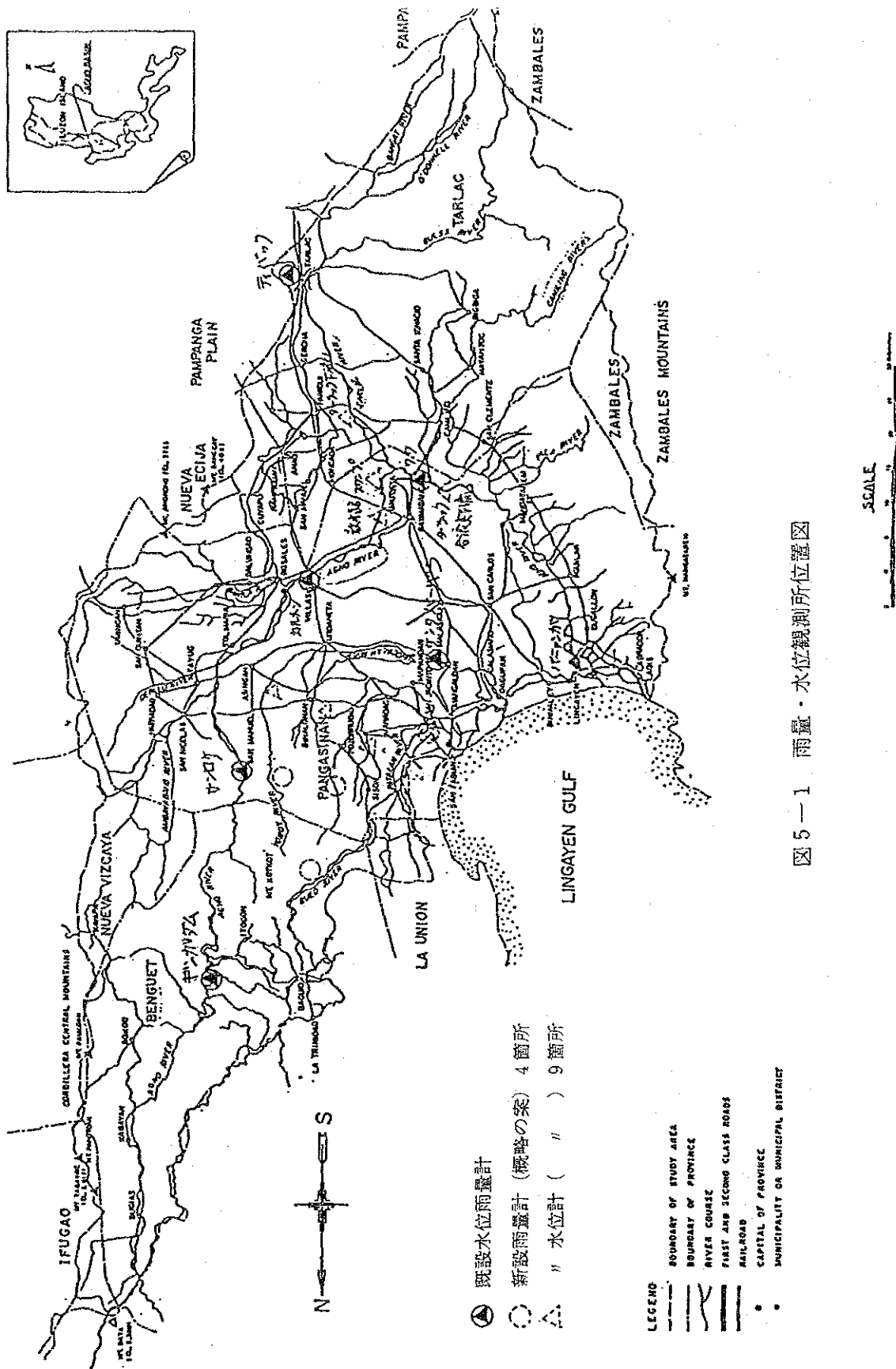


図5-1 雨量・水位観測所位置図

a) 自記雨量計 (4箇所)

関連河川

山岳部をかかえる河川で流域面積の大きい3河川に1箇所ずつ

平野部 1箇所

b) 自記水位計 (9箇所)

アグノ川

ポポント・スワンプ 1箇所

分流放水路 1箇所

タルラック川下流 1箇所

アグノ川 (ポポント・スワンプ下流) 1箇所

関連河川

主要4河川中流部に1箇所ずつ4箇所

下流部 1箇所

・なお設置位置等の詳細については、DPWHの川上専門家に決定を依頼した。

・雨期に入る前に設置し、洪水時のデータを確実にとることが重要。

(d) 流量観測

既存の水位観測所およびウ)に示した水位観測所の中から流量観測に適する箇所を選定し観測する。

(e) 洪水被害調査

聞き込み等により、主要洪水における湛水状況を把握し、浸水実績図を作成するとともに被害額を算定する。

(f) 関連河川の系統図作成

関連河川の系統図を作成し、河川の名称を整理する。

(g) 排水系統調査

内水地区の排水系統を把握し、現況の排水系統図を作成する。

(h) 堆砂量調査

アグノ川本支川、および関連河川について既往調査および図上検討等より生産土砂量を推定するとともに、河床材料調査、既存の横断図との重ね合わせおよび洪水時の浮遊砂量、掃流砂量を測定(あるいは推定)、掃流土砂量、河床変動を調査する。

(i) 河床材料調査 (28点)

調査箇所は、図5-2に示す

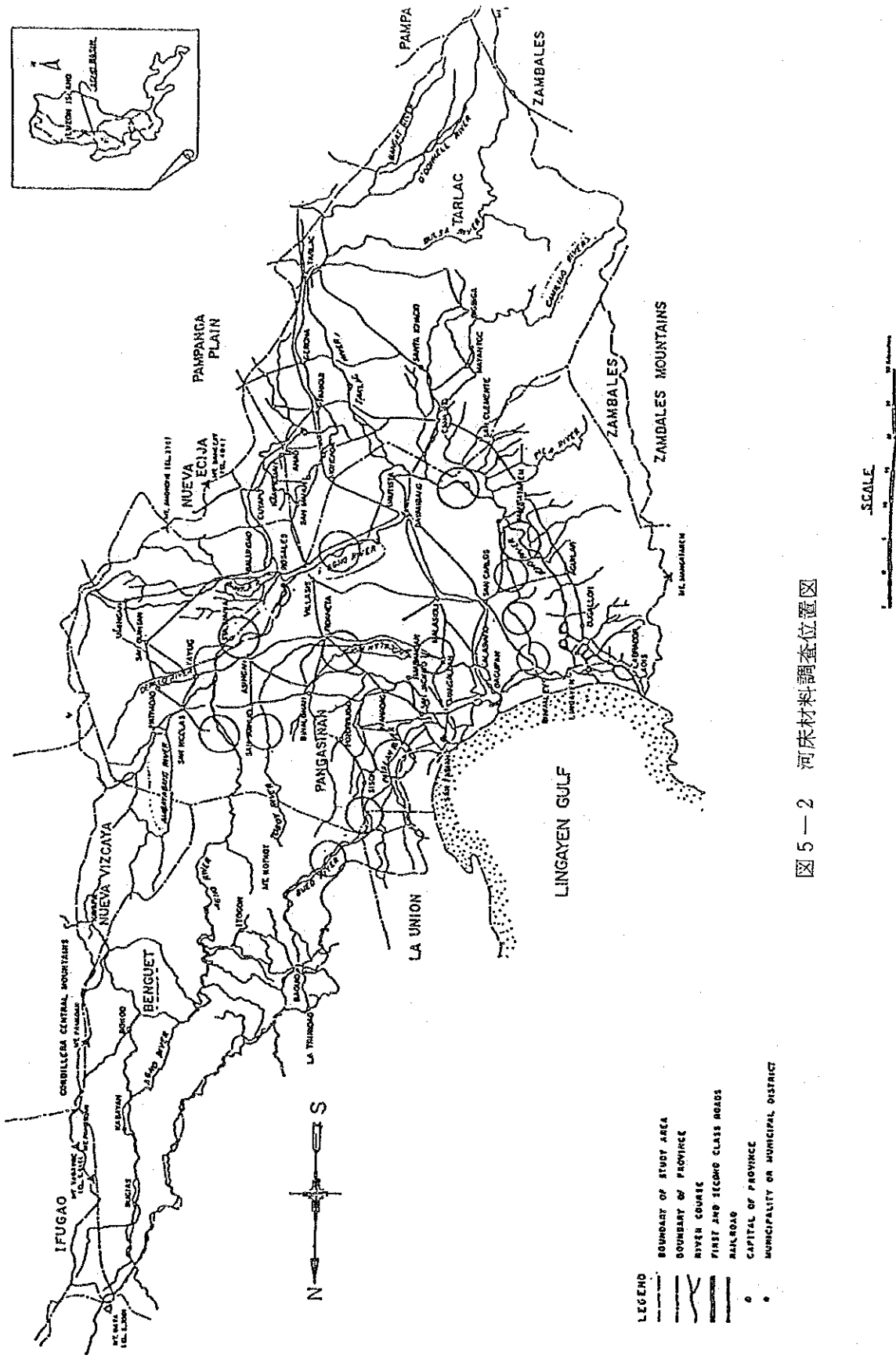


图 5-2 河床材料調查位置图

アグノ川本川の5箇所において、左右岸2点ずつ計10点

主要3川それぞれの上中下流3箇所において、左右岸2点ずつ計18点

(j) 流路変遷の調査

既存資料などによってアグノ川の流路の変遷を調査し、その特性を把握する。

(k) 河道施設調査

アグノ川本支川、および関連河川について治水施設の配置、構造、被災状況を調査するとともに、水制工の効果について検討する。

(l) 既存の DPWH 等の治水計画、ダム計画資料を収集しレビューを行う。

2) 計画洪水の検討

(a) 全国の河川の計画洪水規模の資料を収集し、アグノ川および関連河川の重要度等から必要な計画規模を検討する。

(b) 既往の主要洪水について、氾濫もどし計算を行い、主要洪水の流量を算定する。

(c) 既往の降雨パターンを検討し、アグノ川、主要支川、関連河川について計画洪水規模を決定する。

3) 計画目標年次の設定

マスタープランの計画目標年次は、洪水被害の状況、社会経済状況を勘案して決定する。

4) 土地利用状況の設定

目標年次における土地利用状況を現況トレンド及びフィリピン側の将来計画に基づき設定する。

5) 水文水理解析モデル作成

(a) アグノ川、関連河川について流出モデルを作成する。

(b) アグノ川、関連河川について河道追跡モデルを作成する。

アグノ川については、河道内の貯留効果、堤内地の遊水効果およびスワンプ（計画遊水池）の効果についても評価可能なモデルとする。

6) ダム、遊水地の適地調査

平面図、モザイク写真、既往のダムサイト調査結果を用いてダム・遊水地の適地調査を行う。

7) 堆砂対策検討

河道内堆砂にともなう河道状況の変化の予測およびその対策を検討する。ARIS システムについては土砂堆積の原因を検討する。

8) アグノ川本支川、関連河川流域の治水計画のマスタープランの検討

アグノ川本支川、関連河川について河道の流下能力確保（堤防、掘削）、治水施設（遊

水池，ダム，放水路等）の組み合わせにより洪水防御計画の代替案を検討する。

その際には計画目標年次までの可能投資額，費用，便益分析結果，洪水氾濫の社会状況等を総合的に勘案してアグノ川流域の治水計画のマスタープランを策定する。

(a) アグノ川流域

a) 河道計画

- ・現状の流下能力について検討し，河道計画を立案する。河道計画立案に当たっては，既設築堤をなるべく生かした計画とし流下能力の著しく劣る箇所について引堤等を考慮する。また現在アグノ川の河道の有している遊水効果を十分考慮する。
- ・既設築堤の洪水の洗掘，漏水による被害実体を調査し，現地採取可能な材料を前提とした築堤断面，構造の検討，漏水，洗掘対策上の検討を行う。
- ・既設水制の堤防保護効果について検討し，その評価を行い，水制工の長さ，間隔，高さ，構造について検討する。また，蛇行が著しいアグノ川の低水路安定対策の検討を行う。

・主要河川の合流形状の検討

アグノ川4大支川について，本川になめらかに合流するよう合流形状を検討する。

b) ダム水理検討

ダムサイトの選定，治水容量と可能な洪水調節量の検討を行う。サンロケダム，バロック・バロックダム等のダムについては，治水上の観点から必要性および効果をレビューする。

c) 遊水地

遊水地の有効利用のための施設計画を検討する。

タルラック川については，遊水地の有効利用を考慮しながら合流形状の検討を行う。

d) 洪水予警報システムの検討

アグノ川本支川において洪水予警報システムが設置されているが，関連河川を含めてその将来構想についての補足検討を行う。

(b) 関連河川

a) 河道計画

検討に当たっては，内水問題を生じさせないように掘りこみ方式を基本として検討する。河口部の養魚地による河積の阻害，上流に及ぼす水位上昇について検討し，河口部の必要断面を確保する計画とする。

b) ダム、遊水地、放水路等

河道の改修方式の他、ダム、遊水地、放水路等の治水施設を組み合わせた洪水  
防御計画を提案し、その概略施設検討を行う。

9) 事業費、維持管理費の算定

マスタープランについての事業費、維持管理費を算定する。

10) 経済分析（費用、便益分析）

洪水処理計画の代替案について、治水経済調査により経済効果の分析（費用、便益  
分析）を行う。

11) 社会経済影響調査

この計画を実施することによるフィリピン国およびパンガシナン平野地域の社会経  
済に及ぼす効果および、環境に及ぼす影響について検討する。

(2) フィージビリティ調査

アグノ川本支川、関連河川における治水計画のマスタープランに基づき、本流域の治  
水安全度を向上させるため最も効果的で緊急性の高い事業を数箇所選定し、そのフィー  
ジビリティ調査を実施する。

