社会開発調査部報告書

No. 002

フィリピン国

マニラ都市基本図作成調査

技術移転セミナー

実施報告書

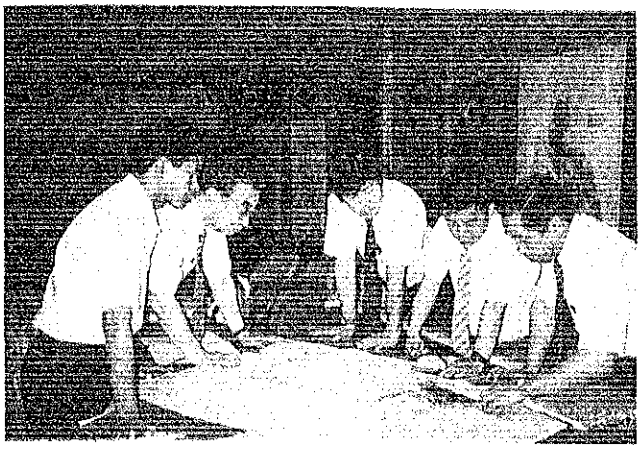
平成２年１月

国際協力事業団

フィリピン国
マニラ都市基本図作成調査
技術移転セミナー
実施報告書

平成 2年 1月

国際協力事業団

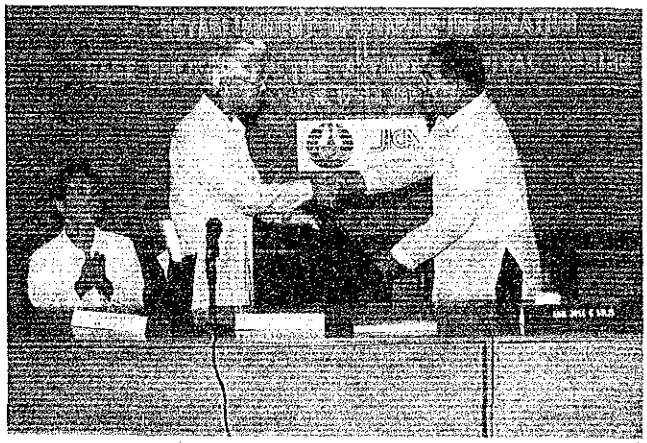


現地踏査行程打合わせ

セミナー開会式

NAMRIA Solis 総裁開会あいさつ

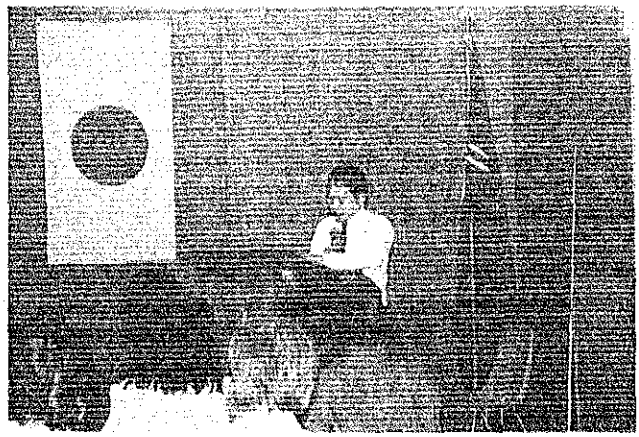
印刷原版引渡し書に署名する Solis 総裁と
JICA 宮本所長



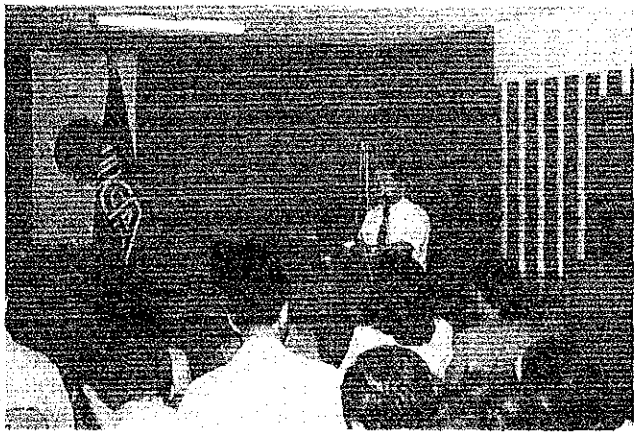
引渡し書署名を終えて握手する Solis 総裁と
宮本所長

セミナー講義風景

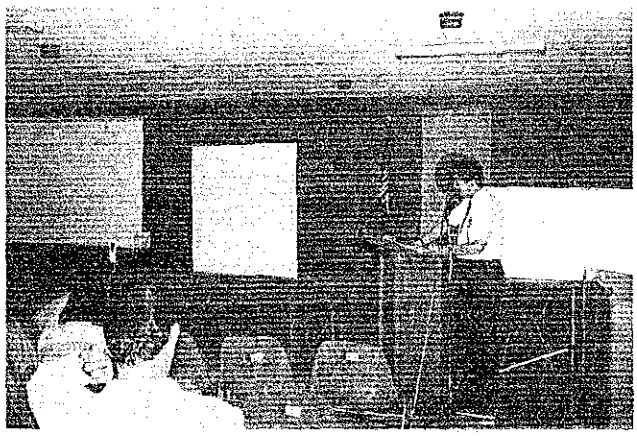
高崎団長



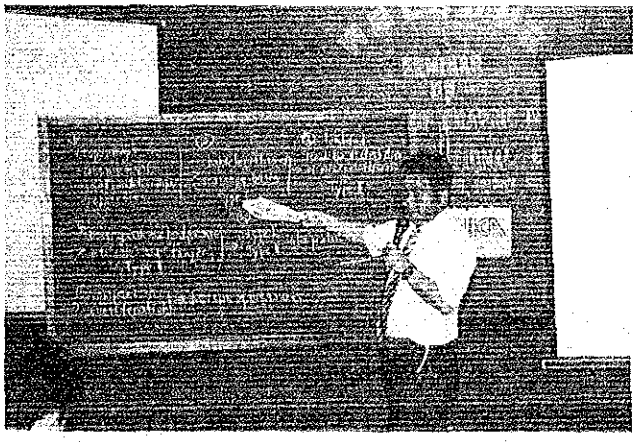
奥泉団員



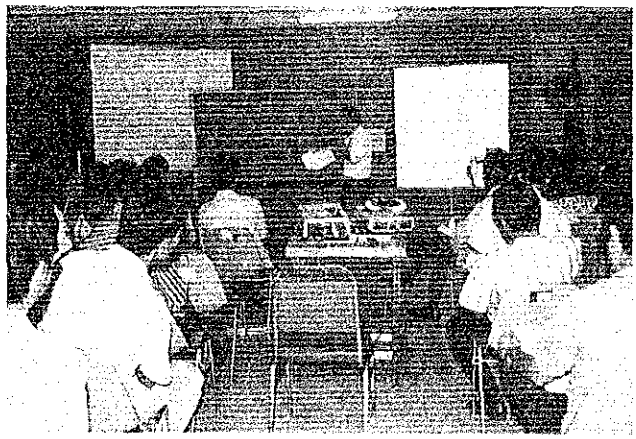
鎌倉団員



宇根団員



赤桐団員



熱心に講義にきき入る参加者

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１．セミナー開催の背景および経緯

フィリピン国の政治、経済、文化の中心であるマニラ首都圏は、急激な人口の流入により、交通施設、防災施設、住宅施設などの都市基盤が未整備のまま過密化し、仮設居住地域の増加、集中豪雨による常習化した浸水等、都市環境が急速に悪化している。

このような多様かつ緊急な都市問題を抱え、それらを適正かつ合理的に解決するためには、マニラ首都圏とその周辺の実態を正しく把握するための都市基本図の整備が急務であり、これに基づいて適正な開発・保全計画が樹立される必要がある。

このような背景のもとにフィリピン政府は、1984年３月、日本政府に対し、マニラ首都圏の都市基本図作成に関する技術協力を要請してきた。日本政府はこの要請に応え、1985年３月に日比両国間で合意された実施細目（Ｉ／Ａ）に基づいて、1985年度から４カ年計画でマニラ首都圏の都市基本図（縮尺１／１万の地形図、平面図、土地利用図及び土地条件図）の作成事業を開始した。1989年３月にすべての事業を完了し、同年７月に「マニラ首都圏都市基本図」がフィリピン政府に提出された。

今回の技術移転セミナーの開催については、今後のマニラ首都圏での多様な開発・保全計画策定等において、４種類の地図が、その情報内容、性質等を十分に理解された上で効果的に利用されることを期待して、調査のカウンターパートである国家地図資源情報庁（ＮＡＭＲＩＡ：National Mapping and Resource Information Authority)からの要望により1989年１月17日付のフィリピン国外務省書簡をもって、本セミナーが日本政府に要請され、それに基づいて本セミナーの実施が決定されたものである。

国際協力事業団は、上記の地図作成事業に関し、４年間にわたって調査団長をつとめた高崎正義氏を団長とする技術移転セミナーチームを組織し、1990年１月14日より１月20日まで現地へ派遣し、ＮＡＭＲＩＡと共催で本件「マニラ都市基本図」に関する技術移転セミナーを実施した。

２．セミナーの目的および概要

フィリピン国政府の要請に基づき、1985年８月から1989年３月にかけて実施した同国マニラ都市基本図作成調査の成果品である１万分の１地形図、平面図、土地利用図及び土地条件図について、その作成方法、解読法、活用方法について解説と討議を行うことにより、フィリピン国側への技術移転を図ることを目的としたものである。

セミナーは以下の要領で実施した。

1) 開催日時：1990年１月17日（水）　10：00～17：30
　　1990年１月18日（木）　10：00～18：15

2) 会　　場：マニラ首都圏タギグ(Taguig)市フォートボニファシオ海軍基地内ＮＡＭＲＩＡビル講堂

3） 内　　容：①マニラ都市基本図作成調査の概要および基本図の特徴の説明
②地形図・平面図の作成方法と見方・使い方
③土地利用図の作成方法と見方・使い方
④土地条件図の作成方法と見方・使い方
⑤土地利用図の活用法
⑥土地条件図の活用法
⑦質疑・討議
（詳細は別添セミナー・プログラムを参照）

3．調査団の構成

高崎正義	地形図・平面図〈総括〉	（日本地図センター）
赤桐毅一	土地条件図の活用法	（建設省国土地理院　地理調査部）
宇根　寛	土地利用図の活用法	（　同　上　）
鎌倉友隆	土地条件図の作成方法と見方・使い方	（朝日航洋株式会社）
奥泉　敦	地形図・平面図の作成方法と見方・使い方および土地利用図の作成方法と見方・使い方	（　同　上　）
遠藤　玲	調査監理	（国際協力事業団　社会開発調査部 社会開発調査第一課）

4．カウンターパート

Mr. Renato B. Feir (Capt., Philippines Navy)
Director, Coast and Geodetic Survey Department (CGSD),
National Mapping and Resource Information Authority (NAMRIA),
その他ＮＡＭＲＩＡ職員

5．　調査日程

1990年1月14日（日）東京---→マニラ PR431（奥泉団員）
10:15　13:50

15日（月）NAMRIA(CGSD) Feir 部長と打合わせ（奥泉団員）
10:00

東京---→マニラ　PR431　（高崎団長　他4名）
10:40　14:30

JICA事務所訪問　宮本所長、守屋所員と面会・打合せ（団員６名）
16:30

大使館表敬　神長書記長に面会・説明（団員６名）
18:00

16日（火）NAMRIA訪問　Solis 総裁表敬（団員６名および守屋所員）
10:00

比国側出席者；Sollis総裁、Yambao副総裁、Villanueva部長（外国援助担当）及びFeir部長（沿岸測地測量部：CGSD）

準備打合わせ（NAMRIA会議室）
11:00

Cadaoas 氏とセミナー会場準備及び事前現地踏査打合せ（団員６名）

セミナー準備　（奥泉団員）
13:30

現地調査（奥泉団員を除く団員５名及び Cadaoas氏）
13:30

セミナー進行最終打合せ（Feir部長と団員６名）
17:30

NAMRIA Binondo Office(CGSD) にて

17日（水）セミナー開催　　（内容は別添資料参照）
10:00

18日（木）セミナー開催　　（内容は別添資料参照）
10:00

19日（金）マニラ→東京　PR432　（奥泉団員を除く団員５名）
14:30　　19:15

ＪＩＣＡフィリピン事務所守屋氏に報告その他事後処理（奥泉団員）
15:30

20 日（土）マニラ→東京　PR432　（奥泉団員）
14:30　　19:10

６．セミナー等の内容

(1) 表敬訪問

セミナーの実施に先立ち、団員一同でＮＡＭＲＩＡ総裁 Solis氏を表敬訪問した。ＮＡＭＲＩＡ側からは総裁の他、副総裁のYambao氏、外国援助担当部長のVillanueva氏及び沿岸測地測量部長のFeir氏が、また、ＪＩＣＡフィリッピン事務所からは守屋氏が同席のもと、セミナーチーム側から講師の紹介、セミナーの内容等についての概略説明等がなされた。ＮＡＭＲＩＡ側からは、作成された地図が地域の発展にとり十分効果的に活用できるよう、今回のセミナー実施には大きな期待を寄せている旨の発言があった。

(2) 現地踏査

セミナーでの予備知識を確実にするため、１月16日午後下記行程で現地踏査を実施した。

行　程	踏　査　内　容
Makati(マニラガーデンホテル) ↓	ホテル周辺のショッピングセンター等代表的な業務地区、商業地区の土地利用
Pasig(EDSA環状道路) ↓	ＥＤＳＡ環状道路沿いに見られる台地上に進出中の業務地区、（ホテル、民間企業ビル等）
Muzon ↓	ラグナ湖沿いの低地帯（洪水常習地）とその土地利用（水田が住居地区及び工業地区等に変貌中）
Quezon City (North Super-Highway) ↓ Novaliches	North Super-Highway に沿って北へ拡大して行く大規模工業地区と住居地区、工住混合地区
Malabon ↓ Navotas	マニラ北部海岸沿いの低地帯（洪水常習地）における砂州上に発達した住居地区・工業地区及びマリンポンド
Tondo ↓	仮設住居地区
Binondo(CGSD)	旧マニラ中心街の繁華街に見られる商業地区と業務地区及び両者の混合地区

(3)　セミナー準備

セミナー準備として、以下の事項を実施した。

①　セミナープログラムの打合せ

②　会場の準備

③　テキスト、配布地図、その他セミナー参加者への配布資料の準備

④　スライドプロジェクター、オーバーヘッドプロジェクター等、機器類の点検設置

(4)　セミナー開催

セミナーに先立ち、日比両国の国家が吹奏され、ＮＡＭＲＩＡ、ＣＧＳＤ部長Feir氏の開会宣言に続いて、ＮＡＭＲＩＡ総裁 Solis氏、およびＪＩＣＡフィリピン事務所長宮本氏のあいさつがあり、地図製版原版（目録）が宮本所長から、ＮＡＭＲＩＡ Solis総裁に贈呈された。セミナーは、１月17日及び18日の２日間にわたり、ＮＡＭＲＩＡのFeir部長および Carandang氏の司会で行われた。冒頭に高崎団長から、セミナーの趣旨について説明があり、別紙プログラムの内容で順調にすすめられた。セミナー出席者は、マニラ首都圏地域の政府・民間関連機関から、ＮＡＭＲＩＡが選定した60名であり（別添参加者名簿参照）、今回整備された都市基本図の主要なユーザーである。両日にわたり講義の終了後に質疑応答と活発な討議が行われた。主な討議事項は別添資料の通りである。また、出席者全員に、サンプル地図およびセミナーテキストが配布

され、また終了時にはＮＡＭＲＩＡからの修了証が高崎団長を通じて授与された。

(5) セミナーの効果

全体的には、参加者の反応がよく質問内容もレベルの高いものが多かったことから、セミナーは十分な効果があったと考えられる。講義内容も、詳しいテキストを用意し、さらにスライドプロジェクター、オーバーヘッドプロジェクターを使用し、また壁面に多数の参考地図を掲示するなどして、ビジュアルなわかり易い説明を心がけたので、参加者に十分理解されたものと判断される。

(6) そ の 他

本件調査に関しＮＡＭＲＩＡは、今回ＪＩＣＡにより整備された地図、ならびに他の地図の印刷能力向上を目標に、印刷所の建設を進めている。しかしながら、ユーザーからの需要に十分対応できるだけの能力をもった印刷機は保有していない。したがって、十分な能力を備えた印刷機械の無償援助を日本側に期待している。また、調査区域の一部しか作成できなかった土地条件図等の作成区域を拡大するための技術援助ないし専門家派遣についての要望も提示された。

7．別 添 資 料

① セミナープログラム
② 主な討議事項の内容
③ セミナー参加者リスト
④ セミナー配布資料（MAIN TEXTBOOK 及び SUPPLEMENT(図式規定）を配布。MAIN TEXTBOOK のみ別添）

7．別添資料

① セミナープログラム

日　時　：1990年1月17日～18日

場　所　：ＮＡＭＲＩＡ講堂

1月17日（水）

10:00～10:50 ：日比両国国歌吹奏

開会の辞　（Feir部長(CGSD)）

ＮＡＭＲＩＡ代表挨拶　（Ｓｏｌｉｓ　総裁）

ＪＩＣＡ代表挨拶　（宮　本　所　長）

土地利用図、条件図原版の引き渡し（Solis 総裁、宮本所長）

10:50～11:00 ：休　　憩

11:00～11:50 ：プロジェクトの概要と都市基本図の特徴（高崎団長）

11:50～14:00 ：昼　　食

14:00～14:45 ：地形図、平面図の作成方法と見方・使い方（奥泉団員）

14:45～15:10 ：休　　憩

15:10～17:00 ：土地利用図の作成方法と見方・使い方（奥泉団員）

17:00～17:30 ：質疑応答と討議

1月18日（木）

10:10～11:50 ：土地条件図の作成方法と見方・使い方（鎌倉団員）

11:50～14:00 ：昼　　食

14:00～15:00 ：土地利用図の活用法（宇根団員）

15:00～15:20 ：休　　憩

15:20～18:15 ：土地条件図の活用法（赤桐団員）

18:15～18:35 ：質疑応答と討議

18:35～18:55 ：閉 会 式

ＪＩＣＡ調査団セミナー終了の辞　（高崎団長）

ＮＡＭＲＩＡ代表セミナー終了の辞　（Yambao副総裁）

修了証の授与（高崎団長、Yambao副総裁）

閉会の辞（Feir部長(CGSD)）

19:00～21:00 ：レセプション

招待状添付のプログラム

SEMINAR

ON

ESTABLISHMENT OF GRAPHIC INFORMATION BASE PROJECT OF THE NATIONAL CAPITAL REGION

* * * * * *

Date : 17 - 18 January 1990

Venue: NAMRIA LECTURE HALL
Fort Bonifacio, Makati, M.M.