1) 計画策定施設の選定

フィージビリティ調査の内容はマスタープランによるが、現時点では、例えば次  
のようなものが考えられる。

(a) アグノ川本川の河道計画

パンガシナン平野一帯をアグノ川本川の洪水から守り、治水安全度を向上させる  
ための最も重要な部分であり、アグノ川水系全体の治水計画に基づいて既存の堤防  
等を十分に活用しながら、新たに必要となる最も効率的な堤防、護岸などの治水施  
設計画を策定する。

(b) ポポント・スワンプ計画

最大の支川であるタルラック川との合流部であり、アグノ川の治水計画上重要な  
役割を果たすと考えられるポポント・スワンプを水系全体の中で洪水防御の観点か  
ら定量的に位置づけ、その効果を最大限に効率よく果たすために必要な施設計画（放  
水路を含む）を策定する。

(c) 関連河川にかかわる治水計画、特に放水路計画

パンガシナン平野北部（アグノ川本川西部）に源を発する降雨は複数の関連河川  
を流下してリングエン湾に注ぐが、いずれの関連河川も流路形態が複雑でかつ十分  
な流下能力を有していない。従って、遊水地あるいは放水路等の抜本的な治水施設  
の整備が緊急に必要と思われるが、それらの中で最も効率の高い施設を抽出し、そ

の施設計画を策定する。

2) 地形地質調査

計画策定にかかる地域について、基本的な設計と概算費用を算出するために必要な地形、地質調査を行う。

(a) 原則として1万分の1の図面を作成する。(但し調査費用の面からの制約も考慮し、可能であれば2万5千分の1の図面を使用することもやむを得ない。)

(b) 縦横断図作成

縦断図測量は原則として500m 毎とする。

(c) ボーリング等による地質調査

(d) 既設構造物に関する現況の実態調査

3) 施設設計

必要な施設の規模および現地条件にみあった設計条件に基づき、基本的な施設の設計を行う。

4) 施工計画

施設を施工するために必要な材料、資機材計画および工程計画を策定する。

5) 事業費の算定

事業実施に要する費用を算定する。

6) 経済分析

費用、便益にかかわる経済効果について分析する。

7) 環境調査

施設を作ることによる社会自然におよぼす影響について総合的に調査する。





(5) ドラフト・ファイナル・レポート

英文 (メインレポート)	40部 (比側提出分30部)
" (サポーティングレポート)	30部 (  "  20部)
" (ベーシックデータ)	4部 (  "  2部)
和文 (メインレポート要約)	10部

調査開始後19カ月以内に提出。

ドラフトファイナルレポートについては、調査団派遣の前に予め比側に送付し、調査団派遣時に比側のコメントを受けるものとする。

(6) ファイナル・レポート

英文 (メインレポート)	80部 (比側提出分50部)
" (サポーティングレポート)	60部 (  "  30部)
" (ベーシックデータ)	4部 (  "  2部)
和文 (本報告書)	30部

上記レポートは、ドラフト・ファイナル・レポートに対する比側のコメントを吟味、検討の上提出する。

## 5-6 要員計画 (案)

### (1) 調査担当項目

- ① 総 括
- ② 社会・経済調査
- ③ 地質・土質調査
- ④ 測量調査 (1) 航空写真, 平面図作成
- ⑤ 測量調査 (2) 縦横断図作成
- ⑥ 流送土砂調査 (河床材料調査, 堆砂量調査, 生産土砂量調査)
- ⑦ 水理, 水文調査 (1) 雨量, 水位, 流量調査
- ⑧ 水理, 水文調査 (2) 洪水被害調査
- ⑨ 水理, 水文解析 (1) 降雨解析
- ⑩ 水理, 水文解析 (2) 流出解析, 河道追跡
- ⑪ 水理, 水文解析 (3) 遊水効果・貯留効果解析
- ⑫ 堆砂, 河床変動解析
- ⑬ 治水計画 (1) 計画洪水検討
- ⑭ 治水計画 (2) 河道計画
- ⑮ 治水計画 (3) 治水施設代替案検討

- ⑯ ダム計画
- ⑰ 施設計画 (1) 基本施設 (堤防, 遊水池, 放水路)
- ⑱ 施設計画 (2) 河床安定, 堆砂対策
- ⑲ 施設計画 (3) 対策工 (漏水, 洗掘, 水衝部対策)
- ⑳ 洪水予警報システム検討
- ㉑ 施工計画
- ㉒ 事業費積算
- ㉓ 治水経済調査, 経済分析
- ㉔ 環境調査

(2) 調査の分野

調査の主要分野は次のとおりとする。

- ① 総括
- ② 治水計画
- ③ 水文・水理/流出解析
- ④ 洪水被害調査
- ⑤ 地形・地質
- ⑥ 堆砂対策
- ⑦ 河道計画
- ⑧ ダム・遊水池計画
- ⑨ 洪水予警報
- ⑩ 施設設計
- ⑪ 施工計画・積算
- ⑫ 社会・経済調査
- ⑬ 環境調査
- ⑭ 航空測量
- ⑮ 河川測量

## 5-7 必要機材

### (1) 基礎的機材

四輪駆動車	3台	現地での調査団の移動
-------	----	------------

### (2) 水理・水文観測用機材

転倒ます式自記雨量計	4箇所	雨量観測
------------	-----	------

自記水位計	9箇所	水位観測
-------	-----	------

流速計	2台	流量観測
-----	----	------

浮子	1式	流量観測
----	----	------

掃流採砂機	2台	送流土砂調査
-------	----	--------

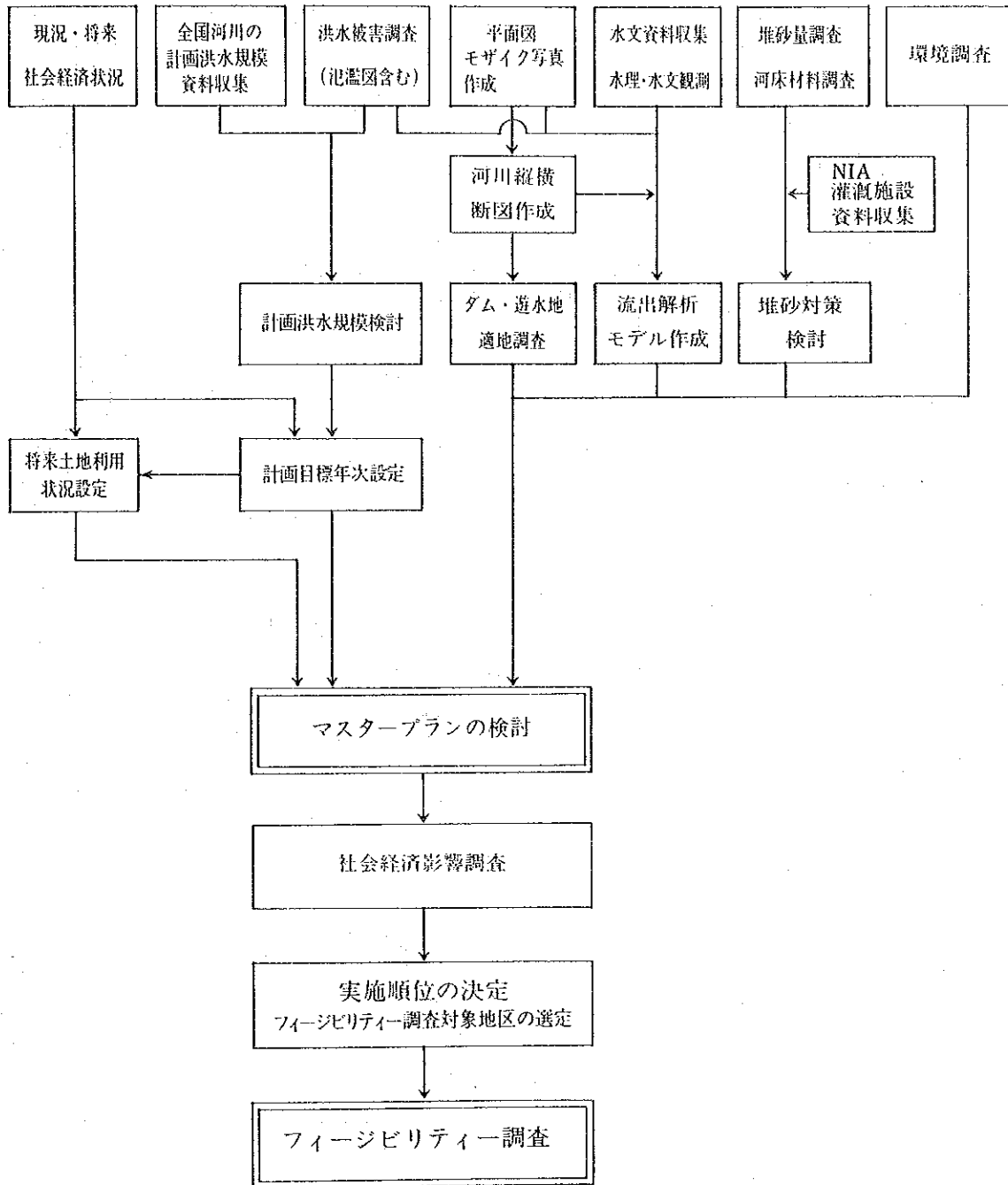
携帯用導電率計	1台	水質調査, 感潮区間調査
---------	----	--------------

卓上式パーソナルコンピューター	1式	水理・水文分析・技術移転用
-----------------	----	---------------

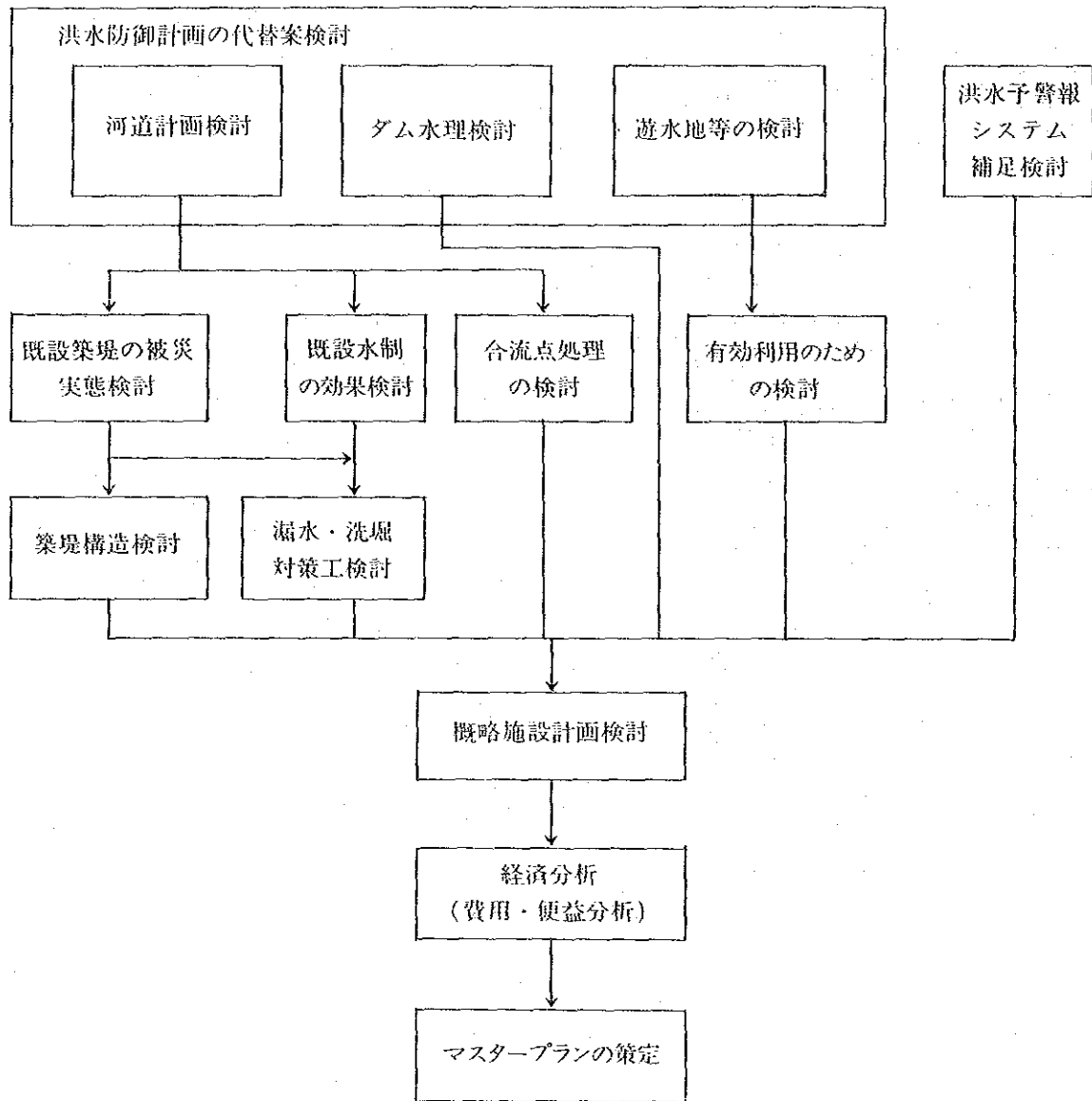
携帯無線	2セット	調査連絡用
------	------	-------

### (3) 土質調査

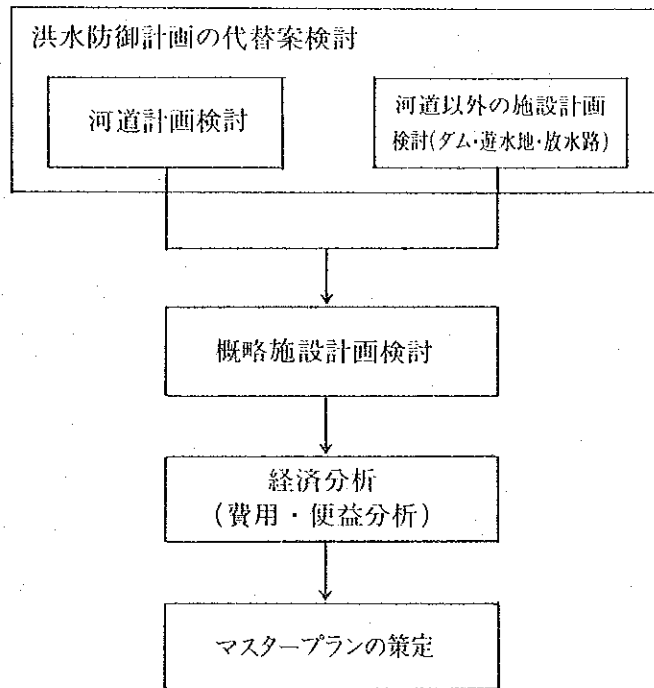
人力オーガーボーリング	1台	基盤土質調査, 堤体土質調査
-------------	----	----------------



調査の全体フロー



アグノ川本支川マスタープラン検討フロー



関連河川マスタープラン検討フロー



## 添 付 資 料

1. フィリピン国政府からの技術協力要請書 (TOR)
2. I/A
3. M/M
4. 収集資料リスト
5. 基礎資料の賦存状況  
(気象・水文, 地形・地質, 社会・経済, 関連計画等)
6. 面談者リスト
7. 参考資料
8. 参考文献



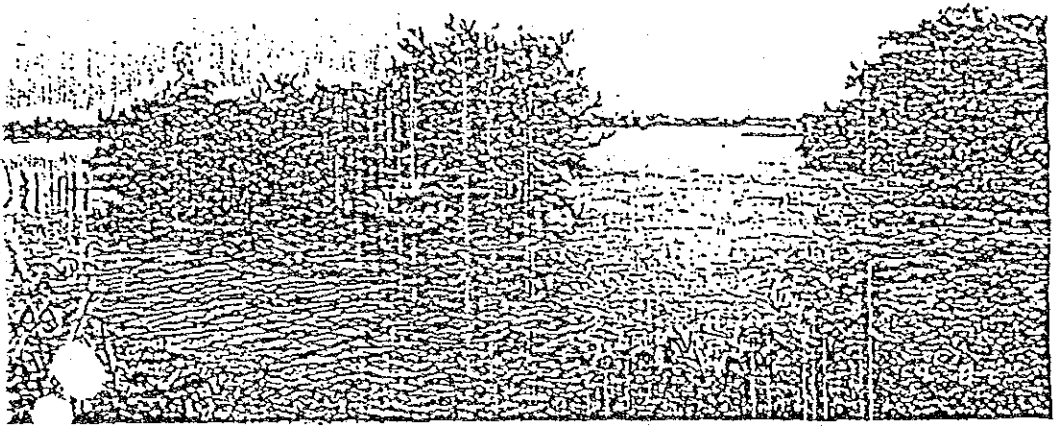


1. フィリピン国政府からの技術協力要請書 (TOR)

TERMS OF REFERENCE  
FOR  
COMPREHENSIVE STUDY  
ON  
AGNO RIVER FLOOD CONTROL PLAN

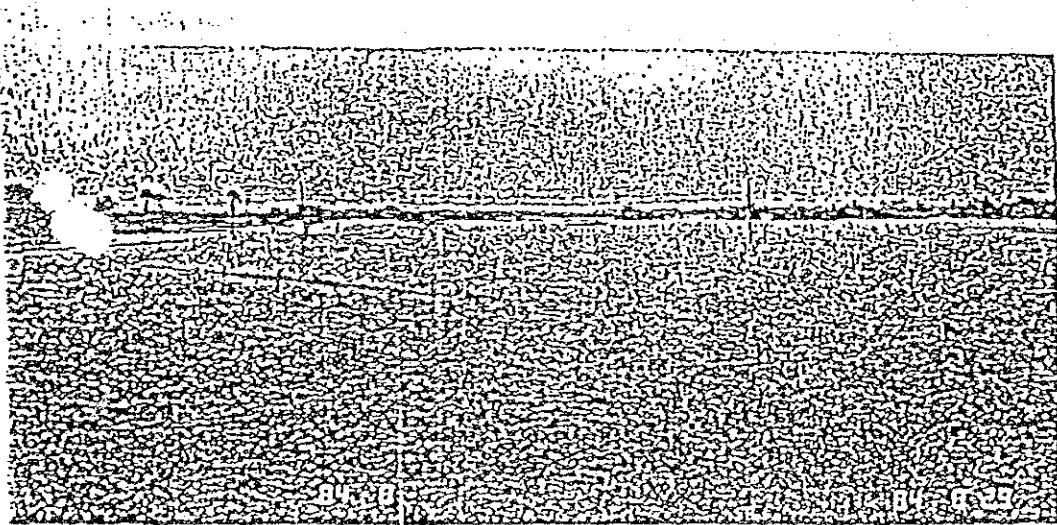
NOVEMBER 1987

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS  
REPUBLIC OF THE PHILIPPINES



Flood viewed from Urdaneta-Manaoag Road

(AUG.29.1984)



Flood at Binalonan in ARIS

## TABLE OF CONTENTS

	<u>Page</u>
1. Introduction .....	1
2. Background of the Project .....	2
Previous Studies .....	6
4. Objectives of the Study .....	7
5. Executing Agency .....	8
6. Scope of the Study .....	9
6.1 Survey and Investigation .....	9
6.2 Reviews and Studies .....	11
6.3 Comprehensive Study .....	11
6.4 Transfer of Technology .....	12
7. Schedule of the Study and Reports .....	12
8. Expertise Inputs .....	13
8.1 Expertise Requirements .....	13
8.2 Equipment .....	15
9. Undertakings of the Government .....	15

## 1. Introduction

The Islands of the Philippines are generally endowed with water resources which are essential substance for sustaining human lives. However, a large seasonal variation of rainfall has caused adverse effects on the national and regional development plans of the Philippines. In particular frequent recurrence of floods amplified by typhoon or tropical storms have caused serious damages to crops, properties and public facilities and endangered the lives of inhabitants somewhere in the country almost every year. Flood damages in the whole country are estimated at several billions of pesos a year.

The Five-Year Philippines Development Plan (1983-1987), the Medium-Term Philippine Development Plan (1987-1992) and the Long Term Philippine Development Plan up to the Year 2000 by the National Economic and Development Authority (NEDA) place emphasis on the pursuit of sustained economic growth, development of human resources, well-balanced growth in all sectors and regions and equitable distribution of the fruits of development. In line with these national development goals, it has been recognized quite important to accelerate throughout the country various protective measures for frequent recurrence of floods which are deemed as major constraints to the socio-economic development of the country.

The Government of the Philippines (GOP) has pursued the integrated approach to develop the major river basins for the past three decades and provided various kinds of flood control measures for alleviation of flood damages and enhancement of efficiency of land use on the flood prone area. In spite of these efforts, however, flood damages have not been relieved completely due to insufficient provisions of facilities and progressive deterioration of existing facilities.

Among the principal rivers of the country, the Government has placed the high priority to mitigation of flood damages in the Agno river basin which is located in the western part of the Central Luzon.

These terms of reference are prepared for conducting a comprehensive study on the Agno river flood control plan, aiming at the full development and effective utilization of water resources in the basin.

## 2. Background of the Project

The Agno river is ranked as the 5th largest scale river in the Philippines and is located in the western part of Central Luzon as shown in Figure 1. The river drains an area of 5,697 km<sup>2</sup> in total and measures 275 km in length. Administratively, the basin area lies mainly on the provinces of Pangasinan, Tarlac and Benguet.

The Agno river originates in the Cordillera Central Mountains of higher than 2,000 m above sea level and flows southward in the mountainous area. After passing this mountainous area, it debouches into a vast alluvial plain and collects runoff from the left bank tributaries including the Tarlac river which is a major tributary of the Agno river. Downstream of the confluence with the Tarlac river, the river flows on the eastern side the Zambales Mountains, directing northwestwards and discharges into Lingayen Gulf.

The climate of the Agno river basin is characterized by distinct dry and wet seasons. The basin is often hit by typhoons during the wet season. The dry season extends usually from November to April and the wet season from May to October. The annual rainfall varies from 2,000 mm in the southeastern portion adjoining the Pampanga river basin to over 4,000 mm in the northern part. More than 90% of the annual rainfall concentrates in 6 months of the wet season. The annual runoff yield of the Agno river is approximately 9,990 million m<sup>3</sup> or 317 m<sup>3</sup>/s on average. The maximum discharge recorded at Carmen was 5,770 m<sup>3</sup>/s (1946).

There are a group of the neighbouring medium scale rivers, termed as the Allied Rivers, on the northwestern part of the Pangasinan plain. The allied rivers consist of the Toboy, Bued and Sincalan and also pours into the Lingayen Gulf. The total area of the Agno basin including these allied rivers is approximately 7,500 km<sup>2</sup>.

The Agno river and the allied rivers basins, being coupled with its adjacent Pampanga basin, have played a role of the granary of the Philippines due to the intensive and large production of rice.

The carrying capacity of the river channel of the Agno river is hampered from place to place due to the insufficient channel width, and is reduced by tremendous sediment deposits on the riverbed and excessive meandering/shifting nature of the river course.

Floods occurred frequently in the Agno river and its neighbouring basins and caused serious damages to the Pangasinan plain. It is estimated that a land of 180,000 ha to 200,000 ha is susceptible to inundation in the provinces of Pangasinan and Tarlac.

In consequence of floods from the Agno and its neighbouring rivers. The population in this flood-prone area is conservatively approximated to be some 700,000. The population density of this area (370 persons/km<sup>2</sup>) is higher than the nation's average of 181 persons/km<sup>2</sup> while the per capita GRDP is about 60% of the nation's average. The basin experienced memorable large floods in 1935, 1936, 1937, 1938, 1943, 1950, 1960, 1968, 1972, 1980, 1984 and 1985. Especially, the flood which occurred in 1972 was the biggest one ever recorded and inundated almost entirely the above flood-prone area. This flood incurred the damages amounting to P2 billion in the Central Luzon basin. The flood-prone area is shown in Figure 2.

The Government started the implementation of flood protection measures in the Agno river in 1947. Based on the study made by the ex-Bureau of Public Works (BPW) in 1959, such essential flood control works as straightening of the river course and construction of earth dikes had been carried out. Thus, in 1960's the Agno river became relatively a more improved river since the flood protection works were built almost the entire stretch of the flood plains. At the confluence with the Tarlac river, there is the Poponto swamp of an approximate area of 30 km<sup>2</sup> which is expected to function as a retarding basin to reduce flood peaks to the downstream reaches, though some improvement works are required for its effective operation. A flood forecasting and warning system was also established in the basin in 1982 as a non-structural measure for mitigation of flood damages.

However, the existing earth dikes have been breached or collapsed in many sections by the rapid current of water with heavy sediment load during the high flow periods.

As the land use has been enhanced greatly by the intensification of human settlements and extension of irrigated areas the basin will be threatened to more disastrous damages than those experienced before. Therefore, substantial countermeasures are required while some urgent rehabilitation works are underway.

The existing flood control structures and on-going rehabilitation works are shown in Figure 3.

Thus the Agno river basin is regarded as one of the most important river systems in terms of flood control which will be a primary key to effective water resources development. The flood control project is expected to contribute much to the socio-economic development of the region through relief of calamities such as loss

of lives and injuries to people and mitigation of losses and damages in production, properties and transportation and communication services.

Another feature of the Agno river is characterized by a large volume of sediment load. The sedimentation, being coupled with metalings from the upstream mines, has made the riverbed unstable and decreased the channel flow capacity. Further, the sediment load also enters the irrigation canals, also having decreased the irrigable area.

Water resources of the Agno river have been tapped for power generation and irrigation purposes. There are two existing dams for hydropower generation on the upstream reaches. They are the Ambuklao dam and Binga dam which had been put in operation in December 1956 and January 1960 respectively. The location of these projects are given in Figure 1 and 4, and the main features of the dam and appurtenant structures of these projects are as follows.

Items	Ambuklao	Binga
Catchment area (km <sup>2</sup> )	617	860
Mean Inflow (m <sup>3</sup> /s)	41.3	57.3
Type of dam	Rockfill	Earth-Rockfill
Height of dam (m)	129	107
Crest elevation (El.m)	758	586
Fill volume of dam (million m <sup>3</sup> )	6.02	1.89
Normal high water level (El.m)	752	575
Effective capacity (million m <sup>3</sup> )	258	48.2
Effective capacity/yearly inflow	0.20	0.03
Installed capacity of power (MW)	75	100

Source; Re-study of the San Roque Multipurpose Project, JICA, 1985.