Jointly Sponsored by: Japan International Cooperation Agency (JICA) and National Mapping and Resource Information Authority (NAMRIA)

M _____

This serves as an invitation

P R O G R A M O F S E M I N A R

17 - 18 January 1990
NAMRIA LECTURE HALL

17 January 1990, Wednesday

1000H - 1050H : Opening Remarks - Director, CGSD
Remarks - Administrator, NAMRIA
- Representative, JICA
Turn Over Ceremony of Map Reproducibles

1050H - 1100H : Break

1100H - 1200H : Outline of the Project

1200H - 1400H : Lunch

1400H - 1500H : Method of Preparation and Usage of Contoured & Planimetric Map

1500H - 1520H : Break

1520H - 1700H : Method of Preparation and Usage of Land Use Map

1700H - 1730H : Panel Discussion

18 January 1990, Thursday

1000H - 1200H : Method of Preparation and Usage of Land Condition Map

1200H - 1400H : Lunch

1400H - 1500H : Application of Land Use Map for Planning Activities

1500H - 1520H : Break

1520H - 1730H : Application of Land Condition Map for Planning Activities

1730H - 1800H : Panel Discussion

1800H - 1815H : Closing Ceremonies
Messages : Dr. Masayoshi Takasaki
Mr. Moriya Miyamoto
Administrator Jose G. Solis
Awarding of Certificates:

1820H : Reception hosted by JICA (NAMRIA LECTURE HALL)

EMCEE: Lt. (jg) Efren Carandang

② 主な討議事項の内容

（1月17日）

－地形図、平面図に関する内容－

Q：今回のシンボル決定は、フィリピン国の既存のものに従って行ったか？

A：1／10,000地形図については、フィリピン国スタンダード・シンボルとして、ＢＣＧＳと、協議を重ね設定した。他の地図については、マニラ首都圏地域のシンボルとして、ＢＣＧＳと協議を重ね設定した。

Q：作成後、どれくらいの期間で地図内容の改訂が必要か？

A：5年間くらいが適当と思われる。

Q：マニラ首都圏の地形図、平面図が、2年間で57面ずつ作成されたことについては、著しく速いと思われる。編集、製図の行程で、自動化が行われたのか？

A：とくに自動化は行っていない。

Q：この地形図に関し、いままでにフィリピン国で発行されてきた地図にないシンボルはあるか？

A：詳細は比較していないが、かなりあると思う。ひとつの例としては、温泉のシンボルが新しく造られた。温泉は、今回の調査対象地域内には存在しないが、近隣のラグナ州などに存在するため、将来その地域が地図化されることを考慮し、スタンダード・シンボルとして加えた。

Q：図化に使用した機械は何か？

A：WILDアビオリットBC-1、オートグラフA-7及びステレオプロッターA-8を使用した。

Q：空中三角測量の座標計算に使用した調整計算プログラムは何か？　また、計算結果の誤差はどうであったか？

A：バンドル法によるブロック調整法で計算を行った。誤差として、平面位置の基準点残差が、2乗平均誤差で0.78m、最大値で1.99mであり、高さの基準点残差は、2乗平均誤差で0.68m、最大値で2.94mであった。

Q：基準点の刺針は、どのように実施したか？

A：標定点及び水準点について、引き伸ばし空中写真を使用して刺針を行った。写真上で不明瞭な標定点については、偏心を行った。

－土地利用図に関する内容－

Q：マカティーの商業地区と比べて、サンパロックの商業地区をどのように区分したか？あるいは、業務地区と商業地区の区別は何か？

A：別添テキストに示されている、土地利用図のSYMBOLS AND SPECIFICATION に従い、区分されている。区分は建物の用途、機能及びそれらの占有率を考慮して決めている。これらの内容は比側と十分討議したうえで合意されたものである。

Q：色基準で、既存のフィリピン色基準を変えているところがあるか？

A：新しい地図シリーズなので、既存の色基準とは別に新しく決めた。

（1月18日）

－土地利用図に関する事項－

Q：フィリピンに最も適する土地利用図の縮尺はどれくらいか？

A：目的によって異なるが、マニラのような都市部では、1/1万程度が妥当であろう。
全土にわたって大縮尺の土地利用図は必要ない。1/10万～1/20万程度で十分だろう。

Q：土地利用図を使って、どのように被害を定量的に予測するのか？

A：日本では建設省などで、地形図、土地条件図を併用して被害想定を実際に行っている。マニラ首都圏地域においても、土地条件図と土地利用図を併用することによって、かなり具体的に浸水被害などの予測ができると思う。

－土地条件図に関する事項－

Q：土地条件図の活用は、洪水及び地震を主にして説明されたが、この地図は他の災害防止にも使えるか？

A：使える。冒頭に述べたように多様に使える。地盤沈下、山地崩壊、道路災害などの他、地下水探査、地域計画のための地域評価などにも有効であろう。

Q：土地条件図の作成に写真判読を使っているが、現地確認は行ったか？　また、データベースを使用したか？

A：判読と現地確認によって作成した。また、（データ・ベースは使わず）すべて人手によった。

Q：地表だけ扱っているが、地震などの被害、特に振動、液状化、居住適否、断層など、浅層地質に関係する事象を、確実に解明できるか？

A：基本的にはかなりできる。地形から相当解明できる。また今回の調査では、一部の地域には、簡易ボーリング調査も実施している。

－土地利用図及び土地条件図に関する事項－

Q：土地条件図、土地利用図を使って被害の見積りをしているか？　また、その方法は？

A：ＧＳＩではしていない。地図利用者のテーマである。しかし、定性的にはテキストでも説明してある通り、容易であり、定量的には各利用機関の目的によるであろう。既にいくつかの都市や河川流域などで、かなり実施されている。

－その他、全体に関する事項－

Q：４種類の地図は、空中写真（の情報）をもとにして作成されているとのことであるが、写真からだけではそれら詳細情報は得られないと思う。何かデータ・ベースを使用したのではないか？　また、これらデータは、実証されているのか？　そして、それらの更新はどうしたらよいのか？

A：データ・ベースは使用していない。地図に記載した情報はすべて空中写真上、あるいはまとめて整理し、これをもとにして編集した。また、編集にあたっては、現地調査や資料収集を行い、写真撮影後の変化についてもチェックするなどのことをしているので、現状に合っていると思う。情報内容の更新については、空中写真の新規撮影を定期的に実施し、加えて現地調査を行った上で、地図の原図を修正すべきである。またデータ・ベースは、これらの地図が作成されて（調査が完了して）初めて作成されるべきものである。

Q：調査にかかった経費はいくらか？

A：４年間の総額で約７億円であった。

Q：これらの地図は、NAMRIAのフォートボニファシオ販売所（NAMRIA本部ビル内）の他では購入出来ないのか？

A：その他にも、SAN NICOLAS 、MANILAの CGSD(COAST & GEODETIC SURVEY DEPPARTMENT)でも販売することになっている。

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SEMINAR FOR ESTABLISHMENT OF GRAPHIC INFORMATION BASE PROJECT OF NATIONAL CAPITAL REGION

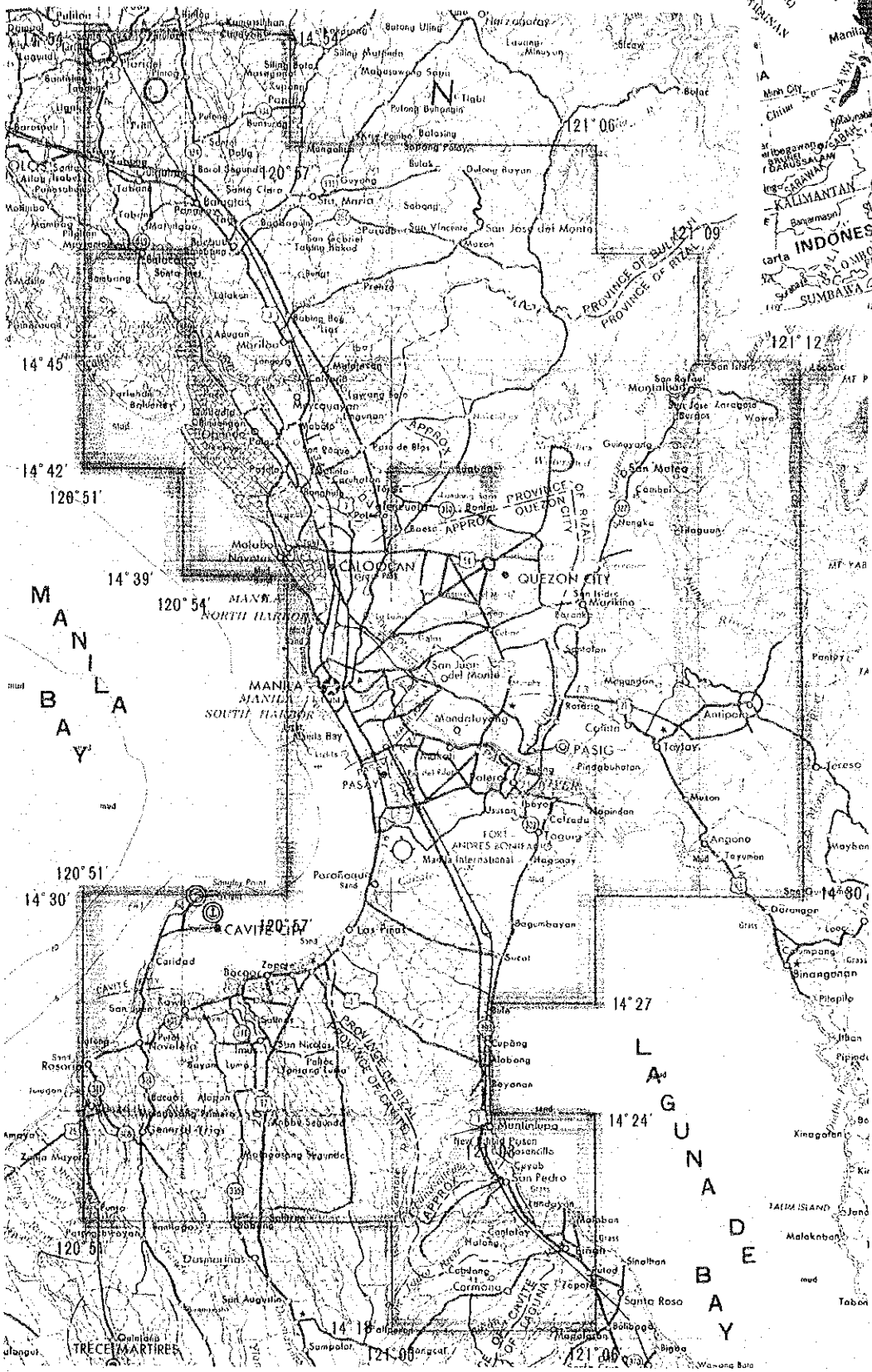
THE REPUBLIC OF THE PHILIPPINES

MAIN TEXTBOOK

MANILA, THE PHILIPPINES, DECEMBER, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

Location Map for Establishment of Graphic Information Base Project of National Capital Region



0 5 10 15 km

Contoured map :

Planimetric map

Land use map :

Land Conditi on map :

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I. OUTLINE OF THE PROJECT

Masayoshi TAKASAKI

Director General, The Japan Map Center

President, Japan Cartographer's Association

1. PROCESS OF THE PROJECT AND PURPOSE OF THE SEMINAR

The Philippine Government requested The Japanese Government in March 1984 for technical cooperation in urban base mapping of The Metro Manila Region.

In response to this request, The Japanese Government sent missions in 1985 to conclude Implementing Arrangement (I/A) in accordance with mutual consent by both governments.

On the basis of the I/A, Japan International Cooperation Agency (JICA) sent a survey team to conduct the urban base mapping in cooperation with Bureau of Coast and Geodetic Survey (BCGS). The entire survey and mapping work were completed in March of this year.

The variety of prepared urban maps in this project are as follows:

Contoured map :1,500 km² 57 sheets
Planimetric map :1,500 〃 57 〃
Land use map : 823 〃 33 〃
Land condition map: 476 〃 16 〃

(See Fig. I - 1, I - 2 and I - 3)

Note:

1) Mapping scale is 1:10,000 in all maps mentioned above.
2) Number of copy for each sheet is 1,000 in all maps mentioned above.

The seminar is to be held to explain the method of preparation as well as how to read and use for these map-series, expecting that those are used effectively for urban planning ,disaster prevention planning, etc. in the National Capital Region.

2. CHARACTERISTICS OF THE FOUR KINDS OF MAP

The urban base maps are composed of the four kinds of map, i.e. Contoured Map, Planimetric Map, Land Use Map and Land Condition Map (mapping scale is 1:10,000 respectively, above mentioned)

The contoured and planimetric maps have been furnished early 1987 and already utilized widely. The land use and land condition maps were completed in March 1989.

The method of preparation, how to utilize, etc. for those four kinds of map will be explained later in detail by four panelists after my lecture. Therefore, I would like to explain what kind of characteristics each map has and why those four kinds of different map are required as urban base maps.

The contoured (topographic) map is utilized not only for studies and plannings but also as a base map for preparation of all other kinds of map. The contoured map in the scale of 1:10,000, prepared in this project, were developed precisely as a 5-colour printed map based upon geodetic control point survey and aerial photogrammetry in which the topography is expressed by 2 meter-interval contour-line (4 meter-interval in the mountainous area) and drainage system, urbanized area, communities in the suburbs, road, railroads, vegetation, etc. are also shown in detail.

The planimetric map was developed as a 2-colour printed map from the contoured map by removing the contourline and colours for watersphere, etc. It is expected that this map is to be used as the base map for the purposes of measuring and designing.

The land use map is a 7-colour printed map developed based upon the 1:10,000 contoured map expressing actual use of lands and buildings

The circumstances of land use in the rural area are fairly recognizable even in the contoured map. However, in the urban area, it is difficult to obtain from the contoured map what kind of usage and function they have in the congested building/housing area.

In the land use map, those usage and functions of the built-up and congested urban area are classified by different colours. The land use even in the suburbs are much more recognizable than the one in the contoured map or planimetric map.

The land condition map is a new map, so the users might not become familiar with it. The land condition map is a 12-colour printed map developed by employing the 1:10,000 contoured map as base map, showing detail classified landform units, micro-relief in the lowland as well as the locations of facilities related to disaster prevention and land development.

The landform classification was made in order to know where is susceptible or not susceptible to disasters such as flooding, earthquake, etc. Roughly speaking, the area coloured in pale blue and green in the map are susceptible to the disasters, while the area in yellow and orange are mostly safe from the disasters. The ground heights, therewith, are shown in detail, which were obtained by the additional direct-levelling, in the lowland in blue or green situated along the coastal area or around the lower part of rivers.

Furthermore, the pubulic facilities related to disaster prevention or land development and useful facilities for the evacuation and rescue during calamities, such as hospitals, churches, schools, etc., are expressed in this map.

3. USAGE OF THESE FOUR KINDS OF MAP

The contoured and planimetric maps are the most basic maps among them, showing precisely the patterns of land configulation, drainage systems, etc. as well as the locations and figures of the buildings, roads, etc. These maps are widely available for various studies and plannings as basic data.

And these maps are important as basic maps or background maps on which the result of surveys or new plans are able to be drawn. In the course of this mapping project, the land use and land condition maps were prepared by using the contoured map as the base map. In addition, the contoured and planimetric maps may be utilized as base maps for various purposes depending upon the users such as

urban planning, road planning, river planning, disaster prevention planning and so on. The contoured and planimetric maps prepared in this time are able to satisfy the requirements in the plenty of studies and plannings, as they were developed according to precise geodetic control survey, aerial photogrammetry and field identification.

The land use and land condition maps are, in recent days, indispensable thematic maps as for urban planning and disaster prevention planning.

If assumed a man's body, the land condition map could be physique and constitution, then the land use map could be the costume or life-style of the man. If the physique/constitution and costume/life-style match together, he would feel comfortable and behave efficiently. However, in case one does not harmonize with the other, he would feel uncomfortable and behave inefficiently.

It is possible to know good use and miss use in a certain area by means of reading these two maps together.

Namely, in the land condition map it is possible to judge the susceptibility of the area to disasters, recognize ground-heights, infer the stability of earth as well as know the existance of facilities for disaster prevention and/or evacuation. While in the land use map it is knowable that how lands are utilized, what kind of usage and function the buildings on the lands have.

By comparing the both maps, not only checking of the suitability of present land use, but also selecting of the area where future improvement is necessary, the area suitable for development and the area where appropriate disaster prevention facilities are required, are able to be conducted.

As mentioned above, it is convinced that these four kinds of map, prepared as the urban base maps in The Metro Manila Area, will contribute greatly, being connected with each other, to the synthetic urban planning and disaster prevention planning in the area.

Metropolitan Regions in Japan, such as Tokyo, Nagoya, Osaka, etc., are situated at the mouth of rivers inside bays. These circumstances resemble those in Metro Manila Area. And those areas are quite similar with Metro Manila Area for

their possiblity of calamity of floodings from time to time caused by typhoons and susceptibility of earthquakes.

In these Metropolitan Regions in Japan, the topographic map, land use map, land condition map, etc. have been alresdy furnished to be utilized for urban planning, disaster prevention planning and so on. Then a great deal of effectiveness has been brought by these maps.

It is cordially anticipated that the urban base maps prepared in this time contribute widely to the future developing plans, redeveloping plans, disaster prevention plans and so on.

4. ACKNOWLEDGMENT

I wish to thank sincerely the officials of BCBS (present; Dept. under NAMRIA) to have cooperated deeply with us in this mapping project over four years in Manila and Tokyo. I would also like to thank other officials of Philippine government who helped us kindly access to the relevant informations.

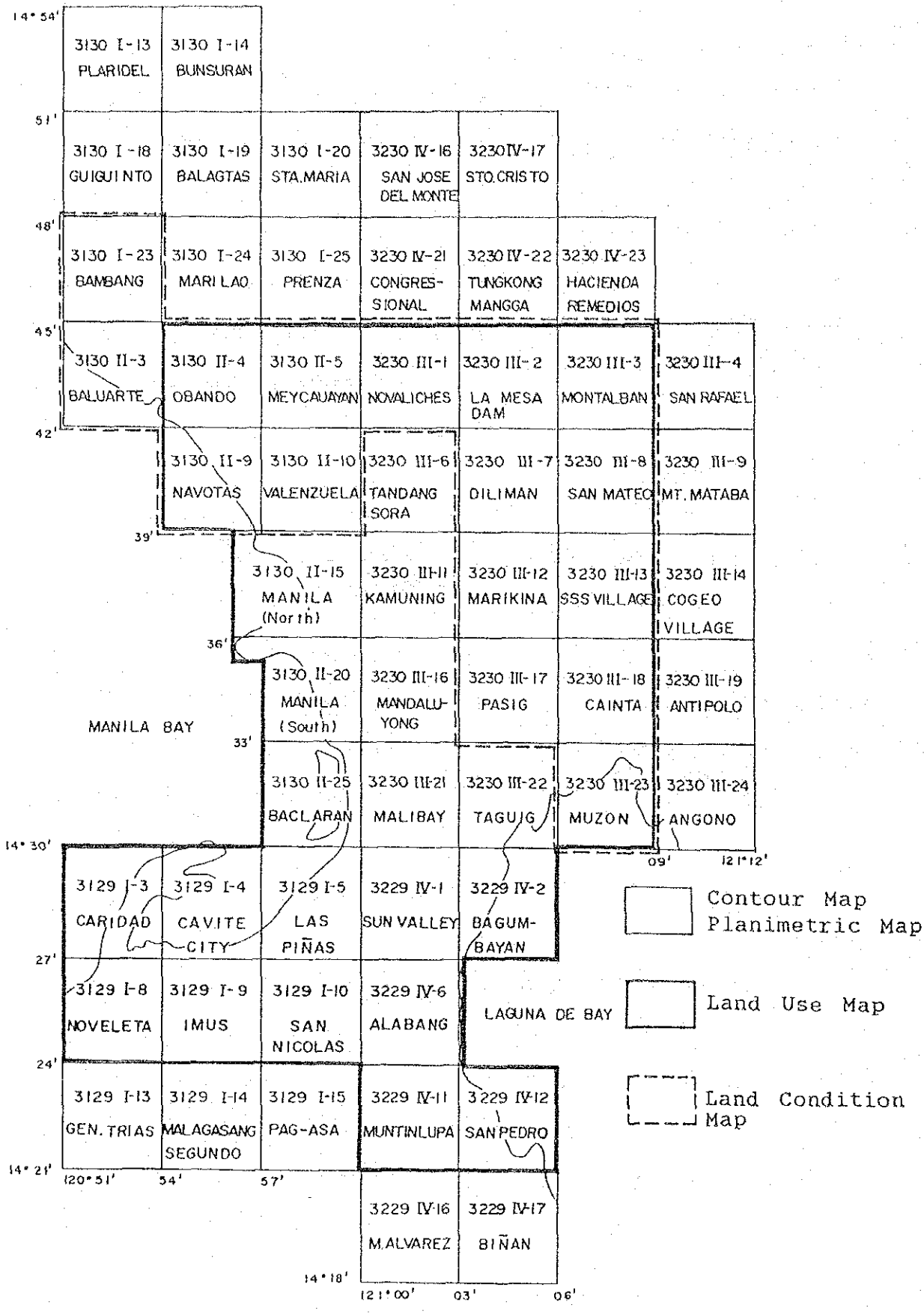

Fig. I - 1 Sheet Name and Number Index

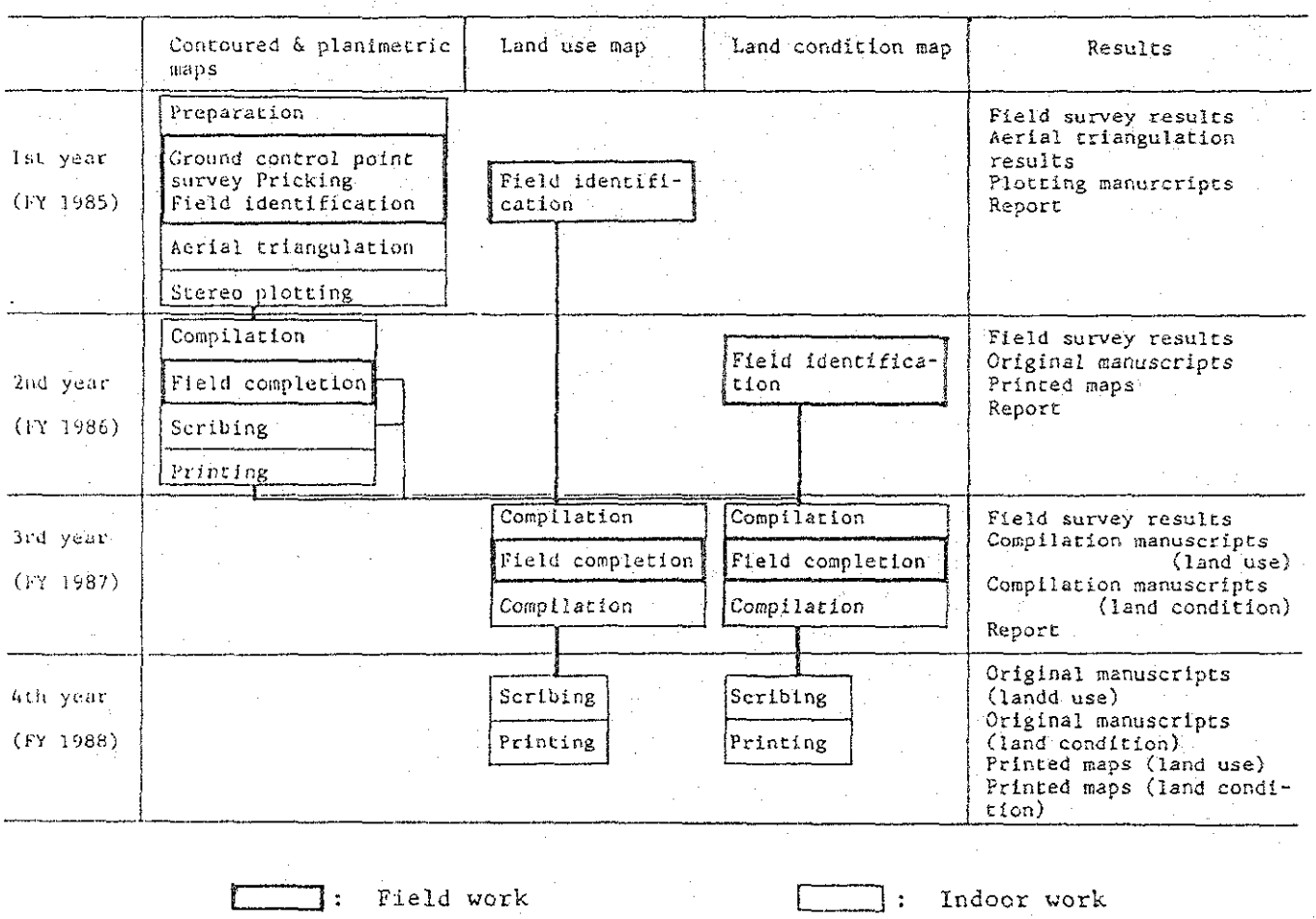

Fig. I - 2 Work Flow of Metro Manila Unban Base Mapping

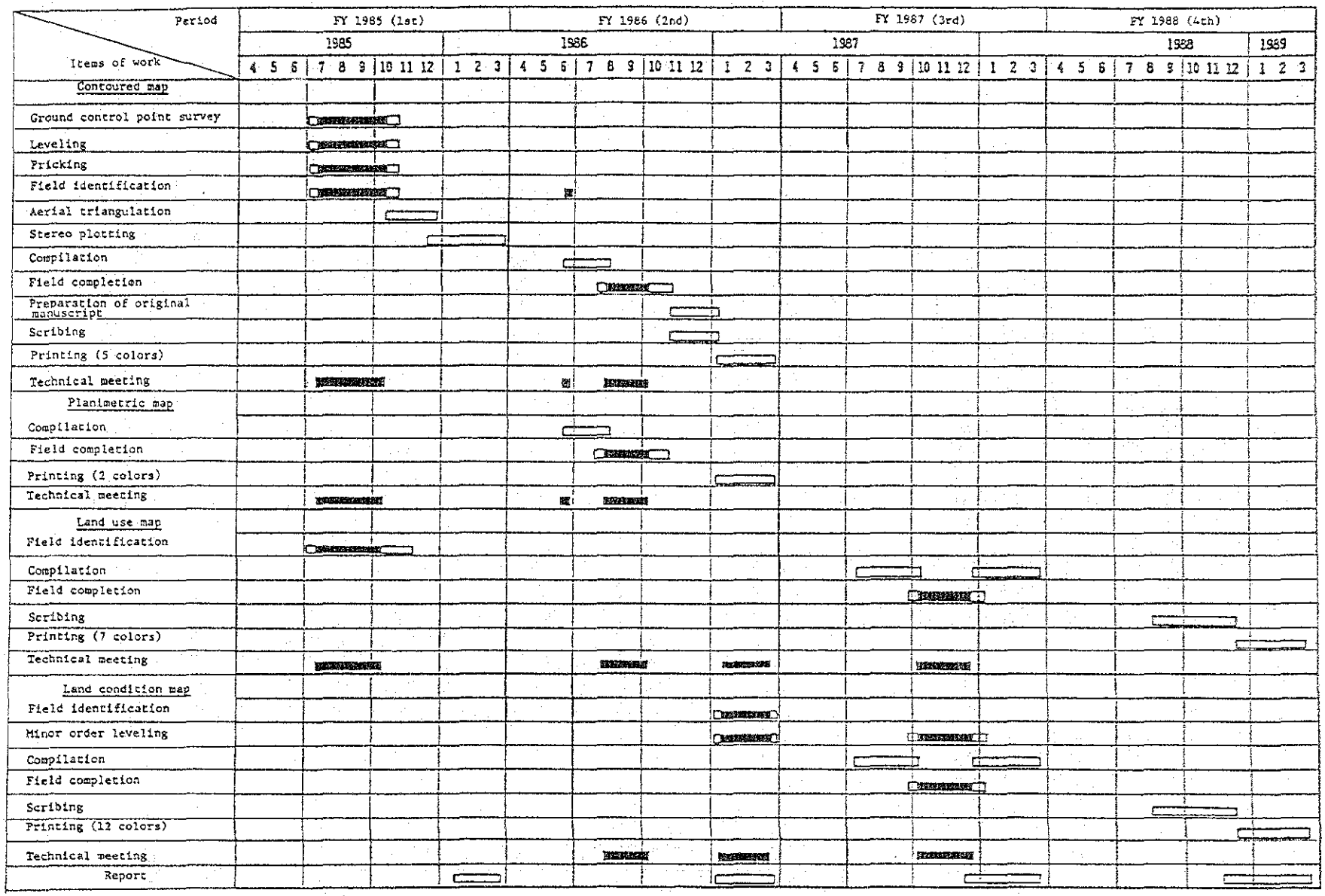

Fig. I - 3 Work Schedule

II. CONTOURED AND PLANIMETRIC MAP

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1. METHOD OF PREPARATION

1-1 Outline of Work

1-1-1 Outline of Work

The 1:10,000 contoured map was prepared using the existing 1:32,000 aerial photographs taken in 1982 by the Philippine side, and the planimetric map was also prepared using the contoured map as the base for the use of designing and planimetry. The field work and technical discussions were conducted in collaboration with BCGS. During the course of such work, technical transfer was also conducted.

The work flow is shown in the following

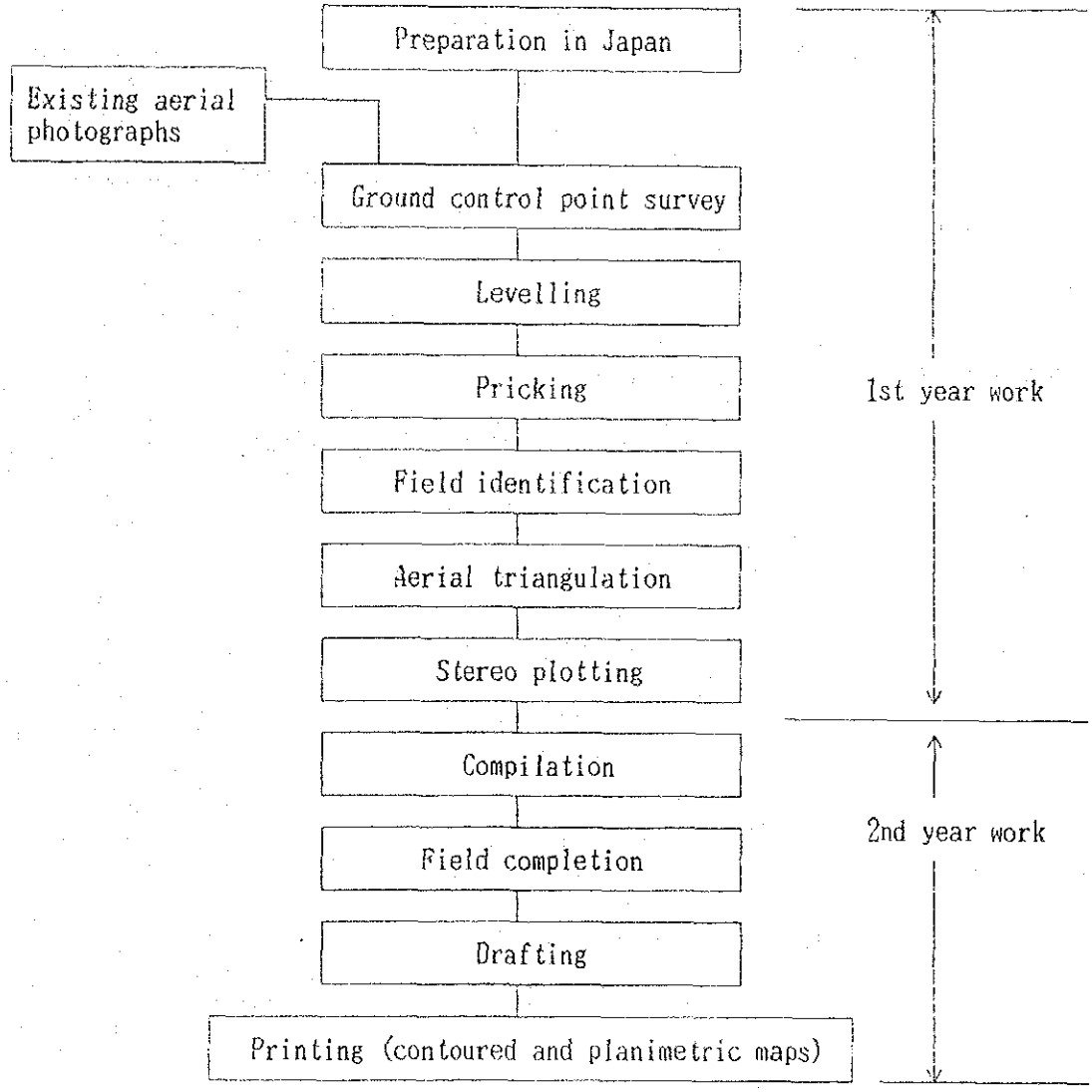

Fig. II-1 Work Flow of Contoured and Planimetric Mapping

1-1-2 Design of Symbols

For the designing of Metro Manila contoured and planimetric map symbols, the following principles were taken into consideration:

(1) Both maps will be urban base maps which are basic materials to be used by national and public organizations for the development, preservation etc. of Metro Manila region.

(2) Symbols will be prepared for the contoured map and the planimetric map respectively.

1) The coutoured map symbols are to be constructed for multi-purpose usage representing topography, river system, cities and towns, villages, roads, railways, administrative boundaries, geographical names etc. in detail on the basis of surveying and aerial photogrammetry.

2) The planimetric map symbols are to be constructed employing two colours for planning/designing which are complied from the contoured map.

(3) Characteristics of printed contoured and planimetric maps

Categories	Contoured map	Planimetric map
Ground contorl point	Black	Blue (spot heights are not shown.)
Boundary	Black	Gray
Road	Blackish blue	Gray
Railway	Black	Gray
Building	Brown	Gray
Function symbol	Blue	Blue
Area	Blackish blue, green, black	Blue, gray (base colours are not shown.)
Small feature	Blue, brown, blackish blue	Blue, gray
Water body	Blue	Blue (base colours are not shown.)
Vegetation	Blue, green	Gray (base colours are not shown.)
Deformed land	Black	Not shown
Contour line	Black	Not shown
Depth curb	Black	Not shown
Annotation	Blue, black	Blue

1-2 Utilization of Aerial Photographs

1-2-1 Outline

The aerial photographs necessary for field identification and mapping work of the contoured map were prepared by using the negative films taken in 1982 by BCGS. For the field completion, the aerial photo maps prepared in 1986 by the Philippine side were utilized.

2-2 Aerial Photographs

(1) Aerial photographs taken in 1982 by the Philippines (see Fig. II-2)

1) Camera	:	RMK-A
2) Photographing altitude	:	16,050 - 16,720 ft.
3) Focus length	:	152.85 mm
4) Scale	:	1:32,000
5) Time of photography	:	February - April, 1982
6) Overlap	:	80 - 90 %

(2) Aerial photo map prepared in 1986 by the Philippine side

1) Scale:	1:10,000

1-3 Ground Control Point Survey

1-3-1 Outline

Ground control point survey was carried out to establish photo-control points which are to be used for aerial triangulation and stereo plotting. (see Fig. II-3)

1-3-2 Accuracy

Relative accuracy: More than 1:25,000

1-3-3 Operation

(1) Particular attention was paid on selection of new points as follows:

- To be easily identifiable on the aerial photos for pricking,
- To be permanently monumented in suitable condition and

To be constructed without danger.

(2) The monumentation was conducted according to the BCGS specifications. (see Fig. II-4)

(3) Observation

Distance measurement, horizontal and vertical angle observation and levelling were conducted for obtaining the coordinates of each new control point. The instruments employed were as follows:

① Distance measurement (Distance-meter)
Rangemaster III
Hewllet Packard 3808A
② Angle observation (Theodolite)
WILD T2
WILD T3

and a part of work was operated by Philippine side.

1-4 Levelling

BCGS re-surveyed and revised approximate 300 km of existing levelling route. JICA team received and verified the revised levelling data and conducted pricking.

1-5 Pricking

Existing triangulation points, newly established ground control points and vertical control points were pricked on aerial photographs in order to be used for aerial triangulation and stereo plotting.

1-6 Aerial Triangulation

1-6-1 Outline

Aerial triangulation was conducted to obtain geodetic coordinates of pass and tie points necessary for stereo plotting based on the results of ground control points and levelling points. Adjustment was based on the block adjustment method. (see Fig. II-5)