There are two existing irrigation intakes on the Agno river as shown in Figure 4 and 5; one is the diversion weir for irrigating the Agno River Irrigation System (ARIS) located 7 km north of San Manuel or just 3 km downstream of the proposed site for the San Roque multipurpose project, and the other is the headwork for the Lower Agno River Irrigation System (LARIS) located downstream of Sta Maria.



The ARIS was designed to irrigate an area of 18,500 ha in the Pangasinan province. However, due to the decreasing flow capacity of the canal systems caused by heavy siltation of sand and mine-tailings, the irrigable area has been reduced to 11,100 ha. The LARIS is designed to irrigate some 8,000 ha. The feasibility study on the Lower Agno River Multi-purpose Project concluded that it would be feasible to irrigate the total area of 70,800 ha as given below after the development of the San Roque project.

Scheme	Potential Net Irrigable Area by San Roque Project (ha)
Agno Right Bank	
(1) ARIS	26,850
(2) ARIS Extension	23,700
Sub-total	50,550
Agno Left Bank	
(3) LARIS	12,650
(4) ADRIS <sup>(1)</sup>	7,600
Sub-total	20,250
Grand total	70,800

(1): Ambayon-Diapolo River Irrigation System

The San Roque multipurpose project is proposed at the location shown in Figure 1, 4 and 5. The project will involve construction of a fill dam of 210 m in height (43 million m<sup>3</sup> of fill volume) for power generation (390 MW), irrigation (70,800 ha), water quality control and flood control. The river drains an area of 1,250 km<sup>2</sup> at the proposed damsite where the annual mean runoff is estimated at 84.5 m<sup>3</sup>/s. The feasibility study of the project was completed in 1979 and its tender/design was completed in 1981.

In the NPC's power development program, the San Roque power plant is scheduled to be put in operation in 1996.

In addition, other dam and reservoir projects such as the Tabu, Ambayon, Balog-Balog and Camiling projects are contemplated on the Agno main stream or its major tributaries.

The Agno and its adjoining rivers are situated in a strategically important position for regional development. For stimulating further development of the region area, a comprehensive study on flood control plan on the Agno river which also integrates other water resources development plans is required as mentioned in Section 4, Objective of the Study.

### 3. Previous Studies

No comprehensive study on the flood control of the Agno river has been made for the last nearly 20 years, except for Nationwide Flood Control and River Dredging Program, 1982 which mainly aimed at preparing a nationwide river dredging program for flood control on the major rivers of the Philippines including the Agno river.

In the past, the following studies were carried out on the water resources development of the Agno river basin including flood control aspects.

- (1) Reconnaissance Report on ARIS Sedimentation Control and Drainage Study, September 1986, ADCA, Japan
- (2) Study on Hydropower Potentials in Luzon Island, August 1987, JICA
- (3) Restudy of the San Roque Multipurpose Project, 1985, JICA
- (4) Preliminary Survey Report on Water Resources Development of Agno River Basin and Pangasinan Plain, September 1984, IECA/MOC, Japan
- (5) Design Report, Flood Forecasting and Warning System for Dam Operation, 1984
- (6) Framework Plan, Agno River Basins, National Water Resources Council, December, 1983
- (7) Nationwide Flood Control Plan and River Dredging Program, November 1982, Nippon Koei in association with Nikken and Basic
- (8) The Balog-Balog Multi-purpose Project, ELC, 1981 and its flood control report, 1984
- (9) Pangasinan Integrated Area Development Project, 1981

- (10) Lower Agno River (San Roque) Multipurpose Project, Irrigation Component, Feasibility Study, ELC, 1981
- (11) Feasibility Study, San. Roque Multipurpose Project, March 1979, ELC - Electroconsult, Italy, Brief Report, Design Report; etc.
- (12) Philippines Flood Control 1977, National Water Resources Council, 1978
- (13) The Country's Plans and Programs on Flood Control and Drainage, Bureau of Public Works, 1977
- (14) Lower Agno Development Plan Multipurpose Project, Preliminary Study, ELC, 1976
- (15) The Task Force Report for Agno River Basin
- (16) Review/Updating of the Agno Basin Flood Control Plan

#### 4. Objectives of the Study

The objective of the study is to formulate an overall and systematic flood control plan on the Agno river and its adjoining river basins which would be a primary key to the land and water resources development of the basins.

Due to the frequent recurrence of floods and insufficient flood control facilities, the socio-economic development of the project area has been severely affected, though the existing earth dikes and other facilities have contributed to mitigation of flood damages. Some urgent rehabilitation works of dikes and revetments and dredging of cut-off channels have been undertaken, though they are far from sufficient due to the budget limitation.

These existing flood control structures are still susceptible to damage. Further, it appears that they were not provided systematically under a comprehensive flood control plan on the whole basin area. On the other hand, the land use has been enhanced greatly by the intensification of human settlements and extension of irrigated areas and the socio-economic conditions of the basin have changed much from the date when the flood control measures were initially provided.

The flood control and sediment control measures in the basin are closely related to the existing and future extension schemes for irrigation and would be quite essential to more effective and full

development of land and water resources of the basin. Therefore, an integrated study on flood control and irrigation/drainage sectors is prerequisite not only for the maximization of agricultural production but also for the overall regional development of the area.

Water resources potentials of the Agno river have been studied or tapped mainly by each agency for its own purpose, while in some projects more effective utilization of land and water resources might be pursued from the nationwide viewpoint.

A number of storage dam schemes are identified or proposed or implementation on the mainstream and tributaries. Due review on existing plans will be necessary, aiming at multi-function developments, if desirable. Therefore, it is strongly required to carry out a comprehensive study for establishing the basin-wide flood control plan which also integrates other water resources developments for irrigation, drainage, power generation, watershed management and others.

The area for this comprehensive study will be limited to the Agno river basin and the allied rivers whose total catchment area is approximately 7,500 km<sup>2</sup>.

#### 5. Executing Agency

The executing agency for the comprehensive study on the Agno River Flood Control Project will be the Project Management Office (PMO) for Major Flood Control Projects, Manila, Department of Public Works and Highways. This PMO is headed by Project Manager and is composed of technical staff and administrative staff. Under this PMO, the Agno River Flood Control Office is established at Carmen on the midstream reach of the Agno river, which undertakes construction, operation and maintenance for the river structures of the Agno river.

In order to carry out the study, technical assistance is expected to be provided by foreign experts under the official development assistance program.

Counterparts and logistic supports necessary for the execution of the study will be provided by the PMO. Liaison or coordination with the other departments, administrations, agencies and local governments concerned will be also arranged by the PMO.

## 6. Scope of the Study

The duration of the study will be twenty (20) months and will be broadly divided into three phases; (i) survey and investigation, (ii) review and studies and (iii) formulation of a comprehensive plan. Besides, during the course of study, the transfer of technology will be provided to the Government staff and counterpart personnel by the foreign experts.

The study shall include but not be limited to the following items:

### 6.1 Survey and Investigation

- (1) Collection and review of existing data and previous documents related to the study; the relevant data will cover topographic maps, hydrology and hydraulics, geology and seismology, meteorology including typhoon, soils, land uses, agriculture, irrigation, agro-economy, regional economy and sociology, etc.
- (2) Undertaking of topographic surveys including aerial photogrammetry of the basin area, plane table survey and longitudinal profile and cross sectional surveys.
- (3) Undertaking of geotechnical surveys including auger/core drillings and soil mechanics test needed for the study.
- (4) Meteorological survey on air temperature, relative humidity, sunshine hour, wind direction, wind velocity, evaporation and rainfall, including typhoon data.
- (5) Hydrological investigation of the river runoff and analysis of upgrading accuracy and reliability of existing data including supplemental discharge measurement.
- (6) Measurement and assessment of sediment transport and volume of minetailings into the rivers.
- (7) Analysis of salinity concentration and intrusion in the river water at the estuaries, including sampling and quality analysis.
- (8) Investigation of flood and flood damaged, including collection of flood records, preparation of flood inundation maps, estimate of inundation area, flood recurrence and assessment of damages to people, houses, crops, irrigation facilities, infrastructures, transportation, communication, etc.

- (9) Investigation of existing river structures and flood protection facilities such as diversion weirs, bridges, levees/dikes, revetments, spur dikes, floodways, cut-off channels (shortcut channel), etc., and preparation of their inventories including conditions of damages.
- (10) Survey on irrigation and drainage sector, concerning present irrigation methods, operation and maintenance, existing rehabilitation and extension plans, etc.
- (11) Survey on agricultural sector, concerning present cropping pattern and farming practices, estimation of cultivated area and crop yield.
- (12) Agro-economic survey, concerning agro-economic data such as national agricultural development policy, population, labour force, land tenure, farm economy, market and farm gate price of agricultural outputs and inputs, agro-industry, marketing and institutional matters.
- (13) Survey on inland fishery on the coastal area, including survey on fish pond area, fish varieties, production and flood damage.
- (14) Investigation and review on existing dam and reservoir projects for flood control, irrigation, power and sediment control.
- (15) Socio-economic survey including analysis of socio-economic data such as national and regional development plan, general economic indicators, population, transportation, electricity demand, municipal and industrial water demand, etc.
- (16) Environmental survey including the assessment of present natural and social circumstances and investigation of environmental impacts resulting from the past projects.
- (17) Conducting of air-survey using helicopter to know the general feature and information of the river and basin area.

## 6.2 Reviews and Studies

- (1) Hydrological and hydraulic analysis, including frequency analysis of flood flow, evaluation of flood routing/attenuation effects by river channels, reservoirs, and retarding basins, estimation of probable inundation depth of the flood prone area and estimation of sediment load.
- (2) Study on flood control plan including estimation of marginal flood flow capacity of existing structures, presentation and comparative study of alternative flood control measures in terms of their mitigation/effects of damages; the proposed San Roque multi-purpose project will be incorporated in this study as committed for implementation in no distant future principally based on the present design, but its effect will be reviewed and the influence to the flood control plan by the postponement of its completion will be investigated.
- (3) Review on existing and extension plan for agricultural and irrigation development.
- (4) Review on hydropower development plan for reservoir type schemes.
- (5) Study on watershed management including sand arresting plan.
- (6) Review and formulation of basinwide land use plan, including delineation of flood mitigation area, agricultural area and other settlement/urban area.
- (7) Environmental assessment covering study on influence of river improvement projects to riparian areas and impact of reservoir projects to ecology and resettlement problems.

## 6.3 Comprehensive Study

- (1) Formulation of an integrated or overall flood control plan over the basin which will fully support the existing and future water resources, development schemes of the basin in most efficient and well-balanced manner. The plan will be phased into a short-term and a long-term development plans.
- (2) Identification and formulation of the priority projects for flood control plan.

- (3) Recommendation of implementation strategy and action program to be taken within 20 years for the overall flood control plan.

#### 6.4 Transfer of Technology

Throughout the course of the study, transfer of technology and training will be provided to the government personnel and counterpart by the foreign experts in the following fields:

- Planning and execution of field survey and investigation of topography, hydrology, geology and environmental aspects
- Hydrological study and analysis
- Hydraulic and structural design of structures such as dams, conveyance canals, earthdikes, etc.
- Procedure for evaluation of flood damages and formulation of flood control plan
- Other topics related with water resources development planning

The above transfer of technology will be carried out in the form of on-the-job training or seminar at the stage of study. Further, overseas training will be also programmed:

#### 7. Schedule of the Study and Reports

The total period required for the study will be twenty (20) months as shown in Figure 6.

During the course of the study, the following reports are requested to be prepared and submitted by the specified time.

- (1) Inception Report to be submitted within two (2) months after the commencement of study, which will contain plan of operation and methodology, work schedule, preliminary findings, problems to be encountered and others.



- (2) Progress Report to be submitted within eight (8) months after the commencement of study, which will contain mobilization/demobilization of experts, work progress, the results of data collection and field surveys, problems encountered, deviation from the original schedule and the anticipated program of the study in the succeeding period.
- (3) Interim Report to be submitted within twelve (12) months after the commencement of study, which will cover the results of all studies and analyses carried out.
- (4) Draft Final Report to be submitted within eighteen (18) months after the commencement of study, which will cover the results of all studies and analyses with supporting data including the conclusions of the comprehensive study and recommendation of the action program with presentation of priority projects.
- (5) Final Report to be submitted within one (1) month after receiving comments to the draft final report from the GOP, which will be issued within one (1) month from the submission of the draft final report.

## 8. External Inputs

For executing the study, the following foreign experts and equipment will be required:

### 8.1 Expertise Requirements

A total of 120 man-months of expertise services will be required and their assignment schedule are given in Figure 7. Specifications and qualifications of the experts are as follows:

- (1) Team Leader a Civil Engineer having a long and wide experience in planning and design of multipurpose water resources development projects in tropical countries.
- (2) One (1) Water Resources Engineer with experience in planning and design of multipurpose water resources development projects in tropical countries.
- (3) One (1) River Engineer with experience in planning and design of river improvement projects in tropical countries.

- (4) One (1) Hydraulic Engineer with experience in planning and design of hydraulic structures in rivers.
- (5) One (1) Dam Engineer with experience in planning and design of multipurpose dam projects in tropical countries.
- (6) One (1) Hydrologist with experience in hydrological analysis in relation with multipurpose water resources development and river improvement projects and in analysis of sediments river in tropical countries.
- (7) One (1) Irrigation and Drainage Engineer with experience in planning, design and implementation of irrigation projects in tropical countries.
- (8) One (1) Agronomist highly experienced in planning of agriculture projects as well as in assessment of land use in tropical countries.
- (9) One (1) Sabo Engineer, highly experienced in investigation and planning of sabo projects.
- (10) One (1) Electrical Engineer with experience in planning and design of power development projects.
- (11) One (1) Fishery Expert with experience in inland fishculture in tropical countries.
- (12) One (1) Geo-technical Engineer with experience in geological investigation and soil mechanics related to water resources development projects.
- (13) One (1) Environmental Expert with experience in environmental assessment in tropical countries.
- (14) One (1) Regional Economist with experience in assessment of regional economy in relation to multipurpose water resources development projects.
- (15) One (1) Survey Guidance Engineer with experience in survey works and well acquainted with the work conditions in tropical countries.

6) One (1) Team for aerial photo mapping consisting of:

One (1) Chief Surveyor with long and wide experience in aerial photogrammetry in tropical countries,

One (1) Surveyor with experience in supervising topographic mapping in tropical countries.

During the study period, the following field investigation will be carried out by employing local investigation firms under direct supervision of the expatriate study team:

- Aerial photogrammetric mapping (scale 1:25,000)
- Supplemental topographic survey
- Soil mechanics laboratory test for construction materials
- Hydrological observation and installations
- Core drilling survey

## 8.2 Equipment

Equipment needed for the study is expected to be provided by the overseas aid. The following is a provisional list of equipment to be required:

- |                                      |         |
|--------------------------------------|---------|
| - Automatic rain gauge               | 3 sets  |
| - Automatic water level gauge        | 3 sets  |
| - Current meter                      | 1 set   |
| - Sediment sampler                   | 1 set   |
| - Electric conductivity meter        | 1 set   |
| - Hand auger                         | 1 set   |
| - Desk-top personal computer/printer | 2 units |
| - Hand talkies                       | 2 sets  |

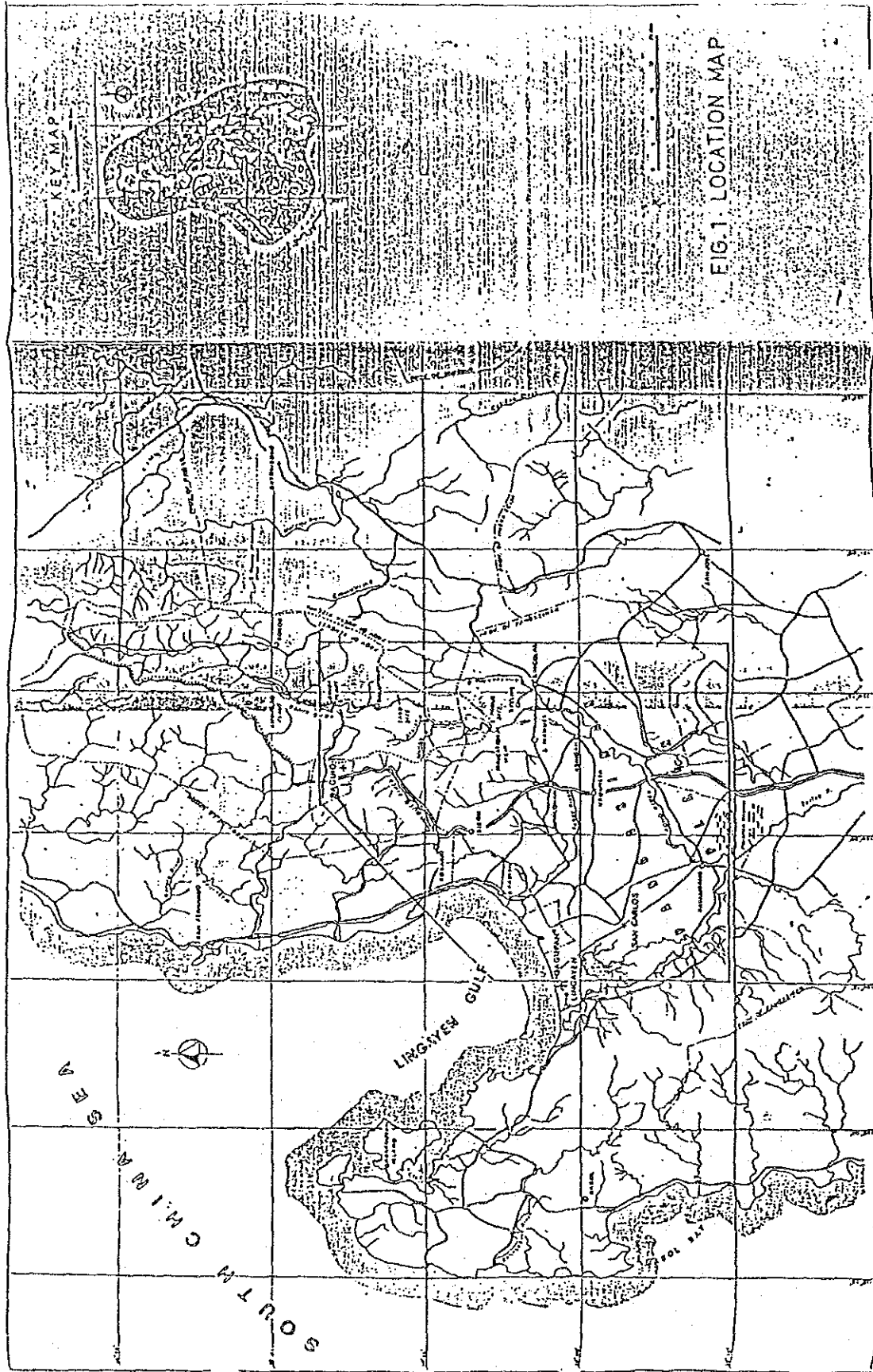
## 9. Undertakings of the Government

In order to facilitate a smooth and effective implementation of the study, the Government of the Philippines (GOP) will undertake the following items as necessary.

- (1) Provision of a counterpart group which will include a project coordinator responsible for the field survey works and any trouble arising throughout the survey period.

- (2) Arrangement for exemption from import duties imposed on personal effects, instruments, equipment and materials to be brought by the study team into the Philippines necessary for the study.
- (3) Provision of a sufficient and suitable air-conditioned office with appurtenant furnitures and facilities in Metro Manila and at site during the period of the services.
- (4) Provision of available documents, such as reports, drawings topographic maps, statistics, data and information needed for execution of the study.

Assistance for giving security of life and property of the experts during their stay in the Philippines.