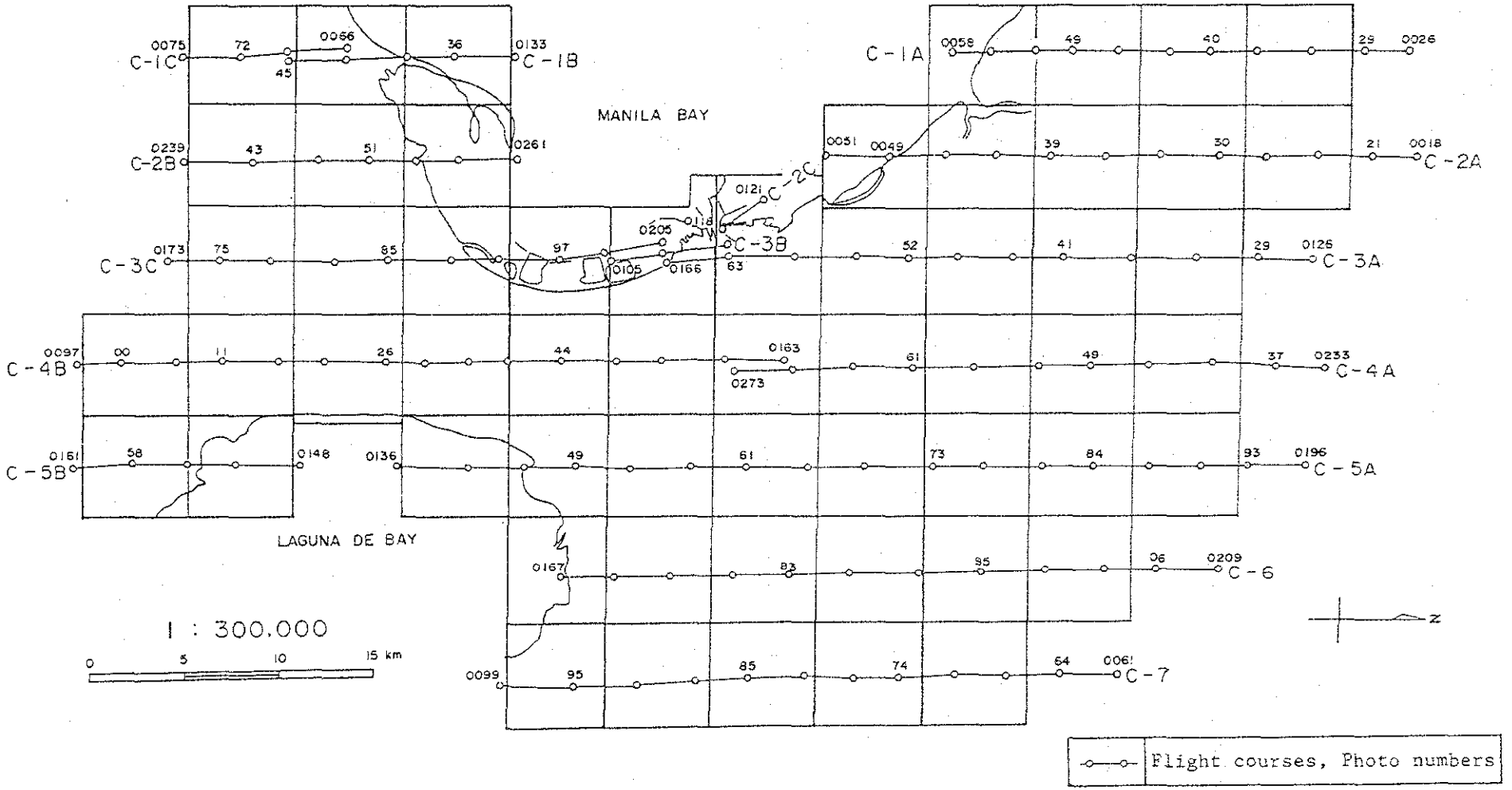

Fig. II- 2 Index Map of Aerial Photography taken by BCGS in 1982

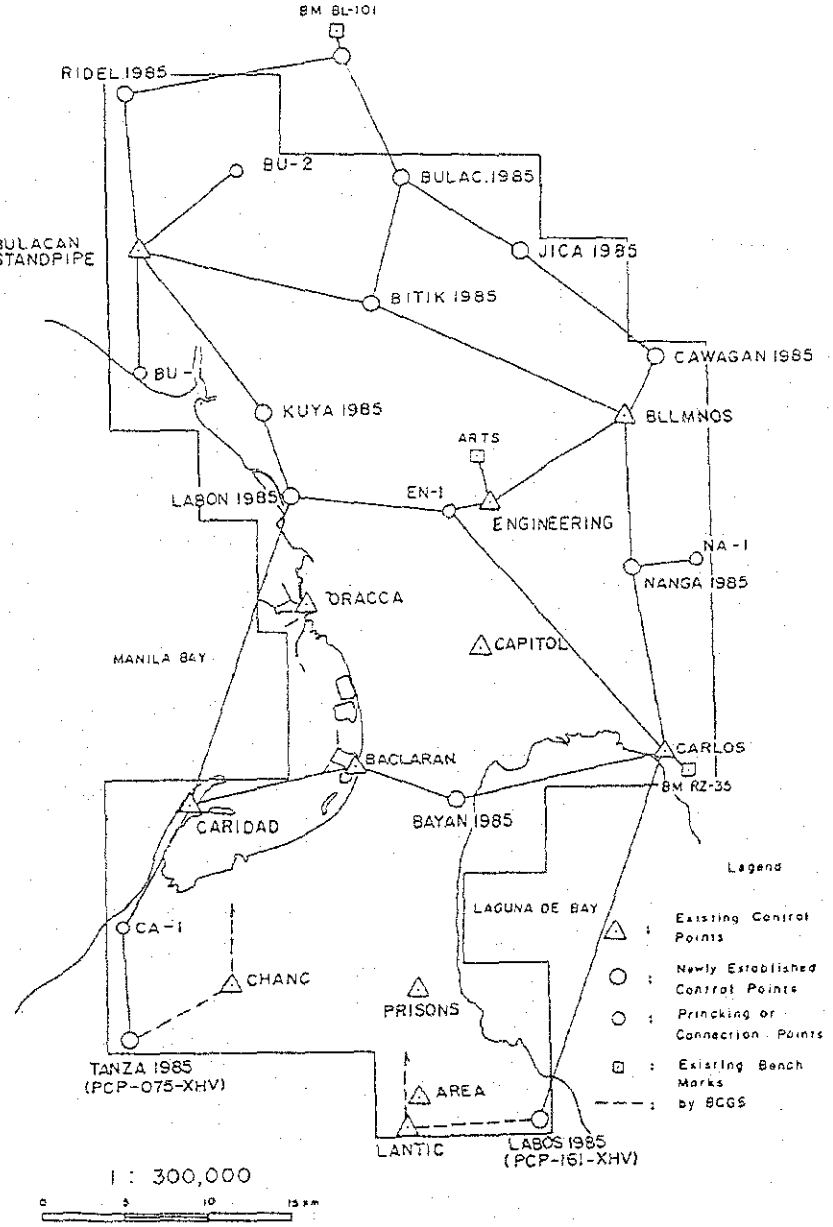

Fig. II- 3 Network of Ground Control Points

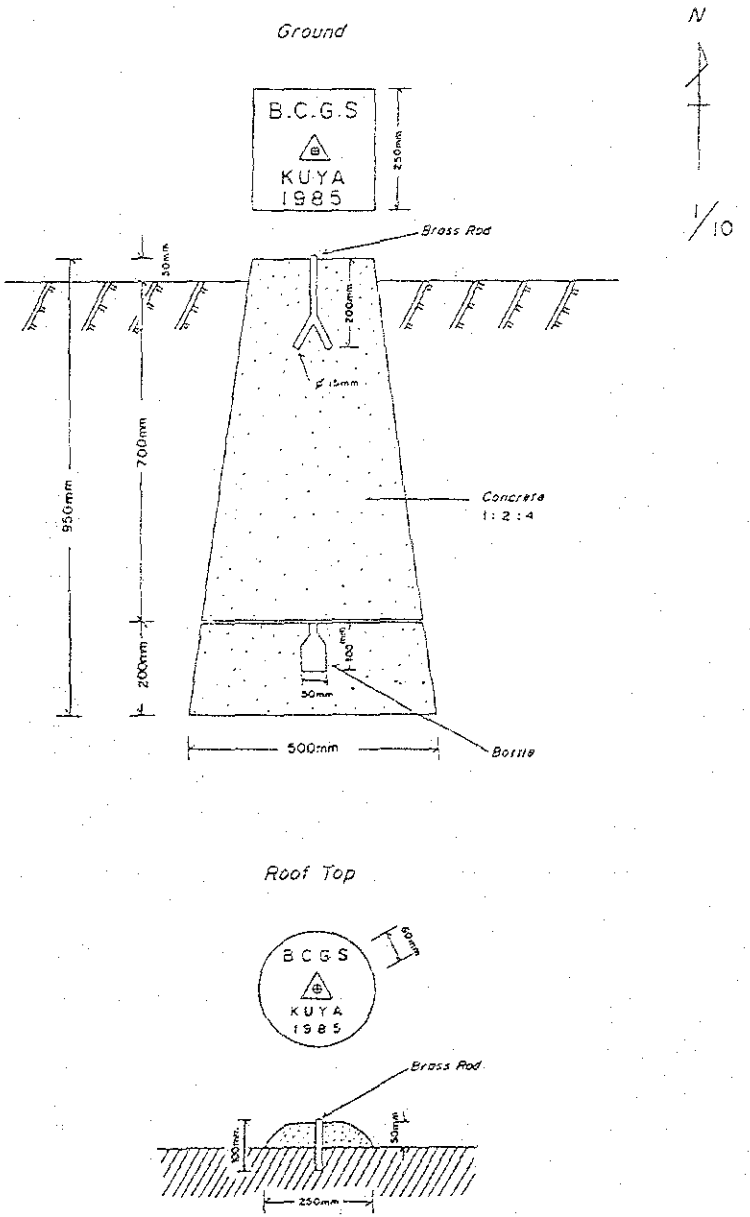

Fig. II- 4 Monumentation of Ground Control Points

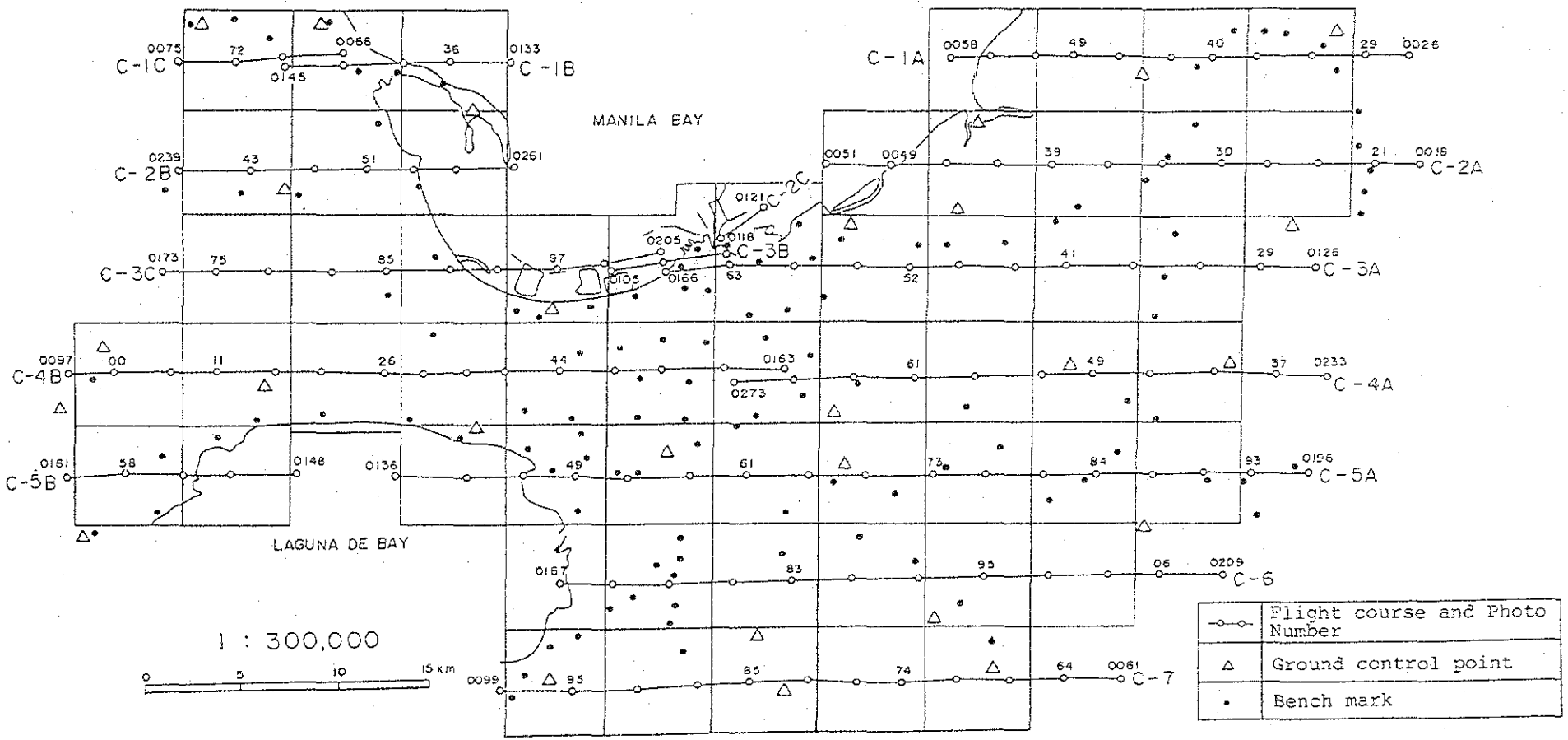

Fig. II- 5 Index Map of Aerial Triangulation

1-6-2 Specifications

(1) Specifications

Photo scale	:	1:32,000
Number of courses	:	10 courses
Number of models	:	123 models

(2) Instruments

Pricking device	:	PUG－Ⅲ・Ⅳ (Wild)
Coordinate mesuring device	:	STECOMETER (ZEISS JENA)
Cumputer	:	ACOS 350 (NEC)

1-7 Field Identification

1-7-1 Outline

The field identification was conducted for verification of various features, geographical names, etc. to be represented on the 1:10,000 contoured map. The results were incorporated on aerial photos and reference materials.

1-7-2 Preliminary Photo-interpretation

The preliminary study was conducted in Japan using the existing 1:50,000 topographic maps, guide maps, tourist maps, etc. Public facilities, parks, historical monuments, etc. were marked on aerial photos. Survey area to be asigned to each operation party, survey routes, etc. were also studied.

1-7-3 Field Work

(1) Based on the results of preliminary study, the field work was conducted, based on the Symbols and Specification for Metro Manila Contoured Map, with regard to unidentified features, road widths, function symbols, building names, small landmarks, vegetation, etc.

(2) Keys for interpretation were prepared to unify the representation of fetures.

(3) Views of the Philippine counterparts were taken into consideration for function symbols, annotations, etc.

(4) When there was no space for names, annotations, etc. on the photographs, a list of annotation was prepared.

(5) Main items for identification are as follows:

1) Roads : Grades, structures of sidewalks, separate zone, etc., widths
2) Railways : Single track, double track, siding, crossing with road
3) Buildings : Classification of independent or generalization in accordance with the map symbol specifications, and selection of annotations and symbols for buildings.
4) Specified areas and small land marks: Names, areas and positions.
5) Rivers : Major rivers, routes and structures of main drainage canals.
6) Vegetation: Those not clearly identified by aerial photograph, vegetation boundaries.
7) Topography: Depressions, cliffs, rocks, banks, cuttings, etc., which are difficult to identify.

1-7-4 Items Surveyed by BCGS

As a result of technical meetings with BCGS upon the completion of the field survey, the following items were surveyed by BCGS.

(1) Effective clearances of overpaths, grade separations, bridges, tunnels, etc.
(2) Administrative and geographical names, administrative boundaries.
(3) Names of roads, rivers, bridges, railways, railway stations.
(4) Wrecks, sewerage outfalls, reefs, lighthouses.
(5) Depth curves of Manila Bay.
(6) Edit of annotations, names and function symbols.
(7) Expression of defense facilities.
(8) Road surface classification .
(9) Classification of 6 different plantations.
(10) Temporary housing area.

1-8 Stereo Plotting

1-8-1 Outline

Based on the result of ground control points survey, levelling, aerial triangulation, etc., protted sheets were prepared by stereo plotter.

1-8-2 Specifications

Mapping scale	:	1:10,000
Coverage	:	1,500 km² (57 sheets)
Contour line	:	Intermediate contour 4 m
		Index contour 20 m
		Auxiliary contour 2 m (flat area)
Plotting instruments:		Autograph A-7, Stereoplotter A-8
		Metrograph, Aviolyt BC1
Projection	:	UMT
Sheet lines	:	EW 3' X NS 3'
Plotting sheet	:	Polyester base #500
Plotting	:	High-speed automatic plotting machine
Accuracy	:	Planimetry; A class (±1.0 mm)
		Vertical; B class (spot height $\Delta h/3$)
		(contour line $\Delta h/2$)

Δh: contour interval (Intermediate contour 4 m)

1-8-3 Stereo Plotting

(1) Plotting

1) Based on field identification results, machine plotting was carried out in order to draw roads, rivers and railway, building, vegetation and contour lines in those order.
2) Plotting was conducted in accordance with the map symbols and application discussed and agreed between Japan and the Philippines.
3) Generalization was applied for the area where more than 70% of the area was occupied by structures. In case less than 70%, the areas were plotted as congested area representing individual buildings and partitions of houses.
4) Temporary housing areas were plotted based on field identification data supplied by BCGS.
5) The minimum unit for indication of spot height was 0.1m. The distribution interval of the spot heights were approximately 5 cm on map.

1-9 Compilation

1-9-1 Outline

Based upon the plotting manuscripts, results of the field identification and related data as well as according to the Symbols and Specifications for Metro Mnila Contoured Map, compilation manuscripts and other source maps necessary for the subsequent work (drafting and pricking work) were developed.

1-9-2 Compilation

(1) Compilation manuscripts were made based upon the JICA specifications and the Symbols and Specifications for Metro Mnila Contoured Map 1:10,000.

(2) Compilation was made on ovelay-sheets. Planimetric features and contour lines were drawn on the same sheet.

(3) Ground control point data sheet, annotation data sheet and road annotation data sheet were prepared.

1-10 Field Completion

1-10-1 Outline

In the field completion, checking and correction were made on important items regarding topography, land features, annotations and function symbols to be expressed on the compilation manuscripts as well as on uncertain items unable to confirm during the compilation work. Further, supplementary survey was conducted on major changes after aerial photography.

1-10-2 Feild Work

(1) For the field completion, the compilation manuscripts and their copies were brought to the project area for checking and confirmation.

(2) As for major changes after the photography, the outline of changed feature was surveyed by traversing and plane table survey and supplemented on the copy of the compilation manuscripts using 1:10,000 aerial photos taken by Philippine side in 1986.

(3) Boundaries of temporary housing area, park, cemetery and military facilities were also confirmed.

(4) As for the Light Rail Transit, plotted based on the data of the field identification, checking and confirmation were conducted.

(5) Starting points and destinations of main roads as well as abandoned railway were confirmed.

(6) The classifications of road surface and administrative were confirmed.

1-11 Drafting

1-11-1 Outline

Scribing was done for each colour using completed compilation manuscript to develop original drafting manuscript.

1-11-2 Preparation of Scribed Sheet

(1) Image printing on scribing base

Scribe plates were prepared by photo-processing of scribing base coated with diazo solution, on which the reversed image of the original manuscript were printed.

(2) Preparation of scribe plates

Scribe plates were developed respectively for each colour in accordance with the specification of map symbol and specifications covering roads, railways, buildings, rivers, contour lines, longitudinal and latitudinal lines, etc.

(3) Preparation of mask plates

Mask plates were prepared as vegetation boundary sheet by employing peel-coat.

(4) Preparation of zip-a-tone sheet

Zip-a-tone sheets for crop land, rice field, broadleaf, etc. were prepared.

(5) Preparation of marginal information sheet and annotation sheet

Marginal information sheets were developed, based upon the sample sheet decided through a series of discussions between both sides, with polyester base using photo-lettering for representing common items of marginal information and compiling legend, diagram, etc..

1-12 Printing

1-12-1 Outline

Printing of the contoured maps was performed by off-set method of multicolour printing. Planimetric maps were printed by combining two colours of plate separation which were produced for the printing the contoured map.

As printing is the final stage of the entire work, proof prints were prepared to make the in-office quality inspection and BCGS checking for securing perfection in prior to the final printing.

1-12-2 Printing of Contoured Map

(1) Preparation of printing plates

Scribe plated, mask plates and annotation plates were developed for each of five colours (black, blackish blue, brown and green) by multiprinting of scribed bases on aluminum PS sheets.

(2) Preparation of proof prints

Proof prints were prepared for each of five colours by using two-colour lithographic printing press.

1-12-3 Printing of Planimetric Map

(1) Preparation of printing plates

Scribe plates, mask plates and annotation plates were combined by multi-printing into 2-coluor (black and blue) separation plates.

(2) Preparation of proof prints

Proof prints using 2 colours were prepared by 2-colour lithographic printing press.

1-12-4 Inspection (Proof Prints)

Inspection was carefully conducted to check whether the results of printing met the specifications or not, regarding colour tone, meeting points between differently coloured lines, etc. by using the proof prints. Also, those were checked by the BCGS chief counterpart and Surveying Technical Center of Japan Surveyors Association (an orthorized public inspection organization of Japan).

1-12-5 Printing

The printing of the contoured map (5 colours) and planimetric map (2 colours) was conducted by off-set method using each colour separation plate.

1-13 Inspection of Results

(1) Using surprints, the final inspection was made by the surveying Technical Center of Japan Surveyors Association.

(2) After the printing, the whole printed copies of contoured and planimetric maps were also inspected by the Survey Technical Center.

Ⅲ. LAND USE MAP

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1. METHOD OF PREPARATION

1-1 Outline of Work

1-1-1 Outline

The land use map is a multi-colour map showing detailed classification of the existing land use, presented on the 1:10,000 base map. This will be used as a basic information of survey and planning for upgrading of land use.

The work flow is shown as follows:

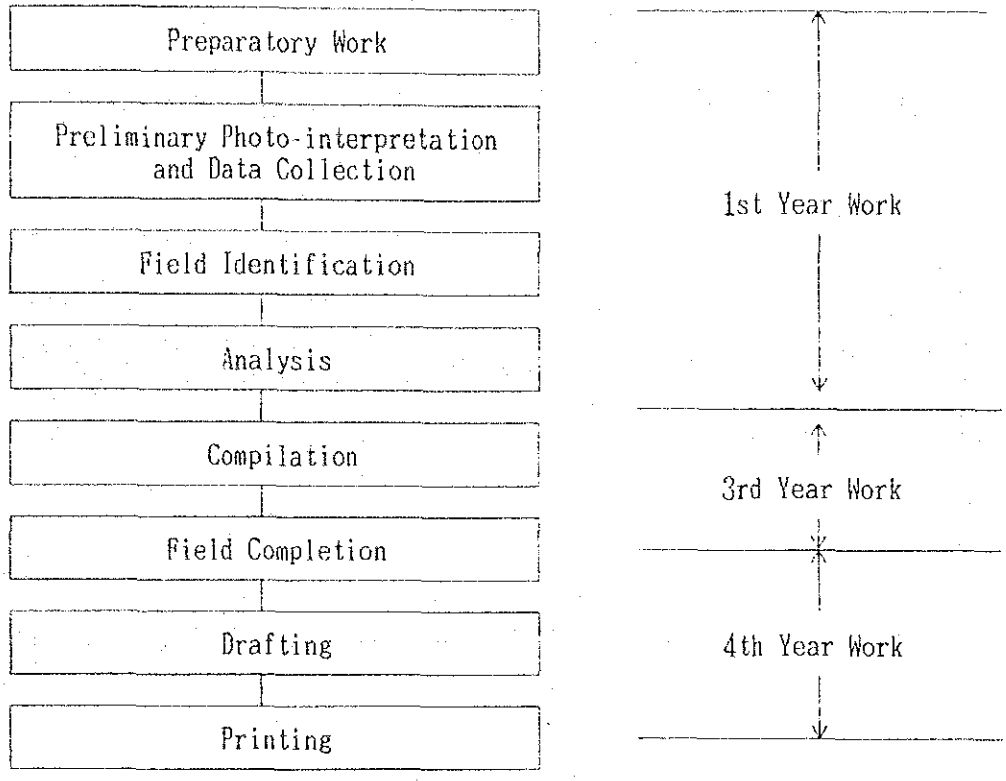

Fig. Ⅲ-1 Work Flow of Land Use Mapping

1-1-2 Preparation of Symbols and Specifications

With regard to preparation of symbols and specifications, the following items were considered.

(1) Symbols and specifications shall be applied as a basic information for upgrading and developing project in Metro Manila area such as land development and preservation, disaster prevention, city planning, etc.

(2) On the basis of the object mentioned above, the existing land use of entire area shall be classified into minimum homogeneus land without exception.

(3) It shall be considered that there is difference in the regional land use characters such as built-up area, forest and farm area, water surface and others.

(4) In three (3) or more story tenanted building, where usage of each floor is different from others, the category "Mixed" shall be applied in the classification.

(5) For consideration on the selection of the colour to make land use features more identifiable, reddish brownish shall be applied for built-up area, greenish shall be applied for park, forest, etc.

(6) Topographic feautres printed on the base map shall be identified together with land use.

1-2 Preparatory Work in Japan

1-2-1 Preparation of Criteria for Compilation and Review on Symbols and Specifications

On the basis of the drafted symbols and specifications mentioned in the Implementing Arrangement (I/A), categories for classification of lands and buildings, definitions and applications were studied. Consequently detailed draft of symbols and specifications were prepared.

1-2-2 Preliminary Photo-interpretation

(1) Preliminary photo-interpretation at the time of field identification was conducted based on the aerial photographs taken in 1982.

(2) Uncertain items found in the course of compilation work as well as items to be confirmed in the field were marked.
Changes in the large-scale land use, the artificial deformation due to housing development, etc. were marked by referring to aerial photomaps made in 1986.

1-3 Field Identification

1-3-1 Outline

In conducting field identification for land use map, the draft specifications prepared by the Japanese side based on the land use classification scribed in the I/A were discussed with BCGS. Based on the results of discussions, the present land use was surveyed and classified.

1-3-2 Field Identification

The field identification for land use was conducted in parallel with that for contoured mapping, taking the results of preliminary photo-interpretation conducted for contoured mapping into consideration. As the survey covered the built-up section of the Manila metropolitan area, a detailed land use classification had to be employed. Field identification was carried out by carrying the classification key prepared on the basis of the map specifications.

Virtually no problem was encountered in residential areas, identifica however the identification of the use of buildings of two stories or more in commercial-residential areas and in industry-residential areas proved to be difficult, as almost all the buildings in these areas were being used for multiple purposes. It was also difficult to recognize the status of usage of those area. It was also difficult to know real land use of the areas enclosed by fence, wall etc. Those area were surveyed by means of interviewing conducted by BCGS counterparts.

The land use patterns were classified on the aerial photographs which were checked with the results of field identification for the contoured map.

1-4 Compilation

1-4-1 Outline

The compilation manuscripts for the land use map were prepared on the basis of the survey results in accordance with symbols and specifications.

1-4-2 Compilation

The compilation manuscripts of the land use maps were prepared from the base map on which the land use boundaries and land use classification symbols were plotted. The work was conducted based on the symbols and specifications using aerial photographs on which the results of the field identification were incorporated.

1-4-3 Items of Compilation

(1) Land use boundary

(2) Classification Symbols

1-4-4 Utilization of Contoured Map and Aerial Photographs

In the later part of the 1st year and 2nd year work, the symbols and specifications for the land use maps were partly corrected. Therefore, some of the classification symbols plotted on the aerial photos used for the field identification did not correspond to those of the specifications. Furthermore, changes after aerial photography had not been corrected. Thus, in the compilation, the items possible to be corrected were compiled using the contoured map and the aerial photos, and other items to be surveyed in the field completion were marked on the manuscript copies.

(1) Utilization of contoured map

As to the contoured map, stereo-plotting were conducted on the basis of the aerial photographs taken in 1982 and the changes after aerial photography were corrected in the field completion in September 1986.
Among the classification items for which the symbols and specifications were changed after the field identification for land use map (conducted in 1985), those items already surveyed in the contoured mapping were classified on the basis of the contoured map.

(2) Utilization of aerial photographs

It is so important for the land use map to present the state of detailed land use such as small-scale housing development for that the correction was made for even small changes of area, unlike for the case in contoured mapping. Aerial photomaps (1/10,000) made in 1986 by the Philippine Government were utilized for selecting the changes of features to be corrected and for plotting them on the manuscripts.

1-4-5 Details of Compilation

(1) The vegetation boundaries printed on the surface of base map were used for plotting land use boundaries.

(2) Land use boundaries were plotted as follows:

1) Distinct land use boundary ———— solid line

2) Under construction, artificial deformation - - - - - - - - broken line

(3) Where land use boundary lines coincide with double line roads, alleys, railways, canals, embankments, revetments, salt beds, marine ponds, tops of landslides, walls and fences, etc., the land use boundaries were deleted.

(4) At the toe of landslide, cut and banked-up slope, land use boundary was delineated if necessary.

(5) Only the area presented as temporary housing on the contoured map was presented as temporary housing area.

(6) Land use boundaries in the generalized area were delineated by tracing method, using aerial photomaps (1986).

(7) Land use boundaries in the built-up area was delineated following the outline of building presented on the base map as much as possible.

(8) Narrow foot-path and water way running between marine ponds or salt beds distributed in the coastal lowland were included in the marine ponds or salt beds.

(9) In the compounds of parks or schools, facilities with different usage were classified according to each usage.

(10) Double line road was not coloured.

1-5 Field Completion

1-5-1 Outline

The field completion was carried out for the classification of questionable matters brought out in the compilation of manuscripts as well as for the confirmation of classification items which might be revised according to change of classification criteria.

1-5-2 Field Completion

Uncertain items and other items to be verified according to changes of classification criteria were marked on the copies of the manuscripts prepared in Japan. Not only survey and verification on those items but also overall checks on the compilation manuscripts were conducted in the field completion.

Three (3)- or more story buildings were needed to be surveyed one by one. Therefore, the survey was conducted on foot in the areas where these 3- or more story buildings were located in such congested areas as Manila, Makati, Quezon City, etc., the central part of cities and towns in the surrounding areas, and the congested areas along the highways.

1-5-3 Changes after Aerial Photography

Regarding changes brought about until March 1986, results of the field identification (1985) were corrected by photo interpretation of the aerial photomaps made in March 1986. Subsequent new changes in land use were surveyed and confirmed in the field completion as much as possible.

As a result, most of chages brought about during the period from the contoured mapping to the field completion (October, 1987) were corrected in respect with the central part of the city area.

1-6 Drafting

1-6-1 Outline

Separation plates for multi-color press printing were prepared by color separation scribing method, utilizing scribed sheet prepared for contoured and planimetric maps in the 2nd year work and compilation manuscripts prepared for land use map in the third year work.

1-6-2 Symbols and Marginal Information

Symbols and marginal information were prepared in accordance with the result of thechnical discussions confirmed with BCGS.

1-7 Printing

1-7-1 Outline

(1) The printing of land use map was conducted on the basis of the sample maps which was agreed in the technical meetings with BCGS in the 3rd year.

(2) The land use map was printed using 7-color separation plates assigned for land use classification.

(3) The "information and usage" of land use map was printed on the back of map sheet.

(4) Printing was conducted with 7 color separation plates (red, orange, blue, yellow, green, brown and black) and their combinations to make the land use patterns easily identifiable.

Residential (Multi-story Housing, Residential, Temporary Housing, Mixed Commercial-Residential), Land Use Boundary:	Red
Business, Commercial, Public (Educational and Cultural):	Orange
Industrial (Large-scale Industrial, Small-scale Industrial, Mixed Industrial-Residential):	Blue-red
Mixed (Mixed Business-Commercial, Mixed Business-Residential):	Red-orange
Public and Government (Government and Quasi-public) and Facilities (Transportation, Service, Sports and Athletics):	Brown
Public and Government (Health and Welfare, Religious and Cemetery, Park and Recreational), Forest:	Green
Agricultural Land:	Yellow-brown
Water Related:	Blue
Base Map and Annotation:	Black

2. LAND USE IN THE STUDY AREA

2-1 Overview of the Land Use

The survey area covers approximately 823 ㎢ of the Metro Manila Area. Manila is located in the center and surrounded by Blacan Province in the north, Laguna Province in the south, the northern part of Laguna de Bay and lower stream of Marikina River in the east and Manila Bay in the west.

The overview of land use is as follow:

1) Built-up area of central part of Manila around the estuary of Pasig River, newly rising Makati Area, Quezon City, etc. are mainly occupied with commercial and business area.

2) Those built-up area is surrounded by residential area where on-going developing sites are involved.

3) North-western part of the area and south-weatern part along coastal line are represented by lowland where marine-ponds are prominantly observed.

4) Northern and southern part of the area are represented by hill and plateau. And the basin of Marikina River is occupied with agricultural land.

5) Eastern part of the area is characterized with forest in mountains.

An elevated railway runs along Manila Bay through Pasay City to Caloocan City as a main transportation network, and Philippine National Railways traverses south to north in the area.

Super-highways run toward south and north as arteries, which are connected by other radial and circular road-net of which the center is old city area of Manila.

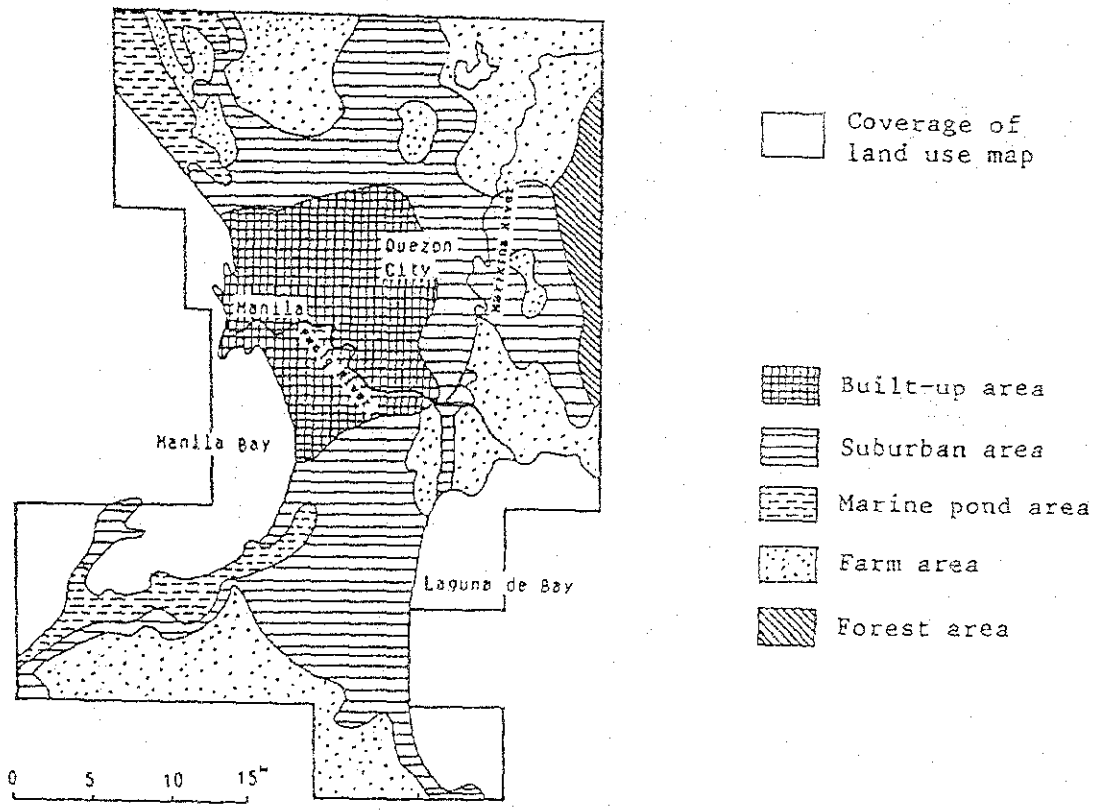

Fig.Ⅲ- 2 Outline of Land Use

2-1-1 Residential Area

The residential area is expressed in two types in this study area, one is purely used as residence and the other is mixture of residential, commercial and business use.

Pure residential area is concentrated around the surroundings of the central part of Manila, Quezon City and Pasay City. While newly rising housing area is expanding in the lowland of lower stream of Marikina River, the vicinity of Laguna de Bay, southern Imus and Novaliches Located north of Quezon City.

Mixed residential area is divided into commercial and residential, business and residential, and industrial and residential. Housing area of the mixed commercial and residential is concentrated along National Highway No.3 going towards north, around the built-up area, developed since old time, of San Nicolas, Binondo, etc. in Manila and along some roads existing Quezon City, Caloocan City, etc.

The mixed business and residential has totally small occupancy in the central area of Manila, Quezon City and Caloocan City. The mixed industrial and residential is rarely observed in the area.

2-1-2 Commercial and Business Area

The commercial area in this area is classified into pure commercial, mixed business and commercial and mixed commercial and residencial which mentioned in 2-1-1.

The pure commercial is observed as a mass in Ermita area of Manila, Makati and Cubao area of Quezon City. And along main roads radiating from Manila towards outskirt are forming narrow belt zone.

Occupancy of the mixed business and commercial is quite smaller than the pure commercial, distributed as small patches in San Nicolas of Manila and along the main roads as same as the pure commercial is situated.

Business area is also able to be classified into pure business, mixed business and residential mentioned in 2-1-1 and mixed business and residential mentioned in 2-1-2. The pure business in this area is observed intensively in the central part of Manila, Coastal Roads area, Makati area, Mandaluyong area and Quezon City.

Other existence is recognized as spots.

2-1-3 Industrial Area

Industrial area is divided into relatively larger industrial zone, relatively smaller industrial zone and the mixed industrial and residential mentioned in 2-1-1. The relatively larger industrial zone is distributed along Pasig River in Manila and Philippine National Railways in San Loga area, lower stream of Marikina River from Marikina area to Pasig area, etc.

Also, large extent of newly rising larger industrial zone is obseved in Caloocan City, north of Manila and the vicinity of Northern Superhighway.

On the other hand, in the southern part of the area, crowds of industrial plant are distributed along Southern Superhighway, around Laguna de Bay and in the vicinity of Montenlupa. Relatively smaller industrial zone is rarely located near the newly-rising large industrial zone in suburb, but coexist with the large industrial zone in Caloocan City, north of Manila and along Pasig River, which were built in old time.

2-1-4 Public and Official District

Public and official district is classified into governmental and public facilities, education and culture, health and welfare facilities, park and recreation facilities as well as cemetery and religion.

The governmental and public facilities in this area are intensively observed in the central part of Manila, where Pasig River penetrates, along the coastal road, around Quezon City Memorial Park, in Makati area and Mandaluyong area as well as in populated area in the outskirt.

The education and culture area is distributed constantly,diversifying its scale, in all around the area excepting grassland belt, paddy field belt and marine-pond belt. Prominent systematic education and culture area is obseved in the vicinity of Sant Thomas University located north of Pasig River in the central area of Manila and in Loyola area and the surroundings of University of the Philippines in Quezon City.

As for the facilities for health and welfare (mainly hospitals), large scale facilities are mainly located in the vicinity of Manila and Quezon City, while small scale facilities are scattered in the suburb.

As for parks and recreation facilities, large scale facilities are existing such as Rezal Park and Quezon City Memorial Park and in the surroundings of sai parks. While small scale facilities are observed sparsely in the residential area.

Chinese Cemetery, Laoka Cemetery and North Cemetery in the northern part of Manila, Manila Memorial Park in Parañaque area, Manila South Cemetery in Makati area, Loyola Memorial Park in Quezon City, etc. are recognized as large scale facilities for cemetery and religion.

On the other hand, small scale cemeteries are distributed homogeneously in each administrative unit located in the entire area.

As for religious facilities, at any part of the area form built-up area to suburb, these facilities are observed quite often. From this it is felt that the life style is based upon religion.

2-1-5 Facilities

Facilities in this area are classified into transportation, service, sports and athletic, and military. As for the transportation facilities, Philippine National Railways traversing south through north, elevated railroad connecting Pasay City and Caloocan City, South and North Harbor of Manila Bay and Manila International Airport are prominently recognized.

Some other large transportation facilities such as oil storage tank along Pasig River in Pantabangan area are also observed.

As service facilities Novaliches Reservoir, water filtration plants in the southern and northern part of Quezon City and a power plant in the western part of Quezon City.

As the facilities of sports and athletic a lot of golf-course are observed along EDSA, in Makati area, Pasay City, Montenlupa area, Antipolo area, etc., these are situated on hill and plateau.

2-1-6 Farm Land and Forest

Farm land in this area is classified into rice field, cropland, plantation and agro-industrial facilities. The rice field is distributed widely in bulacan through Maycauyan in the west-northern part of Manila, Montarban and San Mateo along Marikina River, Taitai in the eastern part of Manila and Cavite in the southern part.

On the other hand, in the suburb of Manila, Quezon City, etc., small scale rice fields are scattered, being altered to housing area.

The occupancy of cropland is much smaller than rice field. Relatively large cropland is recognizable in upper stream of Marikina River in the northern part of Quezon City. However, in other area, only small scale croplands are observed in the suburb on Manila, Quezon City and Pasay City.

As for plantation, large plantation is not observed in this area. Small Plantations, where mainly banana, sugarcane and mango are cultivated, are distributed in the surroundings of scattered barangays in the suburb.

Forest in this area is classified into forest, grassland and bare land. Large scale forest is only recognizable in the vicinity of Novaliches Reservoir located in the northern part of the area. In other area very sparsely forest is distributed. All of them are broad-lieved tree.

The grassland is distributed relatively in the vicinity of Novaliches Reservoir, mountains situated east of Marikina River and the surroundings of Montenlupa. In the central part of Manila, the grassland is rarely identifiable. However, in the suburb, small scale grassland is observed along rivers.

Bare land is recognizable on scarps along rivers, on cut-slopes of roads, etc.

2-1-7 Others

Others are composed of water sphere and open space. The water sphere includes marine pond, saltbed and water-related vegetation. The marine pond is often observed in north-western part of Manila along Manila Bay and vicinity of Cavite City, especially the area in the part of the north-western Manila extend its lowland 8 km toward inland.

As for water related vegetation, mangrove is observed along coastal line in the north-western part of Manila, and water-lily is recognized gregariously in marshy land of Laguna de Bay.

The bare land is seldom observed in the central part of Manila and Quezon City. In the suburb, post-levelled ground in housing development is recognized as bare land in the surroundings of newly rising housing area.

2-2 Classification of Land Use

The land use is classified into the following three major categories:

Built-up Area
Agricultural Land and Forest
Others

These are then divided into 33 sub-classifications.

(1) The category "Built-up Area" is classified into Residential, Commercial and Business, Industrial, Public and Government, Facilities, etc. on the basis of the main usage of the buildings.

(2) The category "Agricultural Land" is divided into Rice Field, Cropland, Plantation, etc. and the category "Forest" is classified into Forest, Grassland and Bare Land. The warehouses for agricultural products and food processing factories are included in Agro-industrial.

(3) The category "Others" consists of "Water-Related " and "Open Space," and the "Water-Related" includes Marine Pond, Saltbed and Water-Related Vegetation

2-3 Criteria for Representation of the Land Use Map

The criteria for representing the land use classification on the 1:10,000 land use map are as follows:

(1) Where building of facilities occupy a common compound, the land use classification is represented by the main usage of the compound.

(2) The minimum area for representation in the Built-up Area is generally 3 mm X 3 mm on the maps. As for the Commercial and Mixed in the Built-up Areas, However, consideration is given to represent about 1.5 mm X 1.5 mm areas on the maps because of their important functions.

(3) The minimum area considered for the representation of the Military, Agricultural Land, Forest and Water-Related is generally 5 mm X 5 mm.

(4) In 2-story buildings whose usages are both as Residential and some other categories (Commercial, Industrial or Business), the classification is of the latter.

(5) In buildings of 3-story or more whose usages are multi-purpose, the classification is Mixed and falls under one of the following four categories according to the main usage of the buildings:

Commercial and Residential,
Business and Commercial,
Industrial and Residential,
Business and Residential

2-4 Utilization of Land Use Map

The land use map is prepared using the 1:10,000 contoured map as the base on which the existing land use patterns are printed in 7 colors.

It is possible to recognize the existing land use together with various features (road, railways, buildings, contour lines, coastal lines, annotations and others) shown on the base map.

It is expected that this land use map will be utilized as follows:

(1) Administrative organizations can use this map for planning the redevelopment of built-up areas, development of suburban area, improvement of transportation systems, housing development, disaster prevention, etc.

(2) Survey and researches organizations (universities, institutes, etc.) can use it for academic researches on geography, regional planning civil engineering, etc.

(3) Public organizations and private enterprises canuse it for the proper selection and development of sites for their activities.

(4) It can be more effectively used, together with a land condition map, for verifying the suitability of the present land use as well as for planning of the proper land development.

IV. LAND CONDITION MAP

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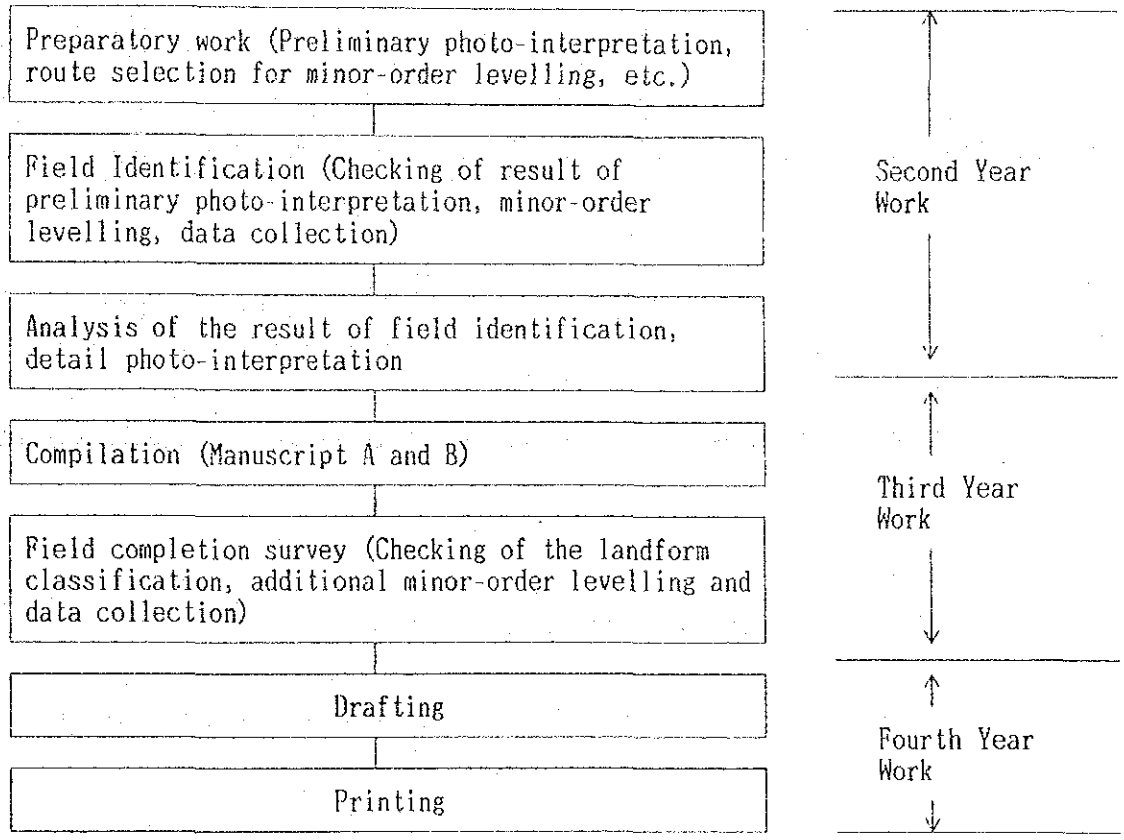
1. METHOD OF PREPARATION

1-1 Outline of Work

1-1-1 Outline

The purpose of Land Condition Mapping is to map out the basic conditions of terrain, which are essential for disaster prevention, land conservation, developing planning, etc. Detail information of landform (landform classification, ground height, ect.), the locations of various organizations, agencies and facilities in relation with disaster prevention and development are surveyed and shown on the multi-color printed maps for which 1:10,000 topographic maps are used as base map.

Work-flow is as follow:



Note: Manuscript A: for landform classification and linear-objectives
Manuscript B: for Annotation and Symbols of organizations, agencies and facilities.

Fig. IV-1 Work Flow of Land Condition Mapping

1-1-2 Preparation of Map Symbols and Specifications

Map Symbols and Specifications for Metro Manila Land Condition Mapping were constructed in accordance with the following basic policies.

(1) The symbols and specification shall be applied for various upgraded developing projects in the Metro Manila Area such as urban development, conservation, disaster prevention, urban planning, etc.

(2) Landform classification shall be done in such a manner that firstly the survey area is classified into Mountains, hills/plateau or lowland as units of large categories, then secondarily respective large category is classified into small categories as detailed as possible in consideration of the regional characteristics of Metro Manila Area as well as the susceptibility for disasters. For example, even in the category of lowland, Micro-relief shall be differentiated from other low marshy area according to a little difference in height and components of the surface mateials, or how original landform was deformed artificially.

(3) The ground height of the lowland mainly located north-west of Manila and in the bottom of Markina Valley, which corresponds to the area of lower stream of Marikina River up to Laguna de Bay, shall be expressed as detail as possible to clarify the micro-relief topography and its susceptibility for disaster.

(4) The organization and public facilities, which mainly relate to land development and disaster prevention/relief shall be shown in the map.

(5) For the selection of the color, brown, orange and yellow shall be applied for the landforms which are not so susceptible to disaster, green and blue shall be employed for the landform with susceptibility of disaster and violet shall be used to express escarpments.

(6) The original form of the artificially deformed land in the lowland shall be able to be interpreted from the map.

The following preparatory work were conducted before starting Field Identification.

(1) Preparation of landform classification categories and a draft of criteria for the classification.

On the basis of available aerial photographs, topographic maps and other collected data, the landform classification categories and the criteria for its application were drafted. It was taken into account for the classification of landforms to express sufficiently local characteristics of the survey are.

(2) Preliminary photo-interpretation

In accordance with the classification categories and the criteria (draft), which are mentioned above, the interpretation of landform was carried out on 2-time enlargements (scale at 1:16,000) which were taken in 1982. In the course of photo-interpretation, some obscare boundaries of landform were recognized mainly on the part of gently sloping hill and plateau with small amplitude as well as micro-relief topography in the low land. Extracted obscare boundaries were ordered as an item to be checked in the field.

(3) Preparation of minor-order levelling

Minor-order levelling was planned to survey the ground-height around lowland, on the basis of the interpretation of 1:10,000 topographic maps and the analysis of collected materials.

The planned route of minor-levelling covered the low area from Malabon to Bulacan, situated north-west of the City of Manila and another low area from lower part of Marikina River to Laguna de Bay, where disasters are likely occurred among them by floods and high-tides.

1-3 Field Identification

1-3-1 Outline

As land condition map has to show landforms, ground-heights, locations of facilities, etc. for the disaster prevention measures, the selection of suitable site for development and etc., the following items were considered in the field work;

1) Checking of surface materials of each landform
2) Minor-order levelling for ground elevations in the lowland
3) Collection of materials concerning public organizations and facilities
4) Interviewing and gathering data of boring survey, records on floods in the past, etc.

1-3-2 Field Work

(1) Detail survey of land classification

Observation of micro-relief topography, investigation of outcrops, minor-order levelling hand-augering, etc. were carried out as field work to clarify mainly uncertain spots and boundaries for classifying of landforms which were extracted during preliminary photo-interpretation.

The observation of micro-relief topography was devoted to identify its physical condition and components of surface materials.

In the investigation of outcrops, physical conditions of hill and plateau, mountains and mountain foot were mainly surveyed.

In the lowland, the physical conditions of surface materials which compose the micro-relief topography were surveyed by hand-augering.

The topographical and regional characteristics of the entire survey area were also observed.