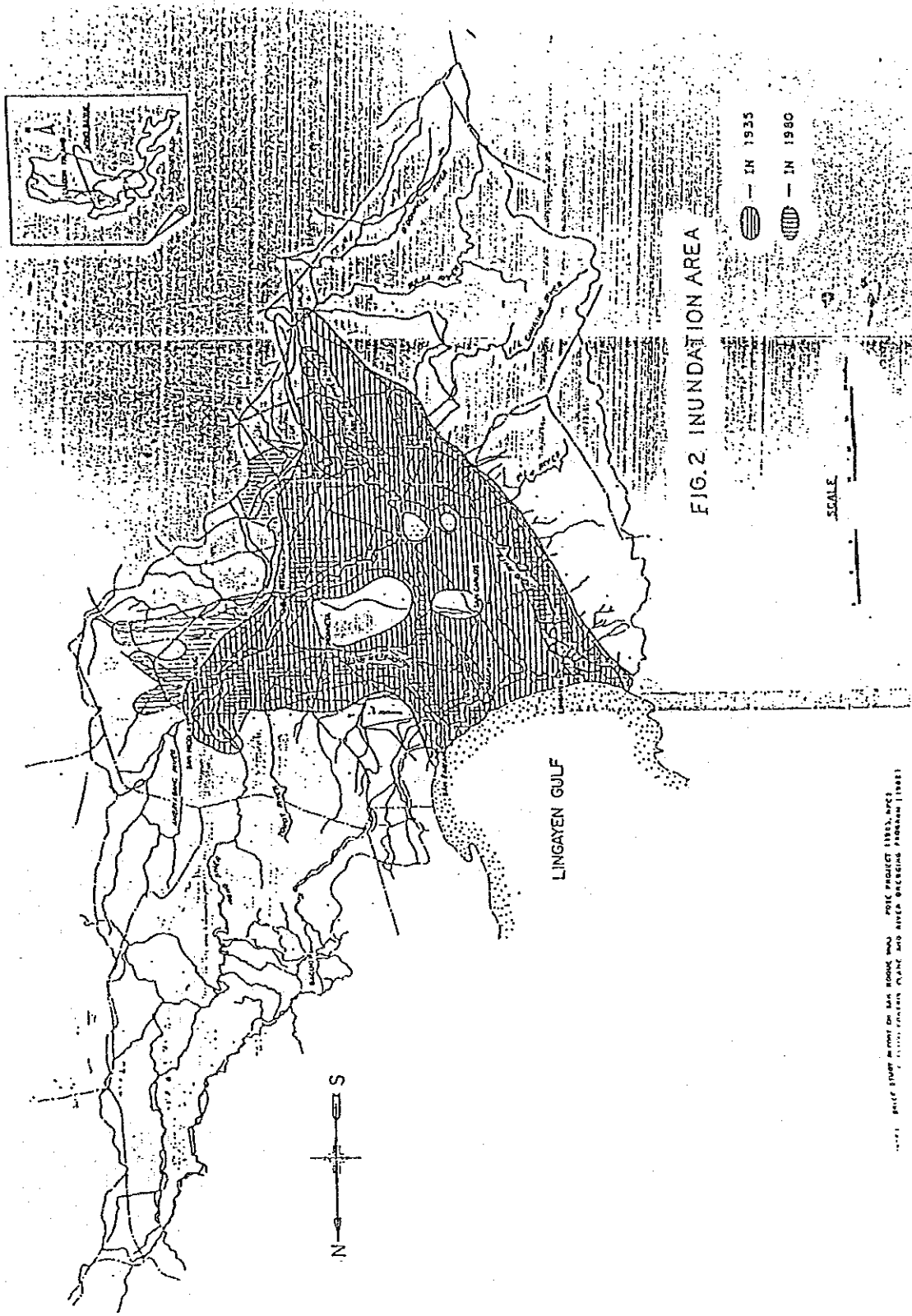


FIG. 2. INUNDATION AREA

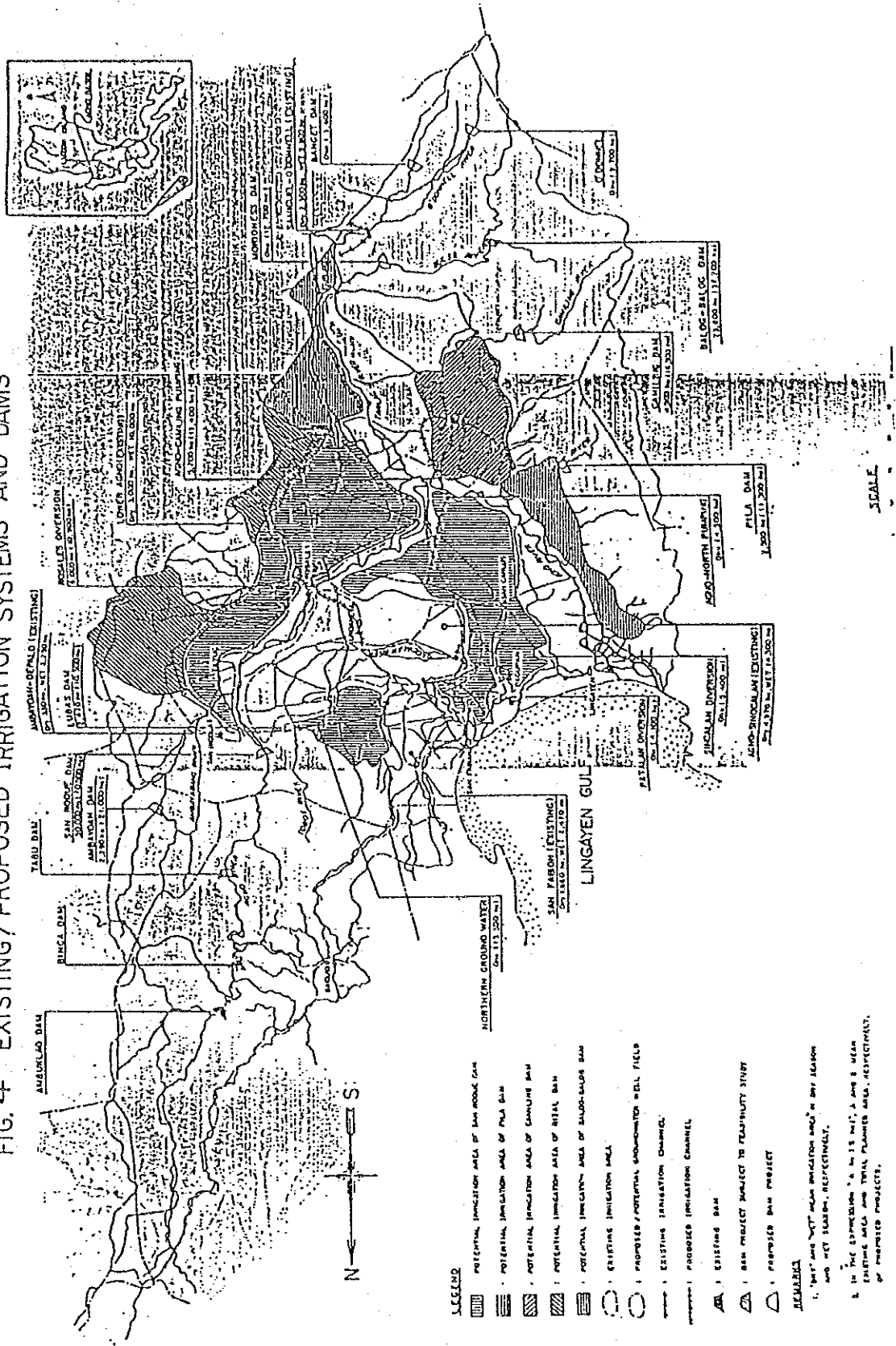
— IN 1935  
 — IN 1980

SCALE

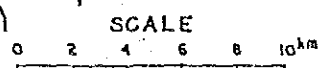
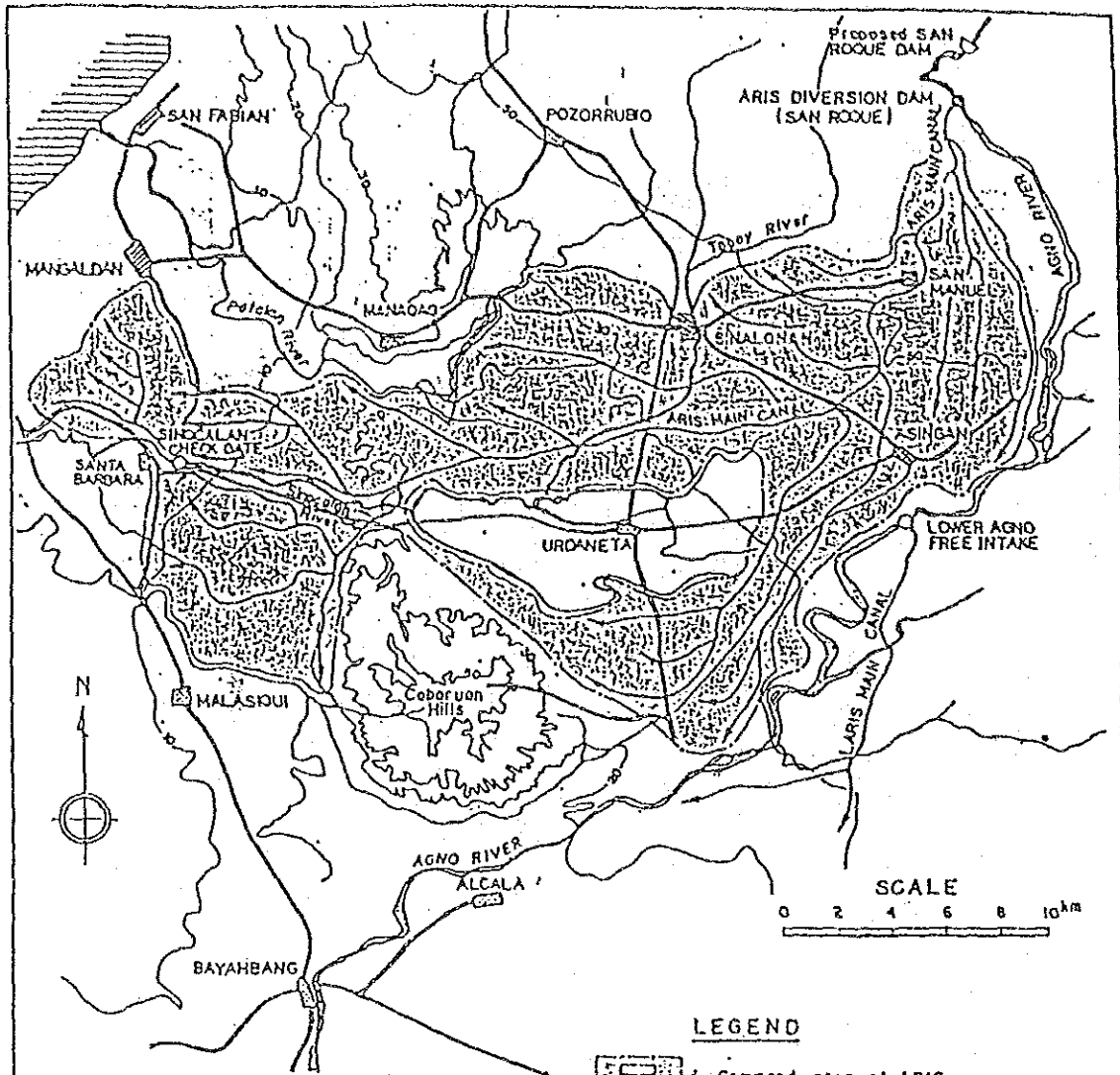
... GULF STUMP MOUNT ON SAN BONDONG MOUNTAIN, PSC PROJECT 1983, APCCS  
 ... GULF STUMP MOUNT ON SAN BONDONG MOUNTAIN AND RIVER DELTA DELTA PROGRAM (1983)



FIG. 4 EXISTING/PROPOSED IRRIGATION SYSTEMS AND DAMS





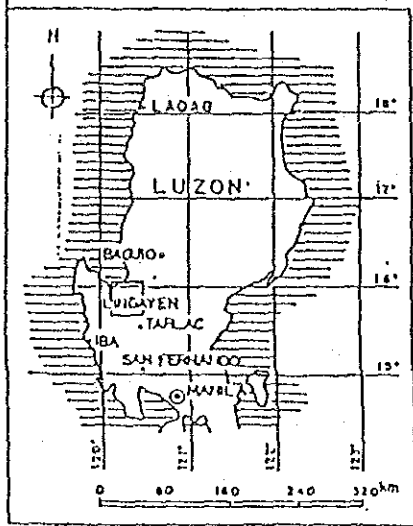


**LEGEND**

- : Command area of ARIS
- : Existing ARIS Diversion Dam
- : Other Existing Headworks
- : Existing Canals

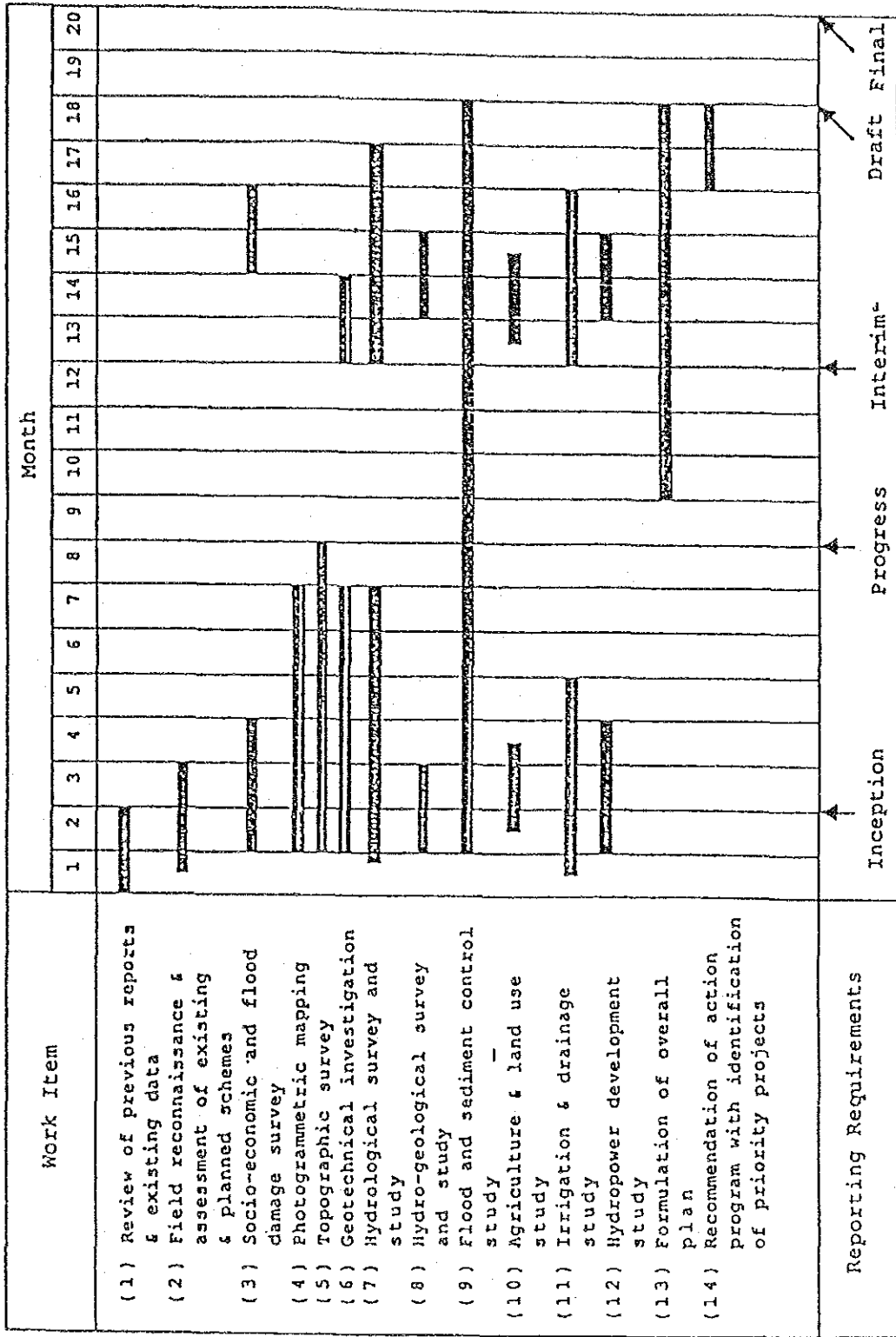
**Note**

ARIS : Agno River Irrigation System  
 LARIS: Lower Agno River Irrigation System



**FIG.5 IRRIGATION AREA**

Figure 6 WORK SCHEDULE





2. I/A

IMPLEMENTING ARRANGEMENT ON THE TECHNICAL COOPERATION  
BETWEEN THE JAPAN INTERNATIONAL COOPERATION AGENCY

AND

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

FOR

THE STUDY OF AGNO RIVER BASIN FLOOD CONTROL

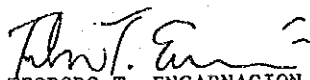
REPUBLIC OF THE PHILIPPINES


AGREED UPON BETWEEN

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

  
TEODORO T. ENCARNACION  
Undersecretary  
Department of Public Works  
and Highways (DPWH)

  
KOZO FUKUNARI  
Team Leader  
Preliminary Survey Team  
Japan International  
Cooperation Agency (JICA)

08 December , 1988

Manila

## I. INTRODUCTION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), the Government of Japan (hereinafter referred to as "GOJ"), has decided to conduct the Study of the Agno River Basin Flood Control (hereinafter referred to as "the Study"), and exchanged the Note Verbales with GOP concerning the implementation of the Study.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of GOJ, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan.

On the part of GOP, the Department of Public Works and Highways (hereinafter referred to as "DPWH"), shall act as counterpart agency to the Japanese Study Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document constitutes the Implementing Arrangement between JICA and DPWH under the above-mentioned Note Verbales exchanged between the two governments.

## II. OBJECTIVE OF THE STUDY

The objectives of the study are:

1. To formulate the Master Plan on flood control in the Agno River Basin and to identify the priority areas.
2. To conduct the Feasibility Study on the flood control projects in the identified priority areas.

## III. STUDY AREA

The study area shall cover the Agno River Basin with the area of approximately 7,500 km.<sup>2</sup>, as shown in Annex-I.

## IV. SCOPE OF THE STUDY

The Study shall include the followings:

### (1) DATA COLLECTION AND REVIEW OF PREVIOUS STUDIES

- 1) national and regional socio-economic data
- 2) data on meteorology and hydrology
- 3) soil and geological data
- 4) existing riparian facilities and other relevant facilities

- 5) river and its water utilization
- 6) present land use and assets
- 7) past floods and their damages
- 8) other related data and information

(2) FIELD SURVEY

- 1) field reconnaissance
- 2) longitudinal and cross sectional river survey
- 3) soil sampling test and river bed material test
- 4) topographic mapping of selected areas

(3) STUDY AND ANALYSIS

- 1) hydrological and hydraulic analysis
- 2) flood damage analysis
- 3) social and environmental impact
- 4) sedimentation study

(4) FORMULATION OF MASTER PLAN

- 1) formulation of master plan on flood control in Agno River Basin
- 2) identification of flood control projects to be urgently implemented

(5) FEASIBILITY STUDY OF URGENT FLOOD CONTROL PROJECTS

- 1) formulation of urgent flood control plan
- 2) preliminary design of the required facilities
- 3) estimation of construction cost
- 4) project evaluation (cost and benefit)
- 5) social and environmental impact

V. STUDY SCHEDULE

The Study will be executed in accordance with the attached tentative schedule, Annex-II.

VI. REPORTS

JICA shall prepare and submit the following reports in English to GOP:

1. Inception Report

Thirty (30) copies at the commencement of the field survey.

2. Progress Report 1

Thirty (30) copies within four (4) months after commencement of the Study.

3. Interim Report

Thirty (30) copies within nine (9) months after the commencement of the Study.

4. Progress Report 2

Thirty (30) copies within fifteen (15) months after the commencement of the Study

5. Draft Final Report

Thirty (30) copies within nineteen (19) months after the commencement of the Study.