On the basis of the above mentioned datail survey, the obscure spots extracted during preliminary photo-interpretation, were clarified.

And the materials collected in the field were analyzed.

(2) Minor-order Levelling

1) According to the planned levelling route the final route for levelling was decided by field reconnaissance and in consultation with Philippine side.
2) Levelling was conducted in accordance with JICA Specs.

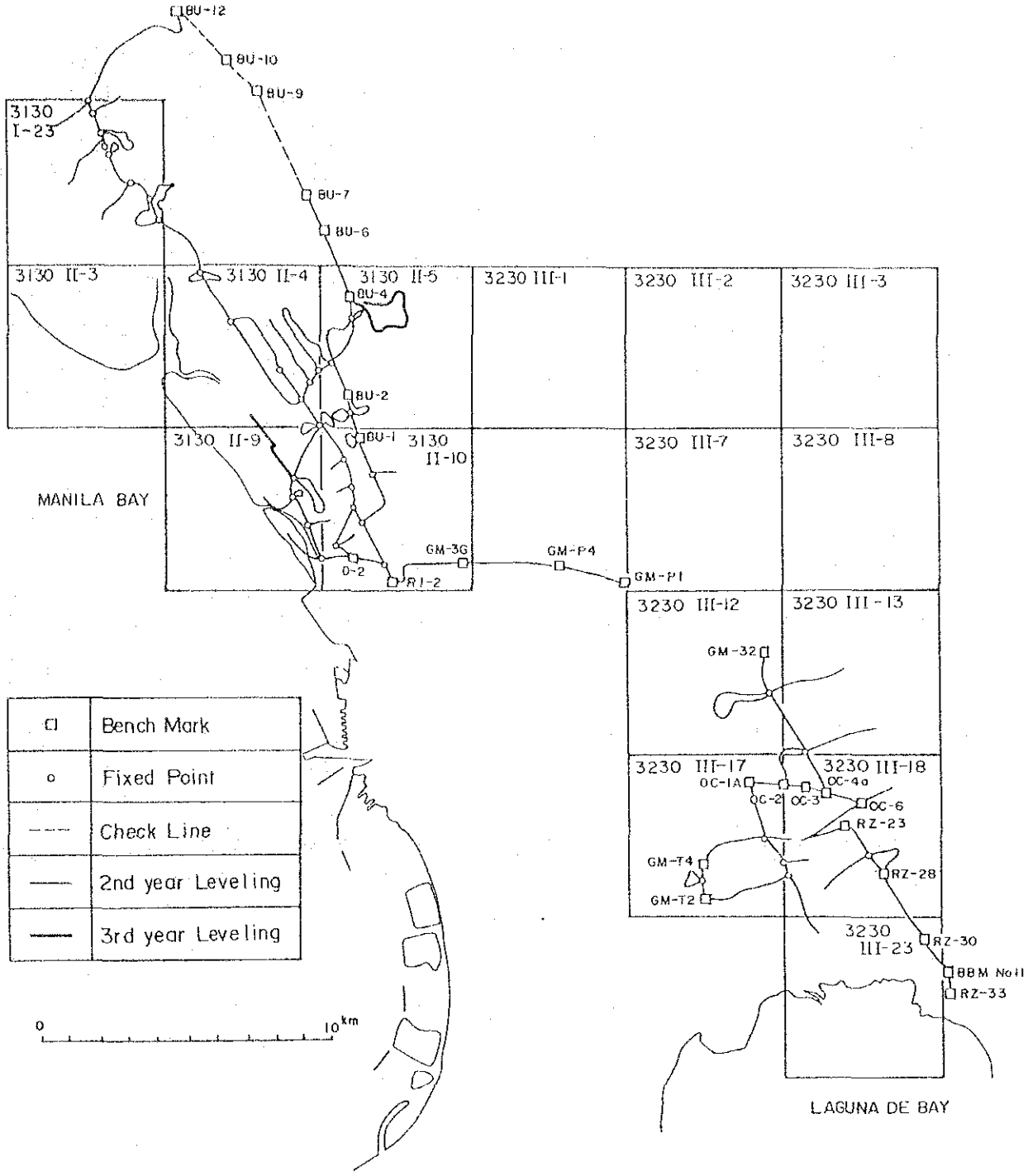


Fig.Ⅳ- 2 Route Map of Minor Order Leveling

(3) Interviewing

In north-western and east-southern part of the survey area that were specially susceptible for disasters caused by flooding. The relations among flood-disasters, landforms, ground elevations, etc. were clarified by interviewing to the local people on the past disasters brought by floods.

(4) Collection of related materials

The materials, requested by JICA Survey Team to BCGS to prepare at the time of field completion survey for contoured mapping in October 1986, and other necessary data for detail expression were collected.

(5) Based upon the contoured (topographic) maps, various public organizations and facilities (the organizations, agencies and facilities for disaster prevention and development) were confirmed.

1-3-3 Analysis and Detail Photo-interpretation

The following were conducted as in-door work after completing the field work.

(1) Analysis of the results of observation of micro-relief topography, investigation of outcrops and hand-augering
(2) Analysis of collected related maps and literature/documents
(3) Analysis of the results of interviewing on the floods in the past
(4) Analysis of the results of minor-order levelling
(5) Analysis of various organizations and facilities
(6) Analysis of the related data on submarine topography along the coast
(7) Detail aerial photo-interpretation based upon the above listed analysis

1-4 Compilation

1-4-1 Outline

In accordance with the results and data of the interpretation and field survey completed by previous year, compilation manuscripts A and B were prepared which were subject to the Symbols and Specifications of Metro Mnila Land Condition Map.

Compilation manuscript A was developed by describing landform classification boundary, linear objects and symbols for lanform classification, based on the Symbols and Specifications for Metro Manila Land Condition Map and in accordance with the aerial photographs on which the results of landform interpretation.

On the other hand, the various organizations and facilities were mapped out on polyester base as the compilation manuscript B, those correspond to the features expressed in the contoured maps.

Consequently coloring and symbolizing of classified landforms were carried out, according to specified colors and symbols, on the copied sheets of compilation manuscript A to develop colored lanform classification maps.

1-4-2 Items To Be Compiled

(1) Boundary and symbols for landform classification
(2) Extraction of public organizations, agencies and facilities
(3) Annotation plate

1-4-3 Detail Items To Be Compiled

(1) For expression, priority was given to linear objects e.g., main roads, railways, water boundary, protected banks, etc. In case these features overlap the boundary of land classification of the base map, the boundary was eliminated.

(2) According to the result of the field work, the classification boundaries of landforms, delineated on the aerial photographs, were transferred on to the base maps, subject to the Symbols and Specifications.

(3) Since land classification was conducted mainly on the basis of the interpretation of aerial photographs, two types of landform boundary were observed. One was distinctly classifiable which was interpreted clearly from turning points of slopes and the other was indistinctly classifiable which is located around gentle slopes and micro-relief topography in the lowland.
Solid line was employed for the photo-identifiable clear landform units and broken line was used for unclear landform units.

(4) Uncertain and/or doubtful boundaries of land classification were extracted to be checked in the field completion survey.

(5) The organization and facilities which are common with those in the contoured maps were extracted.

(6) The main roads were extracted from the planimetric maps for further discussion with Philippine side in the period of the field completion survey.

(7) The following items on sea were set up to be considered in the compilation, those data were provided by Philippine side:
1) Depth curve (1 m interval)
2) Tidal flat (mud)
3) Bar

1-5 Field Completion

1-5-1 Outline

Field completion was conducted in order to clarify uncertain things for expression of landform boundary which were occurred during the compilation of manuscripts and to confirm the information in the field on various organizations and facilities which were provided by Philippine side.

1-5-2 Field Completion (Landform Classification)

The following work was conducted:

(1) Supplemental survey on the outcrops in the hill and plateau area
(2) Confirmation of form and distribution of the landform of the foot of mountain and the delta
(3) Confirmation of depth of banked-up surface of artificially deformed land
(4) Confirmation of depth of cut surface of artificially deformed land
(5) Confirmation of relative height of terrace scarps
(6) Confirmation of drainage system in built-up area
(7) Survey on general landform characteristics of each major category

1-5-3 Field Completion (Ground-heights)

About 8 km of minor-order levelling was carried out, in addition to the minor-order levelling conducted in the second year work, to supplement the data of ground-heights and micro-relief lines in the lowland.

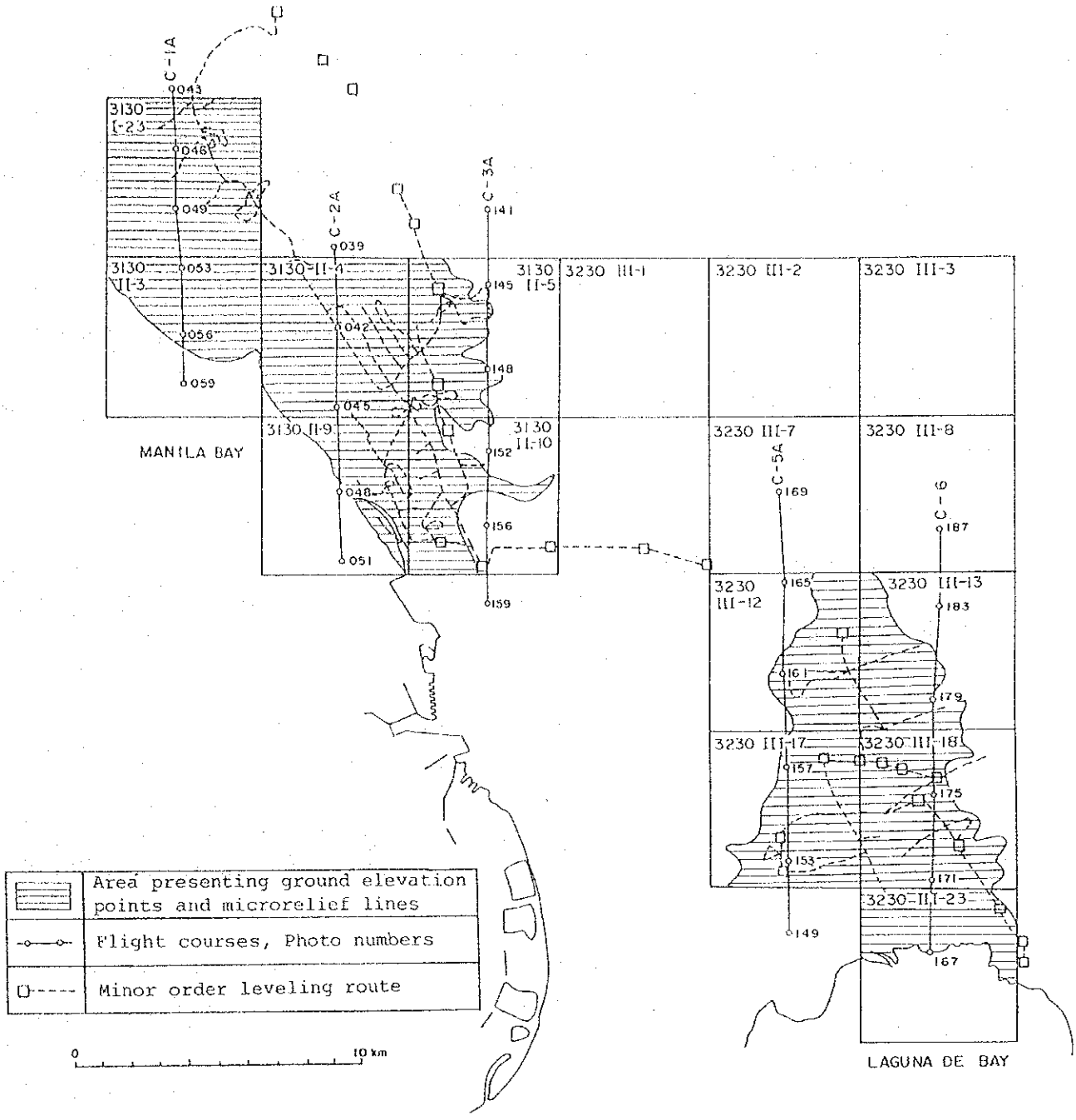


Fig.IV- 3 Areas Representing Ground Elevation Points and Micro-relief Lines

1-5-4 Field Completion (Organization and Facilities)

Data concerning organization and facifilities for the land condition map were divided into as follows:

1) Data to be selected from the contoured map (1:10,000)
2) Data to be provided by BCGS

Government buildings, police stations, hospitals, churches, schools, dams, storage tanks, etc., which can be selected from the contoured map were plotted on the compilation manuscripts.

Items to be provided by BCGS were the water level gauge stations, rain gauge stations, earthquake observatories, river pumping stations, restricted area, dumping area, etc.

The main roads, being considered important for refuge in disaster as well as for land development and conservation, were selected.

1-5-5 Data Collection

Survey reports related to geomorphology and geology in/around Metro Manila, data on organizations and facilities, etc. were collected during the field completion.

1-5-6 Changes after Aerial Photography

Among the changes which was corrected in the land use mapping, housing development area, etc. were classified as artificially deformed land in the land condition map.

1-6 Drafting

Drafting of Land Condition Map was conducted by scribing method in order to develop original drafting manuscripts for multi-color printing.

In accordance with compilation manuscripts A and B developed in the third year work, the original drafting manuscripts were prepared to produce respective plate with a particular colour for printing which corresponds to respective symbol for a particular landform class, organization and facility, etc.

1-7 Printing

(1) The printing of land condition maps were conducted on the basis of the confirmation with Philippine side in the 3rd year work.

(2) The land condition map was printed by employing twelve-colour separation for classification of land conditions.

(3) The "Information and Usage" for the land condition map was printed on the back of map sheet.

Preinting is made in different combinations of 12 colours (brown, purple, green, yellow, orange, yellowish green, blue, sky-blue, silver grey, red, black and dark grey) so that various conditions can be easily understood.

Mountain ---------- Brown series
Piedmont Landform ---------- Yellow series
Hill and plateau, and terrace ---------- Orange/brown series
Flood plain/valley plain ---------- Yellowish green series
Coastal plain/delta ---------- Blue/green series
Artificially deformed land/unstable slope (landslided scarps)
----- Red series
Land form in marine area ---------- Silver grey series
Water surface ---------- Sky-blue
Microrelief line ---------- Brown
Organization/facility ---------- Black and red
Ground-height annotation ---------- Black
Boundary line, and unstable slope (cliff) ---------- purple
Base map ---------- Dark grey

2. USAGE OF LAND CONDITION MAP

2-1 Landform of the Survey Area

2-1-1 Outline of the Landform

Generally the land features in the survey area show characteristically north-south oriented distributions. The area is roughly classified into;(1) lowland along Manila Bay, (2) hill/plateau where Manila and Quezon City are situated, (3)lowland covering the Marikina River basin and Laguna de Bay and (4) mountain/hill located southwest of the Sierra-Madre Ranges.

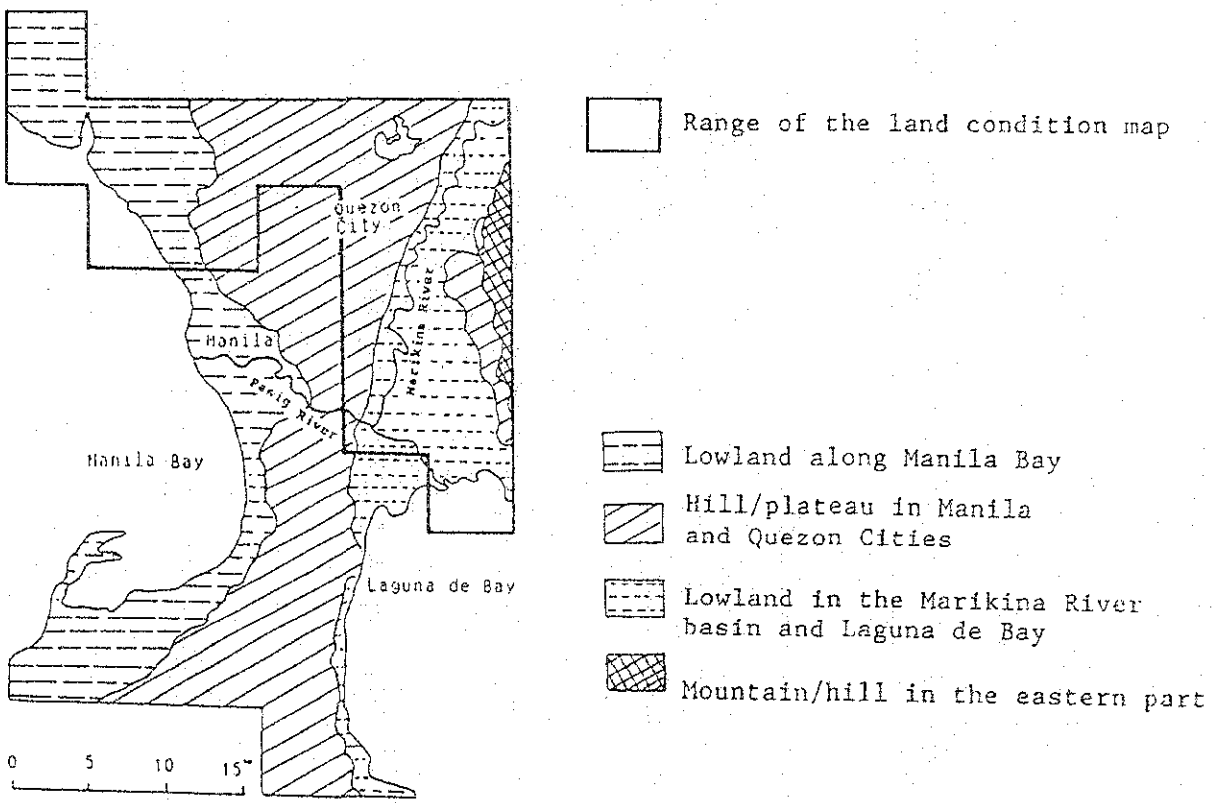


Fig.IV- 4 Outline of Landform

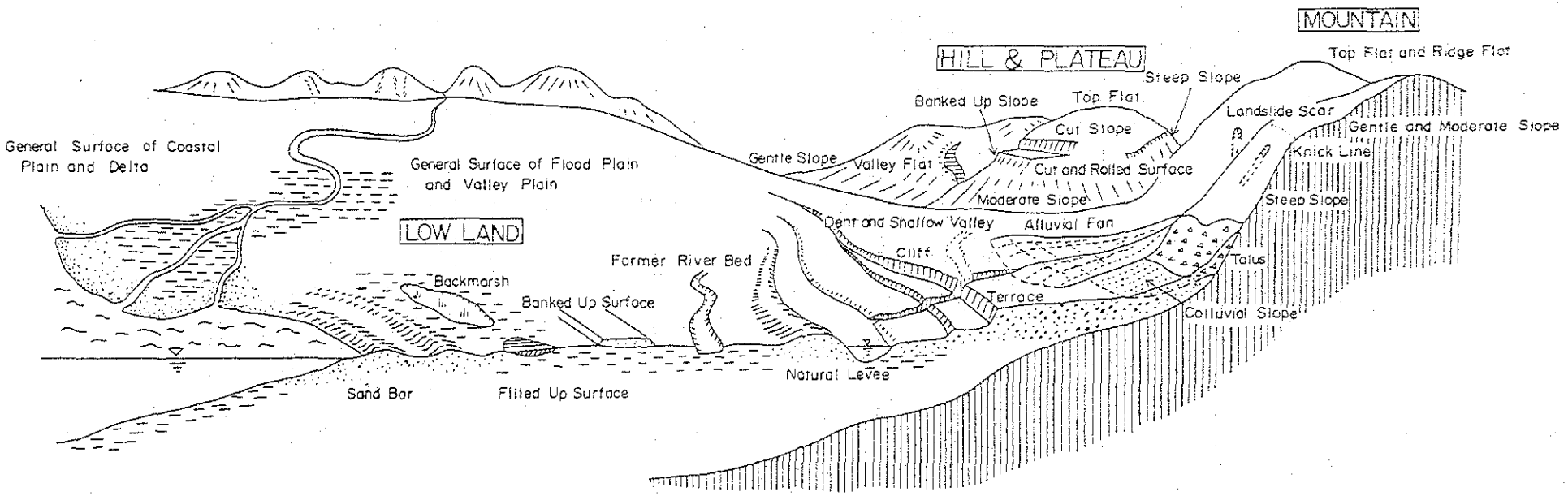


Fig.IV- 5 Illustration of Landform

(1) Lowland along Manila Bay

The lowland, which is narrowly elongated from south to north along curved coastal line of Manila Bay, consists of coastal plain and delta.
The area varies its width such like 7-8 km around Obando in the norhtern part, 2 km around Malabon, about 6 km around core of the built-up area of Manila that is outside of the survey area and about 1 km south of Manila.
The altitude alters from 0 m to several meters; the altitude is especially low in the area where Pasig River meanders in Manila and the area from Malabon to Obando and Bulacan in north. Those are often damaged by flood in the rainy season.

(2) Hill/plateau in Manila and Quezon City

The hill/plateau altered gradually from flat lowland is situated in the center of the survey area. The earth surface is flat in the area covering the built-up area of Quezon City and its adjacent area in east and south. However, the further toward north from the built-up area, the amplitude of the surface gets higher showing broadly and dendritically incised valley.
The width of the hill/plateau is about 15 km in the northern part and 3 km around the area where Pasig River traverses the plateau. The altitude is 20 - 30 m around Pasig River and 40 - 50 m in the built-up area of Quezon City and becomes gradually higher more north up to 80 - 100 m.