GOP will provide JICA with its comments on the Draft Final Report within thirty (30) days after the receipt of Draft Final Report.

6. Final Report

Fifty (50) copies within two (2) months after JICA's receipt of the said comments on the Draft Final Report.

VII. UNDERTAKINGS OF GOP

In accordance with the Note Verbales exchanged between GOJ and GOP, GOP shall accord privileges, immunities and other assistance to the Japanese Study Team and, through the authorities concerned, take necessary measures to facilitate the smooth conduct of the Study.

1. a) GOP shall be responsible for dealing with claims which may be brought by the third parties against the members of the Japanese Study Team and shall hold them harmless in receipt of claims and liabilities arising in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims or liabilities arise from gross negligence or willful misconduct of the above-mentioned members.
- b) GOP shall secure the safety of the Study Team during the implementation of the Study.
2. DPWH shall, at its own expense, provide the Japanese Study Team with the following, if necessary, in cooperation with other agencies concerned:
  - a) Available data and information related to the Study,
  - b) Counterpart personnel and support staff necessary for the Study,
  - c) Suitable office space in Metro Manila and study area,
  - d) Credentials or identification cards to the members of the Japanese Study Team.

3. DPWH shall make necessary arrangements with other governmental and non-governmental organizations concerned for the following:
  - a) To secure the safety of the Japanese Study Team;
  - b) To permit the member of the Japanese Study Team to enter, leave and sojourn in the Philippines for the duration of their assignment therein;
  - c) To exempt the members of the Japanese Study Team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into the Philippines for the conduct of the Study;
  - d) To exempt the members of the Japanese Study Team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese Study Team for their services in connection with the implementation of the Study;
  - e) To provide necessary facilities to the Japanese Study Team for remittance as well as utilization of the funds introduced into the Philippines from Japan in connection with the implementation of the Study;
  - f) To secure permission for entry into private properties or other areas for the conduct of the Study;
  - g) To secure permission to take all data and documents (including aerial photographs) related to the Study out of the Philippines to Japan by the Japanese Study Team;
  - h) To provide medical services as needed and its expenses will be chargeable on the members of the Japanese Study Team.

#### VIII. UNDERTAKING OF GOJ

In accordance with the Note Verbales exchanged between GOJ and GOP, GOJ, through JICA, shall take the following measures for the implementation of the Study.

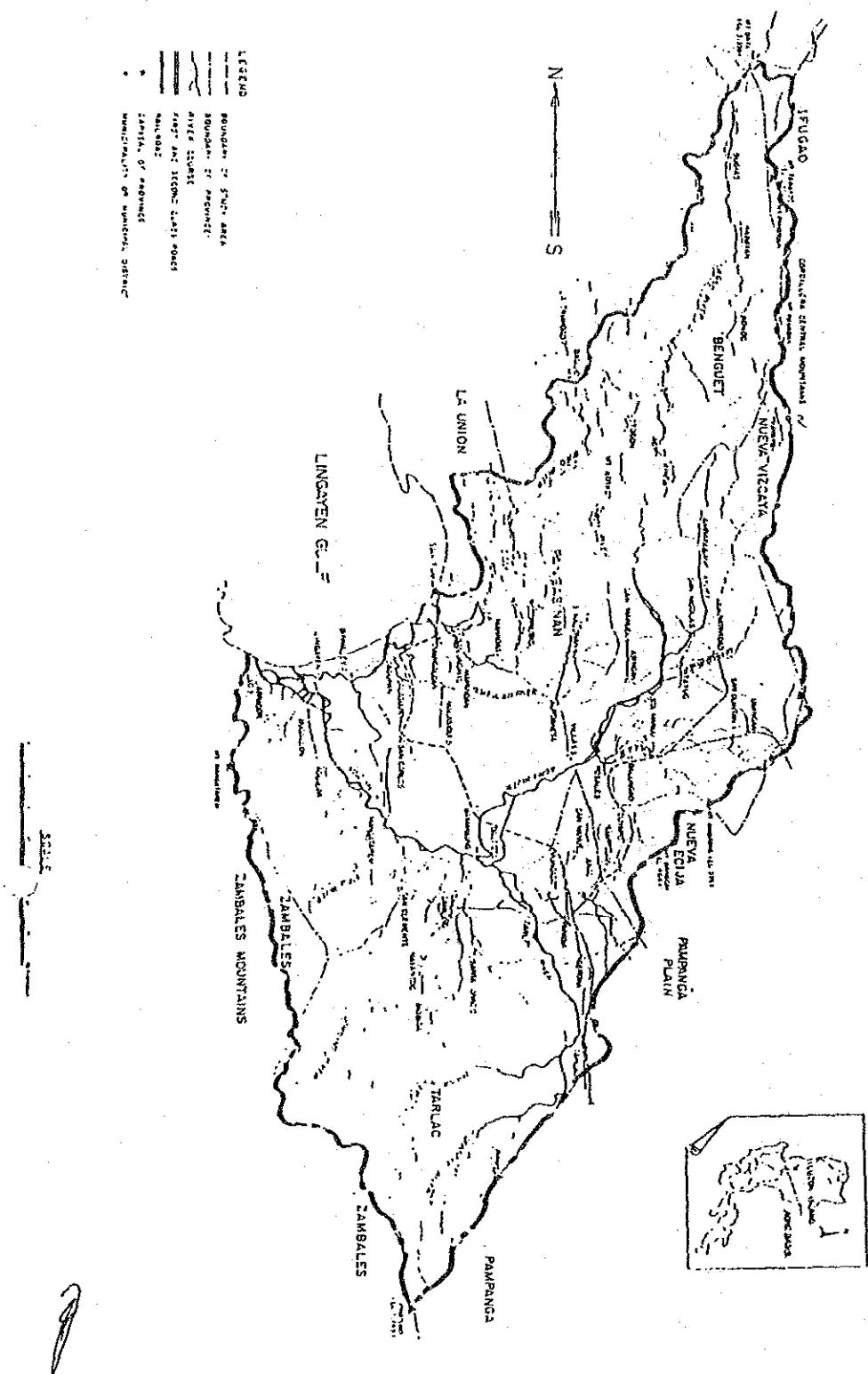
1. To dispatch, at its own expense, the Study Team to the Philippines.
2. To pursue technology transfer to the Philippine counterpart personnel in the course of the Study, by way of training in the Philippines and in Japan.

#### IX. CONSULTATION

JICA and DPWH shall consult with each other in respect of any matter that may arise from or in connection with the Study.



FIG-1 EASIN MAP



TENTATIVE SCHEDULE

ITEM	MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
STUDY IN PHILIPPINE		=====																								
		=====																								
		=====																								
STUDY IN JAPAN		=====																								
		=====																								
		=====																								
REPORT	A																									
	Ic/R	P/R1	I/R	P/R2	DF/R	F/R																				
	Ic/R	P/R1	I/R	P/R2	DF/R	F/R																				

(REMARKS)

Ic/R : Inception Report  
 I/R : Interim Report  
 © : Comment  
 P/R1.2 : Progress Report  
 DF/R : Draft Final Report  
 F/R : Final Report



### 3. M/M

MINUTES OF DISCUSSION  
ON  
THE STUDY OF THE AGNO RIVER BASIN

D a t e : 02 and 08 December 1988  
P l a c e : Conference Room DPWH Building  
A t t e n d a n c e : Attached Annex-I

In connection with the Implementing Arrangement of the STUDY OF THE AGNO RIVER BASIN FLOOD CONTROL, the following major issues were discussed between JICA Survey Team and DPWH:

1. For the hydrological observation, JICA Survey Team pointed out the necessity of establishing new stations, namely; four (4) stations for hourly rainfall gauge, nine (9) stations for water level gauge and some stations (to be identified later) for flood discharge observation.

JICA will provide the hydro-meteorological equipment such as automatic rainfall gauge, water level staff gauge and/or automatic recorder. In case the existing hydro-meteorological facilities are not operational, JICA will in addition, provide the necessary replacements.

DPWH shall bear the necessary expenses for the installation (civil works), observation and maintenance thereat;

2. Regarding the sediment and erosion control works, the Master Plan will include the necessary works in the flood plain. On the upper reaches (mountainous areas) only conceptual plan will be presented.

3. On the required surveys and investigations, the Survey Team and the DPWH agreed on the following:

I. MASTER PLANNING STAGE:

1. The conduct of Aero-photo-mapping including establishment of ground controls shall be borne by JICA;
2. Longitudinal profile and cross-section surveys on the main Agno River and its tributaries shall be borne by JICA;
3. Soil surveys including laboratory test shall be borne by JICA;
4. Longitudinal profile and cross-section surveys on the allied rivers shall be borne by DPWH.

II. FEASIBILITY STAGE:

Additional surveys and investigations that maybe required at this stage, such as:

1. Topographic and river surveys including selected major structure sites along the main Agno River and its tributaries shall be borne by JICA;
2. Necessary geologic sub-surface investigations including field sampling and laboratory test along the main Agno River, its tributaries and in the allied rivers shall be borne by JICA;
3. Topographic and river surveys including selected major structures sites in the allied rivers shall be borne by DPWH.

4. DPWH requested for inclusion in the study, the rehabilitation of the existing Agno River Irrigation System.

However, JICA Survey Team based on the request and discussion stated, that the rehabilitation study cannot be included. Only the sediment aspect affecting the existing system may be considered.


5. DPWH requested that four (4) four-wheel drive type vehicles for the study be provided by JICA.


DPWH expressed that they will provide drivers, fuel, and maintenance of the four (4) new said vehicles.

DPWH shall also provide at least two (2) units of service vehicle.

6. DPWH requested the necessary survey equipment such as current meter, sediment sampler and micro-computer for hydrological and hydraulic analysis, be provided by JICA.

7. JICA Survey Team answered that the above request (Items 5 and 6) of DPWH will be presented for consideration by the JICA Tokyo Head Office

  
TEODORO R. ENCARNACION  
Undersecretary  
Department of Public Works  
and Highways (DPWH)

  
KOZO FUKUNARI  
Team Leader  
Preliminary Survey Team  
Japan International  
Cooperation Agency (JICA)

08 December, 1988

Manila

LIST OF ATTENDANCE

1. Philippine Side:

Teodoro T. Encarnacion	- Undersecretary Department of Public Works & Highways
Manuel M. Bonoan	- Asst. Secretary for Planning, DPWH
Antonio A. Alpasan	- Project Manager IV PMO-Major Flood Control Projects, DPWH
Rogelio A. Flores	- Project Manager III PMO-Major Flood Control Projects, DPWH
Jose C. Guanzon	- Chief Civil Engineer PED, Planning Service, DPWH
Toshiki Kawakami	- JICA Expert, DPWH
Abelardo Y. Armentia	- Head, Feasibility Reports and Environmental Section, NIA
Yasuhiko Mishima	- JICA Expert, NIA
Yokisori Oouch	- JICA Expert, NIA

2. Japanese Side:

Kozo Fukunari	- Team Leader of the Preliminary Survey Team, JICA
Katsumi Seki	- Flood Control Planning
Hiroshi Horiuchi	- Hydrology, Hydraulics
Kazuhiko Toda	- Cooperation Planning
Hiroshi Yasuda	- Project Planning
Seiichi Yamakawa	- Facility Planning

#### 4. 収集資料リスト

##### (1) 一般

- ① Framework Plan-Agno River Basins (Chapter III-Objectives of Development, Chapter IV-Area Profile, Chapter VI-Present and Future Development and Resource Needs), Dec. 1983, NWRC, 報告書
- ② Infrastructure Projects/Annual Budget by Category (1981-1988), DPWH, タイプ1枚
- ③ Budget for Flood Control Program/Nationwide, Region I, Agno Flood Control System (1981-1987), DPWH, タイプ1枚
- ④ Socio-Economic Profile/Pangasinan Integrated Area Development Project, Jan. 1986, 表紙, 目次のみのコピー6枚

##### (2) 地形・地質

- ① Framework Plan-Agno River Basins (Chapter V-Water and Related Land Resources). Dec. 1983, NWRC, 報告書
- ② Topographic & Hydrographic Map of Agno River, Soale 1 : 10,000, 青焼7部

##### (3) 気象・水文

- ① Framework Plan-Agno River Basins (Chapter V-Water and Related Land Resources), Dec. 1983, NWRC, 報告書
- ② Philippines Water Data 1971-Surface Water Records No. 14, NWRC (Agno River Basin, Bued River Basin, Dagupan River Basin のみのコピー, 計26枚)
- ③ Climatological Normaland Extremes of Rainfall in the Philippines, May 1988, PAGASA, コピー
- ④ Rainfall Intensity-duration-frequency data of the Philippines, Vol. 1 first edition, 1981, PAGASA, 報告書コピー

##### (4) 洪水防御及び関連資料

- ① Feasibility study on Balog-Balog Multi-purpose Project/Flood Control component, (Jan-1984, MPWH), 報告書コピー
- ② Flooded Area, 縮尺 1 : 200,000, 作成年 : 不明, DPWH, 図面1枚
- ③ Breaches/Gaps Damaged Caused by Floods, 縮尺・作成年 : 不明, DPWH (Agno Flood Control System Office), 図面1枚
- ④ Agno River Control Project-Tarlac and Pangasinan, Proposed CY\*-'88 Proposed Projects, 縮尺 : 不明, DPWH (PMO-Agno Flood Control System), 図



面1枚

- ⑤ status of CY\*-1988 Regular Infra. Program-As of Sept. 15, 1988, DPWH (PMO -Agno Flood Control System), タイプ3枚
- ⑥ Water Resources Developments-Central Luzon Basin, 縮尺・図示, Feb. 1966, United States Dept. of the Interior Bureau of Reclamation, 図面1枚
- ⑦ Structural Chart, Position Chart, Functional Chart DPWH (Project Management Office, Agno Flood Control System) 図面3枚
- ⑧ Framework Plan-Agno River Basins (Chapter V-Water and Related Land Resources, Chapter VII-Water Resources Development Framework), Dec. 1983, NWRC, 報告書
- ⑨ Brief Study Report on San Roque Multipurpose Project, Apr. 1983. NAPOCOR, 報告書コピー
- ⑩ San Roque Multipurpose Project-Electromecanical Works, Vol. I Bid and Contract Documents-General Information, Jan. 1982, ELC, 報告書コピー
- ⑪ Agno River Irrigation System-General Layout, 縮尺1:40,000, 作成年:不明, NIA, 図面1枚
- ⑫ Introduction of the Agno-Sinocalan River Irrigation System, 作成年:不明, NIA, タイプ5枚
- ⑬ Brief Information of Agno RIS Clearwater Development Project, 作成年:不明, NIA, タイプ2枚
- ⑭ Project Proposal/ARIS Rehabilitation & Sedimentation Control Studies, 作成年:不明, NIA, タイプ7枚
- ⑮ Irrigation Operation Support Program (IOSP), Dec. 1985, NIA, 報告書(目次, Summary, Conclusions & Recommendationsのみのコピー, 計15枚)
- ⑯ Project Profile-Lower Agno (San Roque) River Multipurpose Project, Irrigation Component, July 1983, NIA, コピー
- ⑰ River Dredging Project II, Nationwide Flood Control Plan and River Dredging Program, Nov. 1982, Nippon Koei Co., Ltd./Nikken Consultants, Inc. & Basic Technology & Management Corporation, 関連部分(2.2.1~2.2.92)のみコピー
- ⑱ Masterlist of Canals/Laterals, Agno River Irrigation System, コピー1枚
- ⑲ 大統領令, Executive Order No. 277, No. 224, Presidential Decree 705, コピー7枚
- ⑳ 対象流域治水事業5カ年計画(1986~1990), コピー7枚

- ②① アンブクラオダム（貯水池）ルールカーブ，1988年，コピー1枚
- ②② Agno River Irrigation Project-Diversion Works, Drawing 図面1/8～8/8 計8枚，青焼



## 5. 基礎資料の賦存状況

### REQUIRED DATA AND QUESTIONNAIRE

#### 1. GENERAL

1-1 National development plan (existing long-term plan or five year plan)

NEDA で入手可能

1-2 Regional development plans related to the Study

NEDA で入手可能

1-3 National census related to the Study

National Census Office で入手可能

1-4 Provincial Profile (Benguet, La Union, Pangasinan, Nueva Vizcaya, Nueva Ecija, Ilocos, Zambales) 各 Provincial Government Office で入手可能

1-5 Socio-economic conditions in and around the Agno river basin

a. Administrative district (city, town, and village)

b. Population and household

c. Beneficiaries from the Project

d. Land use

e. Infrastructure

- Road condition

- Transportation

- Electricity

- Telecommunication / postal service

- Potable water supply

- Wells

- Industry

- Agriculture (irrigation)

- Tourism and historical points

対象流域は幾つかの州にまたがっているため、Provincial Profile などを利用して調査する必要がある。

1-6 Budget in the last five years (公共事業)

a. National budget 収集資料(1)―②, ③参照

b. Flood control / Dam construction / Erosion control / Forestation (whole country)

c. -ditto- (Agno river basin)

d. Maintenance cost for road, bridges, flood control facility, etc.

e. Annual report of the DPWH

上記 b, c, d の Flood Control については収集資料(1)―②, ③, (4)―⑤参照

1-7 Agencies and their main duties and territories in planning, implementing and operating flood control, river improvement and inundation prevention projects 本報告書, 収集資料(4)―⑦参照

1-8 Up to date organization chart of the aforementioned agencies

1―7 に同じ

## 2. TOPOGRAPHY AND GEOLOGY

### 2-1 Topographic maps covering the Agno river basin

- a. Key map and area covered by the above maps
- b. Scale
- c. Interval of contour line
- d. Agency and administrative office : NAMRIA (National Mapping & Resource Information Authority) 1/25万地形図は入手可能, 1/5万は入手困難である。

### 2-2 Geological maps covering the Agno river basin

- a. Area covered by the above maps (section, columnar section)
- b. Scale
- c. Agency and administrative office : Bureau of Minesにて入手可能 (但しフィリピン全体の地質図)

### 2-3 Plan, longitudinal profile and cross-section of river improvement

- a. Plan of existing river improvement
- b. longitudinal profile and cross-section of existing river improvement
- c. River width in major reaches or points
- d. Channel depth in major reaches or points
- e. Variations of river course and river bed in the past
- f. Agency and administrative office

河道部分平面図 (縮尺1/1万) —サンロケ地点付近よりアグノ川河口まで  
横断図: 縦1/100, 横1/500, 間隔500m

} DPWH  
にて入手  
できる。

### 2-4 Aerial photographs (the latest photos)

- a. Area covered by the above photos
- b. Scale
- c. Photographing year
- d. Agency and administrative office
- e. Permission for the Study Team to take them out of the Phillippines to Japan
- f. Control point (location and altitude)
- g. Triangulation station  
添付資料—参考資料参照

### 2-5 Soil-mechanical data at major river structures

- a. Boring log data
- b. Ground-water survey
- c. Permeability test
- d. Seismic prospecting

殆どない

### 2-6 Land use maps covering the Agno river basin

- a. Scale and year of publication or investigation
- b. Agency and administrative office

参考文献⑤, 収集資料(1)—①参照

### 3. CLIMATIC AND HYDROLOGICAL DATA

3-1 Location map of climatological and hydrological stations covering the area  
(including the vicinity of Baguio)

- a. Rain gauge stations
- b. River gauging stations (water level, discharge)
- c. Tide gauge stations : リンガエン湾には無く, La Union 州にはあるとのことであったが  
未確認
- d. Flood warning stations  
本報告書参照

3-2 List of aforementioned stations showing;

- a. Station name
- b. Location / address
- c. Classification of station or code number, if any
- d. Observation items indicating equipment in use
- e. Period of observation
- f. Authorities concerned  
本報告書参照

3-3 General climatic condition in terms of monthly averages at major climatological  
stations

PAGASA にて入手可能

3-4 Specific climatic condition (rainfall and wind,tide)ever recorded at major stations

PAGASA にて入手可能

3-5 Hyetograph of storms which caused major histrical floods in the subject area

- a. Hourly distributions of storm rainfall at major stations
- b. Hourly Hydrograph of flood flow at major stations
- c. Probable rainfall intensities for the following duration;  
60, 120, 180 minutes  
4, 6, 12, 18, 24 hours
- d. Isohyetal maps  
収集資料(3)―③, ④参照

3-6 Water level and discharges

- a. Monthly average discharges at major non-tidal river gauging stations
- b. Annual maximum water level and discharge, together with the data of occurrence,  
recorded at major stations (long term data are necessary)
- c. Water level and discharge hydrographs observed during major floods in the past
- d. Relationship between water level and discharge at major stations (H-Q curve)
- e. Method of discharge observation
- f. Authorities concerned  
本報告書参照

#### 4. FLOOD CONTROL AND RELEVANT INFORMATION

##### 4-1 Reports, records or information on the past flood damage in the Basin

- a. Occurance year
- b. Cause
- c. Inundation area and damage on the farm land and properties
- d. Damage on the flood control facilities and other infrastructure facilities such as bridges, roads, railway, dams, irrigation weirs
- e. Extent of damage

本報告書参照

##### 4-2 Fundamental policy for flood control program in the Basin

特に決っていない

##### 4-3 Present condition of existing flood control facilities in the Basin

DPWH のアグノ川洪水制御事務所にて入手可能

##### 4-4 Information regarding the completed / ongoing / proposed flood control projects in the Basin covering the project name, title and contents of project reports

収集資料(4)―⑤参照

##### 4-5 Information regarding the completed / ongoing / proposed dam construction projects in the Basin covering project name, title and contents of project reports

NAPOCOR, NIA にて入手可能

##### 4-6 Information regarding the completed / ongoing / proposed river intake structures in the Basin covering project name, title and contents of project reports

DPWH, NIA にて入手可能

##### 4-7 Reservoir operation rule for flood of the existing dams in the Basin

NAPOCOR にて入手可能

##### 4-8 Distribution of design flood discharge in the Basin

本報告書参照

##### 4-9 Existing flood warning / evacuation system in the Basin

DPWH, PAGASA にて入手可能

##### 4-10 Sediment observation record in the Basin

- a. Suspended sediment
- b. Silt sediment
- c. Riverbed material analysis

NAPOCOR にて入手可能

##### 4-11 Land conservation of the Basin

- a. Forestation
- b. Erosion control
- c. Record of landslides

NAPOCOR, Bureau Forestry にて入手可能

## 5. OTHERS

5-1 Environmental quality standard, especially for landscape, water quality and pollution

DPWHにて入手可能

5-2 Seismological observation data

DPWH-Bureau of Design, Bureau of Mines, Philippine Volcanology Officeにて  
入手可能

5-3 Currency exchange rate

5-4 Public holidays

5-5 Unit price and wages of construction workers

5-6 Record of water quality





## 6. 面談者リスト

### (1) 比側関係者

#### 1) DPWH

Mr. Teodoro T. Encarnacion/Undersecretary

Mr. Manuel M. Bonoan/Assistant Secretary for Planning

Mr. Antonio A. Alpasan/Project Manager IV, PMO-MFCP

Mr. Rogelio A. Flores/Project Manager III, PMO-MFCP

Mr. Resito V. David/PMO-MFCP

Mr. Jose C. Guanzon/Chief, PED-Planning Service

註) PMO-Project Management Office

MFCP-Major Flood Control Project

PED-Project Evaluation Division

#### 2) PAGASA

Mr. Juanito F. Lirios/Deputy Director for Operations & Services

Bayani S. Lomotan/Weather Services Chief

Eduardo S. Borbolla/Meteorologist II

#### 3) NIA

Mr. Avelino S. Rivera/Manager, Project Development Department (PDD)

Mr. Abelardo Y. Armentia/Head, Feasibility Studies & Environmental Section,  
PDD

Mr. Faustino M. Galit/Head, Survey & Mapping, PDD

Mr. Tiburcio C. Layug, VR./OIC-Region I

#### 4) NAPOCOR

Mr. Rodolfo C. Dela Cruz/Manager, Hydro Development Division

Mr. Greg Cayetano/OIC Operation Control & Information Services Dept.

Mr. Roland S. Quilala/Plant Manager, Ambuklao Hydro-electric Plant.

Mr. Honorato B. Gambon/Maintenance Superintendent, Ambuklao Hydro-  
electric Plant,

#### 5) Pangasinan Provincial Office

Hon. Rafael Colet/Governor

(2) 日本側関係者

1) 日本大使館

神長耕二/一等書記官

2) JICA 派遣専門家

川上俊器/DPWH 所属

Yasuhiko Mishima/NIA 所属

Yukinori Ouchi/NIA 所属

Atsushi Yoshii/ESCAP/WMO 台風委員会所属

3) JICA マニラ事務所

宮本守也/所長

大島勝彦/副所長

小沢勝彦/所員

## 7. 参考資料

### (1) 航空写真

NIA でパンガシナン平野部の灌漑計画のため航空写真測量を行っており、写真、ネガ等の資料は NIA に保管されている。測量の概要を次に示す。

- 1) 撮影年            1976年
- 2) 写真縮尺        1 : 8,000
- 3) 図化範囲        灌漑計画区域のみ (図-1 参照)
- 4) " 縮尺         1 : 4,000
- 5) " 等高線       1 m

また、1981年～1982年にかけて縮尺 1 : 60,000 で航空写真が撮影されており、対象地域も含まれていることからこれが利用できれば河道形状の変化などを検討できる。入手先等については本格調査時に現地で確認する必要がある。

### (2) 河川横断測量

アグノ川本川の河口部から San Manuel (中流部) 付近まで 500m 間隔で測量済。作成年は不明。DPWH 所有。

### (3) 河川 (河道) 平面図

上記の区間で縮尺 1 : 10,000, 等高線間隔 1 m の平面図が作成されている。DPWH 所有。

### (4) 地形図等の所轄官庁

従来 of 国防省所管の沿岸測地測量局 (BCGS) は、環境・天然資源省所管の新組織、地図・資源情報庁 (National Mapping and Resources Information Authority - NAMRIA) に吸収され全業務が引き継がれることになった。



## 8. 参考文献

- ① San Roque Multipurpose Project, Feasibility Study Appendix D. Floods and Flood control, ELC, March 1979
- ② サンロケ多目的ダム開発計画調査 最終報告書, 1985年9月, JICA
- ③ アンブクラオダム修復計画, 調査報告書, 昭和63年3月, JICA
- ④ ビンガダム修復計画調査 中間報告書, 昭和63年7月, JICA
- ⑤ アグノ川流域水資源総合開発計画調査報告書, 昭和59年9月, 国建協
- ⑥ Son Roque Multipurpose Project, Feasibility Study Appendix C. Meteorology and Hydrology

JICA