(3) Lowland in the Marikina River basin and Laguna de Bay

The lowland formed by external agency of Marikina River at the foot of eastern edge of the hill/plateau and Laguna de Bay has the extent of about 25 m in length, in width of 4 km in north and 6 to 10 km in middle to south.
The altitude varies from 1 m to several meters near Laguna de Bay where innundation occurs in every flooding.
In this lowland at both sides of the northern part of Marikina River, 2 to 3 river terraces with small relative height are recognizable which is subducting under the sedimentation surface of the flood-plain in middle and south of the area.

(4) Mountain/hill

The mountain/hill in the study area consists of mountainous area with the altitude of 200 - 300 m and hilly area with the altitude of 50 - 100 m.
The mountainous area forms the west-sourthern fringe of Sierra Madre Ranges. The more north-east, the altitude becomes higher toward Sierra Madre Ranges. Steep slopes are observed remarkably in the north-eastern part. However, it can be said that the entire area is gently inclined with some flat crests scattered around middle and southern part.
The hilly area recognizable in the middle and southern part inclines gently toward west and submerges beneath the surface of alluvial plain. In general terrain surface is composed by gentle slopes.

2-1-2 Composition of the Land Condition Map

The land condition map is composed of the following 3 elements:
Landform calassification, ground elevation, and organizations/facilities.
They are further divided into 91 items.

(1) Landform classification

In the landform classification, various types of landform composing the ground surface are grouped into mountains, hills, plateau, and lowland (such as flood-plain, delta, and others) based on the classification units where the form, process and surface material are homogenous.
In the sub-classification, safety or susceptibility to disasters is also taken into consideration.

(2) Ground-heights

In order to show susceptibility to floods/high tides in the lowland, ground-heights and micro-relief lines are shown.

(3) Organizations and facilities

As to organizations and facilities, organizations in charge of disaster prevention and development, facilities for rescue and relief, observatories, facilities for supply and processing, river and coastal structures and others are shown with special reference to those especially relating to disaster prevention, rescue and development.

2-2 Criteria for Presentation in the Land Condition Map

(1) Landform classification

1) The minimum size for the landform classification is approximately 2mm × 2mm on the map, and the minimum size of linear symbols is approximately 5 mm on the map.
2) In the landform classification, sections where the boundaries between terrain units are difficult to be established are presented by broken lines.
3) Bars, tidal flats, bathymetric lines presented in the sea area are based on the information provided by BCGS.

(2) Ground-heights

1) Ground-heights are presented in 10 cm units; the ground-heights obtained from the minor-order levelling and those obtained from the photogrammetry are expressed in vertical print and slant print, respectively.
2) Contour lines for those ground-heights are presented at 1 m interval.

(3) Organizations and facilities

1) As to river and coastal structures, those relating to rivers with the width of more than 4 m or those of more than 50 m in length are presented.
2) Of the transportation facilities, main roads of more than 1 km in length are presented.
3) Of the facilities in coastal areas, ports/habors and fishery harbors of different sizes are presented by varying the sizes of the symbols.
4) The facilities for rescue and relief, facilities for dangerous materials, observatories, and facilities for supply and processing are all presented.
5) Those not listed above are based on the presentation criteria of the contoured map.

2-3 Utilization of the Land Condition Map

The land condition map was prepared using the 1:10,000 contoured map as the bese map, on which the actual conditions of landform classification, ground elevation and organizations/facilities were printed in 12 colours.
One can assume the following by reading the land condition map:

(1) Low or marshy land where damage caused by flood/high-tide is expected.

(2) Unfavourable conditions of surface layer where earthquake damage is expected.

(3) Alluvial plain where damage caused by ground subsidence due to pumping of excessive ground water.

(4) Artificially deformed land and unstable slopes such as mountain and hill where landslides are expected.

(5) Plateaus and gentle hills relatively safe against disasters, such as flood and landslide.

Therefore, the land condition map can be utilized as the basic information not only for disaster prevention planning but also for land development planning, and its combined use with a land use map can be more effective.

3. SUMMARY OF THE SURVEY AND COLLECTED DATA

3-1 Geology of the Survey Area

The survey area is located at the south edge of Central Luzon Valley which was formed between the late Mesozoic and the early Cenozoic. At the west side of Sierra Madre Ridge, Marikina Valley and Laguna de Bay are located, in the central part of the hill/plateau from Caloocan City in the north to Taguig in the south extends, and on the west side Manila Bay extends. The entire area has N-S oriented landforms.

The survey area consists of the Cretaceous Kinabuan formation cropped out in the east edge of Sierra Madre Ridge, the Pleistocene Quarternary Guadalupe formation recognizable in the south-west foot of Sierra Madre Ridge and in the entire hill/plateau in the central part, and alluvium deposite in Marikina Valley and along the coast of Manila Bay. The beds observed in the west of the area are newer than the one in the east, except the alluvium in Marikina Valley. There are many lineaments along Marikina Valley. Especially along the hill in the west foot of Sierra Madre Ridge in the north-east of the survey area, very clear faults exist. This suggests that Marikina Valley is a graben formed by fault. The clear fault extending in the NE-SW direction along the hill on the west side is well known as "Marikina Fault", about which many studies have been done. (see Fig. IV-6)

3-2 Flood

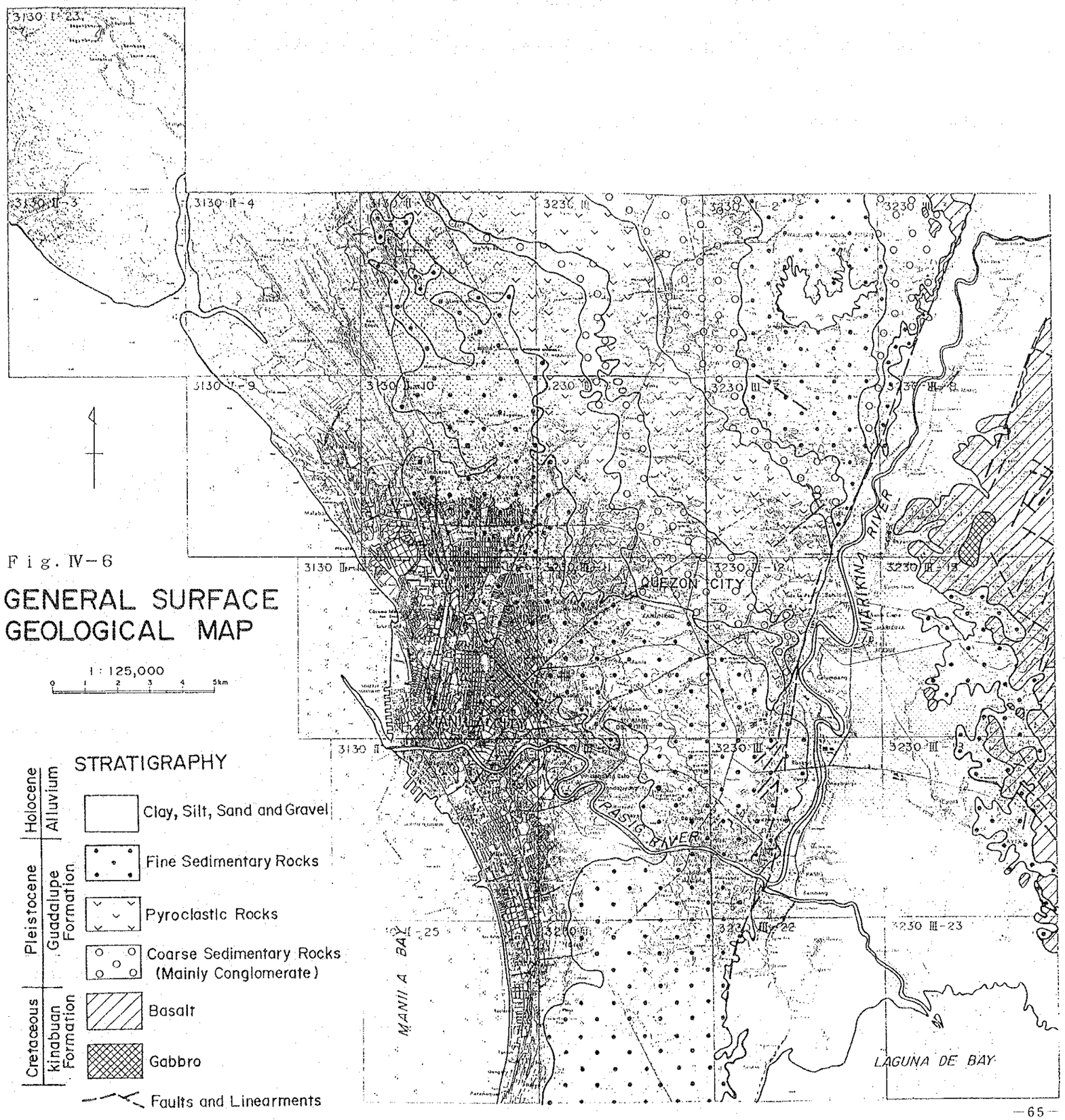
The Republic of the Philippines is located at the east edge of the Pan-Pacific area, where the route of typhoons exists. Every year several typhoons hit the country with the great deal of calamity.

In 1985 and 1986, during this survey, several floods broke out in each year to discontinue the survey several times.

In the survey of land condition mapping, the information concerning floods were collected to study thoroughly of the actual situation of flooding, especially around Metro Manila.

Fig. IV-6

GENERAL SURFACE GEOLOGICAL MAP



3-2-1 Flood in September 1986 studied by this survey team

When this project team encountered a typhoon during the 2nd Year Field Survey, an investigation for inundation was conducted.

The typhoon brought torrential rain mainly in Luzon Island from Aug. 31 to Sep. 1, 1986.

The aerial survey was conducted by helicopter on Sep. 5 when the effect of the typhoon disappeared.

The survey was focused on the lowland along the coast in the north-west of Manila, and the lowland in Marikina River and its vicinity near Laguna de Bay.

As the survey was performed 3 days after the beak of the rain, the area where the recession of water was relatively faster was not able to be identified. However, the submerged area identified by this survey are inferred to be ponded very often. (see Fig.IV-7)

3-2-2 Interviewing

In the second year of this project during the field survey of the land condition mapping, the interviewing about recorded floods was conducted for local people.

The contents of information received from residents are as follows:

* The maximum water level among floods experienced in the past.
* Data of the flood causing the maximum water level and the name of the typhoon.
* Ponding period during the maximum water level in the floods.

The inquiry survey was carried out at 147 sites in the survey area for the above listed information.

Result of the survey is summarized as follows (see Fig. IV-8):

(1) In the north-west part of Manila, even the natural levees or sand-bar where barangays scattered are inundated in the most part. The ponding period is shorter in this area than in peripheral lowland, but the ponding lasts for several days. In the entire Obando, sand-bar is fully submerged. In the part of coastal plains between sand-bars and the marshy area behind the natural levees the ponding period is much longer. Occasionally it reaches the period of several months.

(2) The flat-top of hill/plateau has good drainage. However, the areas in the small and middle river valleys incising those hill/plateau are often submerged instantly.

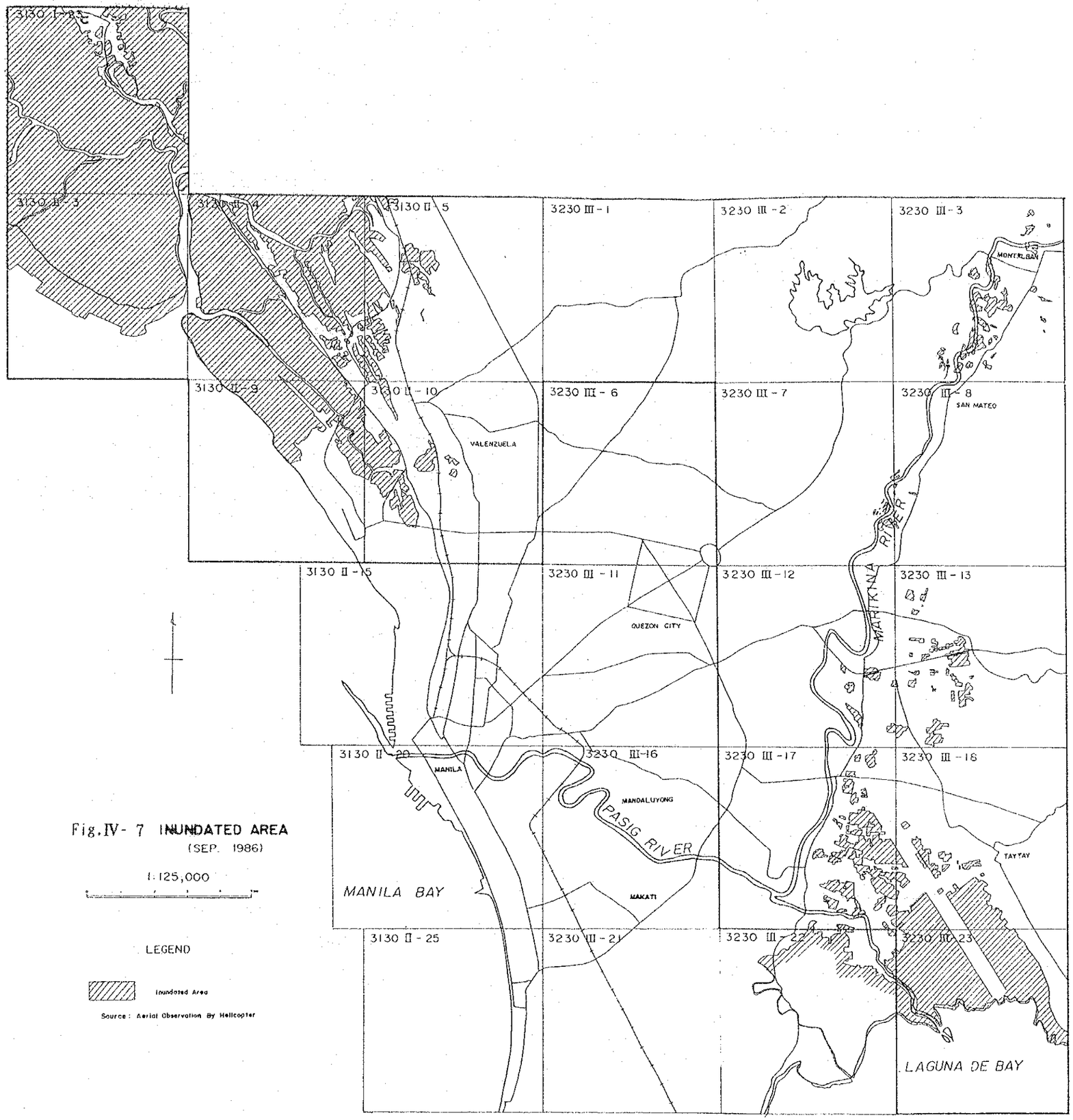


Fig. IV- 7 INUNDATED AREA
(SEP. 1986)

1:125,000

LEGEND

Inundated Area

Source : Aerial Observation By Helicopter

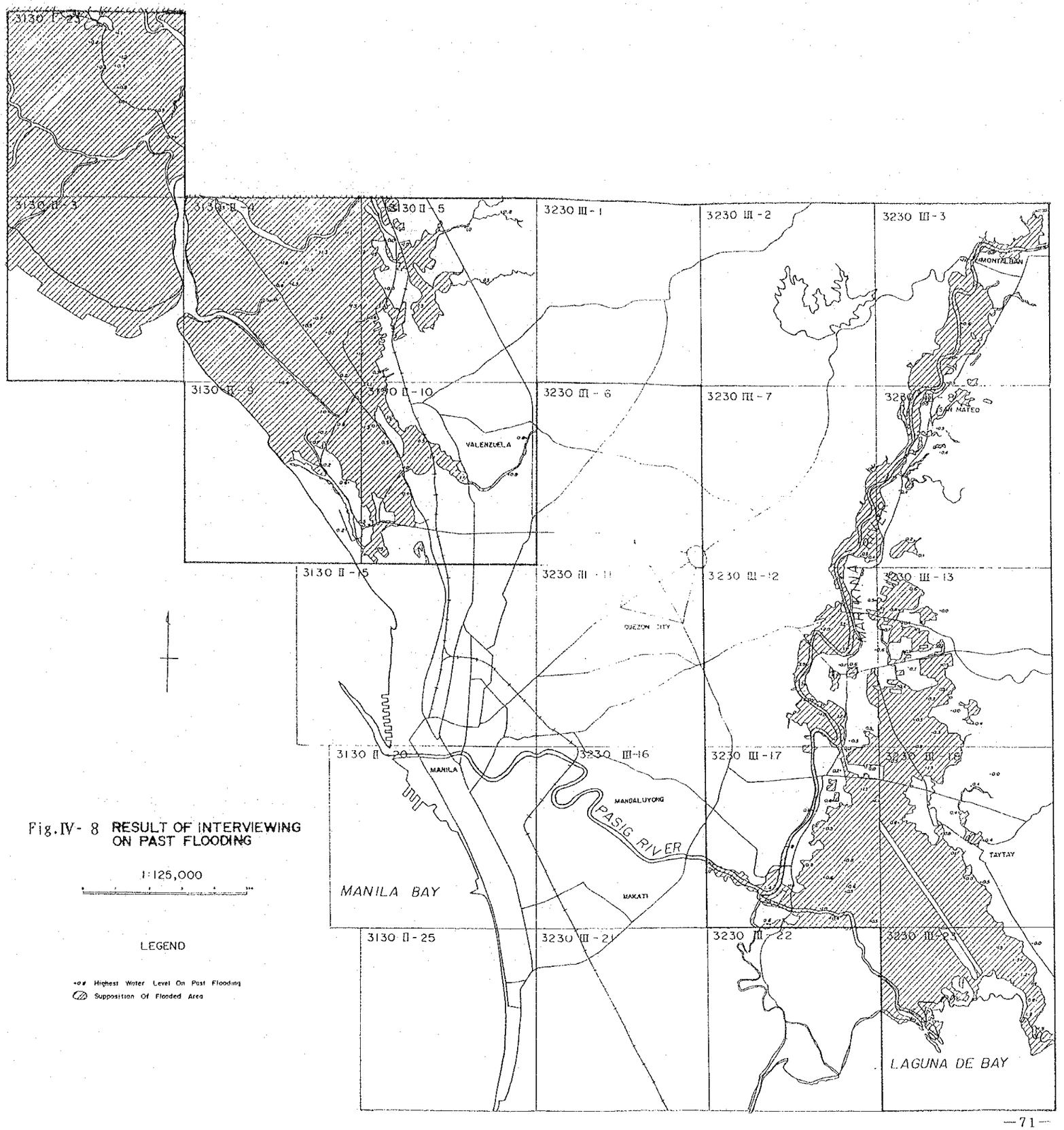


Fig.IV- 8 RESULT OF INTERVIEWING ON PAST FLOODING

1:125,000

LEGEND

+0.0 Highest Water Level On Past Flooding

Supposition Of Flooded Area

(3) The flood plain/lower terrace along Marikina River forms a submerged range, but the water recedes rather quickly. In contrast, the ponding range with poor drainage tends to appear along the roads on the upper terrace surface.

(4) In the flood plains from Marikina River to Laguna de Bay, the area on the natural levee is hardly inundated, but the whole flood plain behind the natural levee is submerged. this area covers a lot of newly developed land for housing, but most of the land is submerged. The surrounding paddy field surface is ponded for a long time. The depth of inundation increases closer to Laguna de Bay, and ponding may continue for several months.

3-3 Earthquake

The Philippines, located on the west edge of Pan-Pacific, like Japan, has many volcanoes and frequent earthquakes.

In the land condition mapping in this time, the information concerning earthquakes in the Philippines was collected for understanding of the local environmment. The information is oulined below:

Fig. Ⅳ-9 is an illustration of the incidence of earthquakes from 1949 to 1979.

The earthquake prone area are the coastal area in the middle south part of Luzon Trench stretching along the islands, and the west side of the trenches.

3-3-1 Earthquake of 1968

This material provided by the Office of Civil Defense is a report prepared by UNESCO just after the earthquake on Aug. 2, 1968.

Around 4:00 on Aug. 2, 1968 , a violent earthquake hit Manila. The seismic center was near Kasigren Town in Aurora Province approximately 230 km east of Manila, and the seismic scale was Magnitude 7.3. The seismic intensity in Rossi-fores scale was 8 within 50 km radius from the seismic center, 6 in Manila 230 km away from the epicenter, and 5 in Quezon City, Pasai City, Makati and other cities in the periphery of Manila.

The seismic intensities in major cities mainly in Luzon Island are summarized in Fig.Ⅳ-10. The seismic damages included collapse of buildings, ground fissures, and landslides mainly in Manila and Aurora Province, at the seismic center. In Manila, especilally, collapse of buildings resulted in heavy casualties.

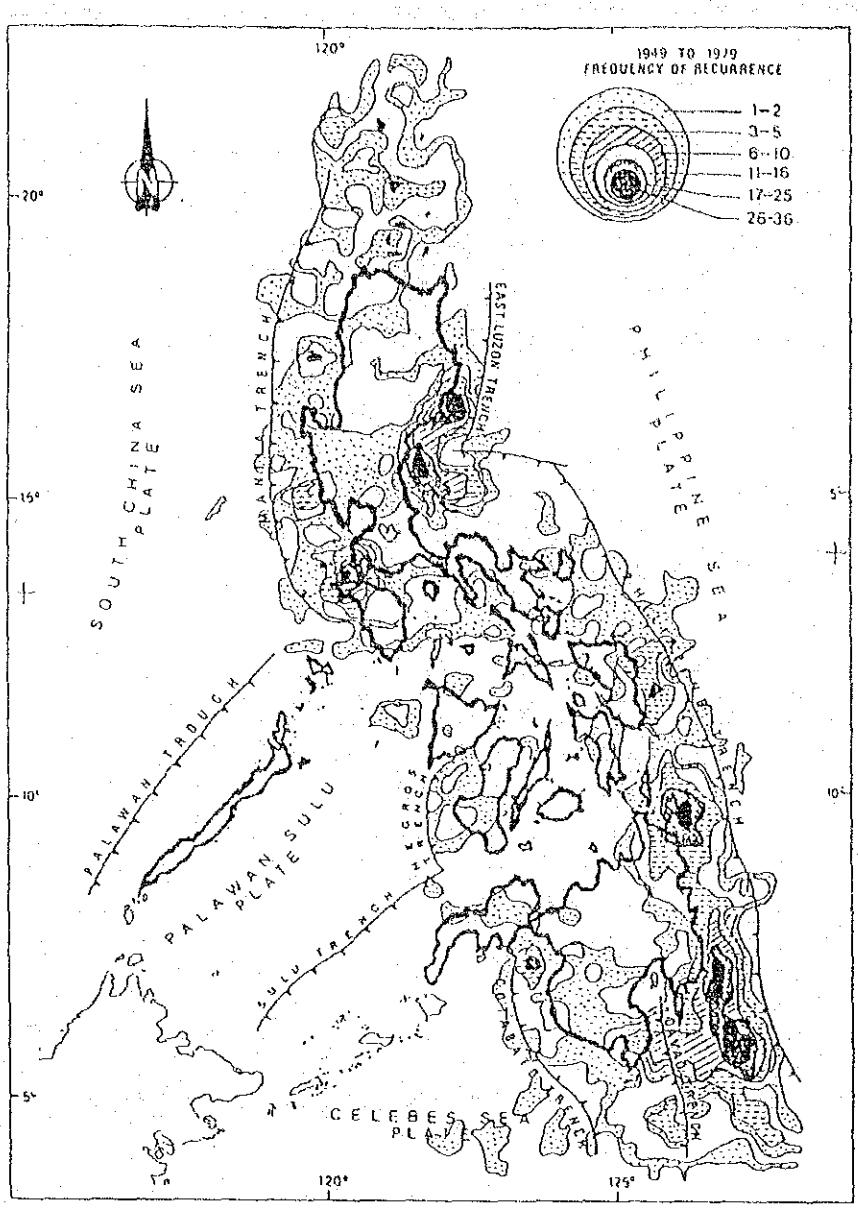


Fig.IV- 9 Earthquake-prone areas in the Philippines

Source; PHIVOLCS

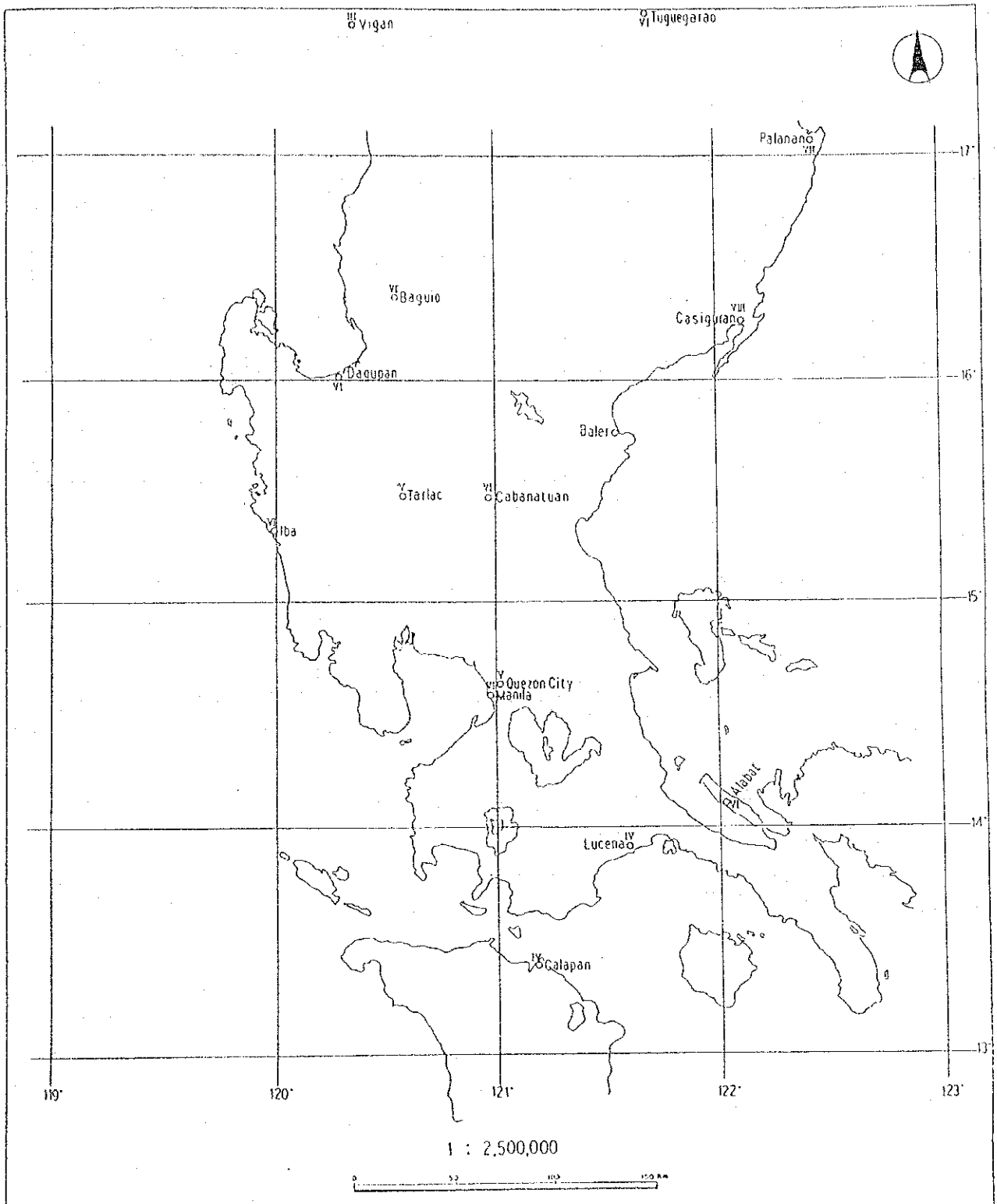


Fig.IV-10 Seismic Intensity Map (August 2 1986)

3-4 Volcanoes

3-4-1 Distribution of Volcanoes

The Philippines is a country where two major geological disasters occures often, e. g. earthquakes and volcanic eruptions.

The Philippines has 220 Quaternary volcanoes including 21 assumedly active ones. Detuin and Liy (1982) classifid the Philippine Islands into 4 major volcanic belts. (see Fig. IV-11)

(1) West convex volcanic belt (the west part of Luzon Island).
(2) East convex volcanic belt (from south-east Luzon to Samar/Dabao).
(3) West volcanic belt (Negros/Panay).
(4) South-west volcanic belt.

These volcanic belts relate to the subduction of the oceanic plates in the Manila trench, the Philippines trench, the Negros trench, the Cotabato trench and the Sulu trench.

Among these trenches in the periphery of the Philippine Islands, at the Philippine trench the most active subduction of the plate occurs westward with the annual displacement of 8 km. Bicol Volcanic Chains (east convex volcanic belt) is the most active volcanic chain closely relating to this trench.

The Philippines has currently 21 active volcanoes, of which 5 volcanoes, Taar, Mayon, Bulsan, Caraon and Hybock-Hybock, repeat volcanic activities at relatively short intervals (8-50 years).

As recent major volcanic eruptions, Hybock-Hybock Volcano in 1952, Taar Volcano in 1977 and Mayon Volcano in 1984 are listed.

Of active volcanoes distributing over the whole country, Taar Volcano which is likely to have the greatest effect to Metro Manila, is described in the next section.

3-4-2 Taal Volcano

(1) Volcanic landform

Taal Volcano located approximately 60 km south of Manila has an area of 23 km^2, surrounded by fresh water calderas (see Fig. IV-12).

Taal Volcano is the volcano with the lowest altitude in the world; the highest elevation on the south-west edge of the major crater is only 311 m above sea level.

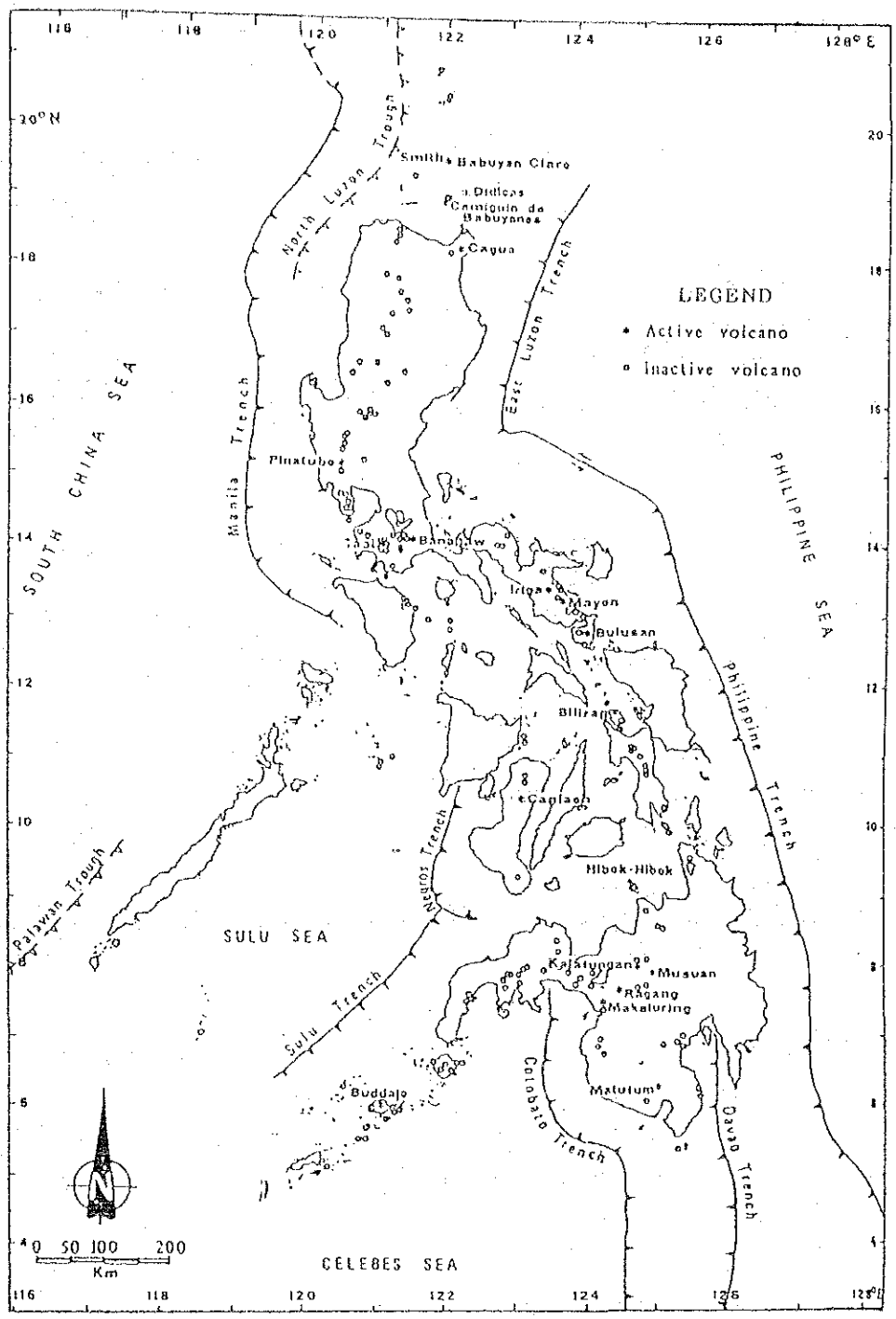


Fig.IV-11 Distribution of active and inactive volcanoes in the Philippines

Source; PHIVOLCS

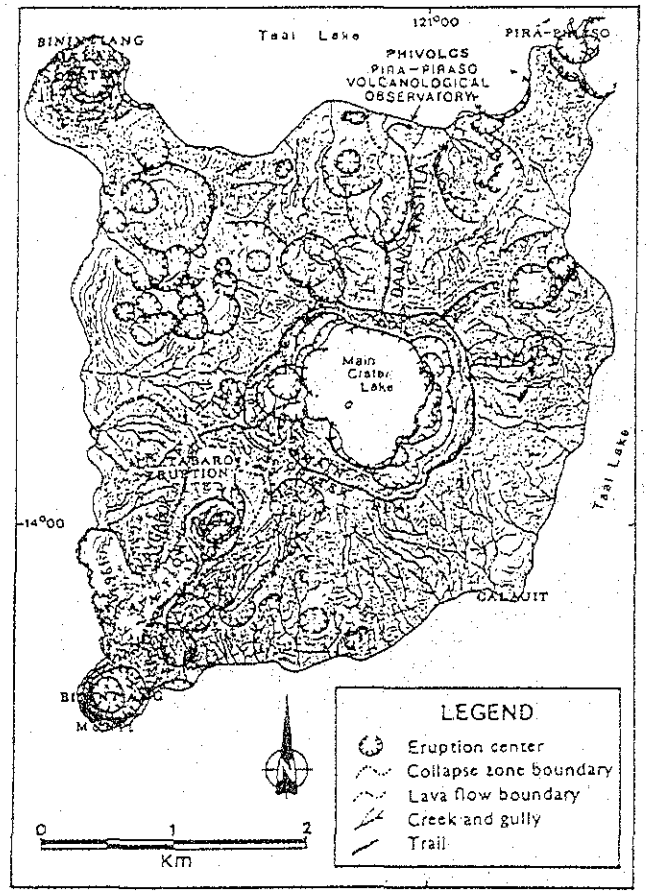


Fig.Ⅳ-12 Map showing eruption centers at Taal Volcano Island (R.S. Punongbayan and H.B. Ruelo, 1985).
Source; PHIVOLCS

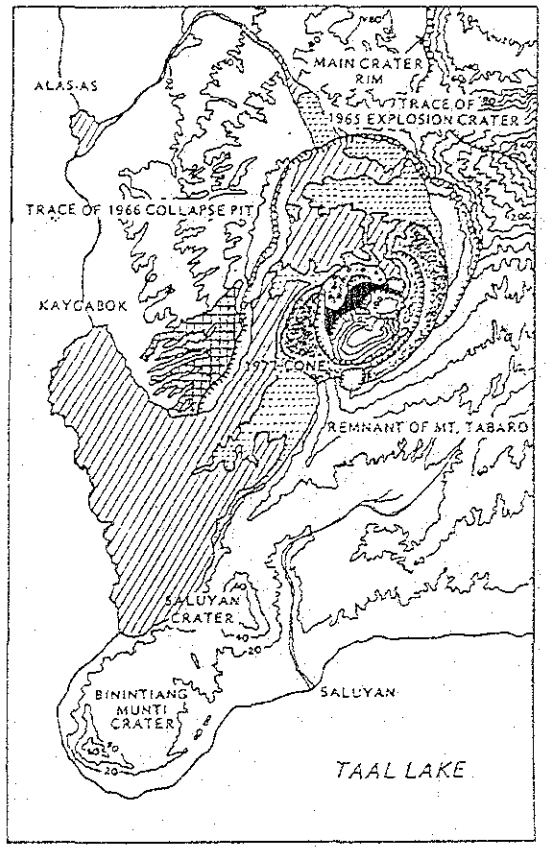


Fig.Ⅳ-13 Geologic map of Mt. Tabaro eruption site
(H.B. Ruelo, 1983)
Source; PHIVOLCS

Taal Volcano was formed through several eruptions. It consists of at least 35 volcanic cones, and has some 47 craters or concaves.

The major crater located in the center of the volcanic island has a diameter of approximately 1.9 km. The crater has calm and bluish green lake, from the surface of which a small island of approximately 100㎡ emerges.

This island is the remnant of the past eruption of the major crater. Past records indicate 12 eruptions of the major crater between 1749 and 1911.

The violent eruption in 1965 near Mt. Tabaro had changed the landform of this area until 1969 by the ejecta and lava flow (see Fig. IV-13).

(2) Eruption of Taar Volcano

By 1984, Taal Volcano recorded 33 eruptions since 1572 when the earliest one occured. During this period, most violent eruptions broke out in 1754 and 1911. The eruption of 1754 destroyed the old towns of Sara, Lipa, Tanauan and Tar isai.

The eruption of 1911 destroyed the whole area of this volcanic island with 1334 deads. Volcanic ash which erupted from the central crater reached Manila, covering the area of 2,000 ㎢. The form of the volcano implies phreatic explosion or phreatomagmatic explosion.

After the eruption of the central crater calmed down, the following eruptions started om Feb. 1965. However, the crater of those eruption emerged near Mt. Tabaro about 11 km south-east of the central crater.

The eruption near Mt. Tabaro broke out every year after 1965. The eruption of 1968-1969 which blew up lava from several craters and from the foot of the flank of the crater, implies the Stromboli type.

The eruptions near Mt. Tabaro were very violent until 1969. After 1969, the violence of eruption has decreased gradually. However, precise monitoring is still required.

V. APPLICATION OF LAND USE MAP

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1. UTILIZATION OF LAND USE MAP

This land use map is prepared using the 1:10,000 contoured map as the base on which the existing land use patterns are printed in 7 colors.

It is possible to recognize the existing land use together with various features (roads, railways, buildings, contour lines, coastal lines, annotations and others) shown on the base map.

It is expected that this land use map will be utilized as follows:

(1) Administrative organizations can use this map for planning of the redevelopment of built-up areas, development of suburban areas, improvement of transportation systems, housing development, disaster prevention, etc.

(2) Survey and Research organizations (universities, institutes, etc.) can use it for academic researches on geography, regional planning, civil engineering, etc.

(3) Public organizations and private enterprises can use it for the proper selection and development of sites for their activities.

(4) It can be more effectively used, together with a land condition map, for verifying the suitability of the present land use as well as for planning of the proper land development.

1-1 Utilization for Administrative Activity

The information of the existing land use can be used in various kind of administrative activities.

1-1-1 For Redevelopment of Built-up Areas

Excessive congestion of small buildings in the city reduces the efficiency of land use, arrests the sound development of the area and raises the hazard of disasters like a fire, an earthquake, etc. Government should make proper redevelopment plan for such areas based on accurate data. Land use map can provide a lot of useful informations for redevelopment planning, such as the distribution of congested built-up areas, numbers of buildings

of each categories, existence of substitute area for the residents, etc.

1-1-2 For Land Use Planning

In order to promote systematic and smooth development of the national land, it is indispensable for the national government to prepare the national land use plan intended to accomplish totally well-balanced development of the whole country.

On the other hand, for the purpose of the development of the urban and suburban area coordinated with the national land use plan, it is necessary to establish more detailed city plan which refers to every individual building and manage the land usage intensively and carefully.

In the processes of both these plannings, the information of existing land use must be one of the most fundamental materials for designing the effective plans.

In Japan, these processes are put forward in accordance with the "National Land Use Planning Act" and the "City Planning Law".

The former obliges the government to establish the National Land Use Plan, classifying the national land into 7 categories, agricultural land, forest land, natural grassland, water surface, road, building land (subdivided into residential land, industrial land and office, shop land) and other land, setting up present states and targets of the areal scales of each categories, and also obliges local governments to lay down the Land Use Master Plans including the classification maps, based on the National Land Use Plan.

The City Planning should be promoted under the requirements of the latter law on the City Planning Area designated by the Land Use Master Plans. Local governments shall classify the area into mainly 8 use districts, low-storied exclusive residential district, multi-storied exclusive residential district, residential district, neighborhood commercial district, commercial district, quasi-industrial district, industrial district and exclusive industrial district accompanied with some special zones e.g. school zone, port zone, scenic zone, green space conservation zone, etc., make the Use District Classification Maps and regulate so as every building shall be in accord with the designated usage. In order to make sure the effectiveness of these administrative systems, 1:2,500 Existing Building Usage Maps are prepared in every 5 years.

1:10,000 land use map for Metro Manila Region would be much useful for the design of land use master planning and city planning for this region as

the fundamental information of existing land usage, although implementation of more detailed survey should be reviewed which can express the features of every building for the purpose of urban planning.

1-1-3 For Agricultural Planning

It seems also effective to establish the agricultural promotion plan for rational development of the agricultural area, which shall include areal allocation of products. Land use map can provide the information concerning to whether existing distribution of each product is supposed to be well-balanced or not, where the particular products should be encouraged or how integrations of smaller farmlands should be promoted.

1-1-4 For Land Taxation

Usually charging of land taxes is based on not existing but registered land usage, and registered land uses often differ from the existing land uses, therefore land use map itself cannot be the source of taxation, yet it can be used as the reference data for charging the land taxes, for example, it can be the basis of rough estimation of land tax revenues from each area.

1-1-5 For Planning Traffic Systems

In the process of traffic system planning, it is indispensable to estimate the existing flow of persons and articles and predict its future. Land use map can be an indirect information source on these estimation, such as the scale of inhabitants and commuters in an area (from distribution of residential, business, industrial and governmental areas), direction and quantity of commodity flows (from distribution of commercial and transportation areas), possibility for construction of some transportation facilities (from distribution of open spaces), etc.

1-1-6 For Housing Development

Land use map would be also useful for preliminary selection of suitable sites for housing development, by picking out the unurbanized areas but relatively accessible to downtown.

In Japan, in order to clarify the trends of supply and demand of

housing lots in three large city areas, i.e. Metropolitan Tokyo and the suburbs of Osaka and Nagoya, "Survey on Trends of Land Use for Housing" has been conducted, whose contents are to prepare detailed past and present digital land use data from 1:10,000 scale land use survey conducted in every 5 years supported by the computer.

1-1-7 For Disaster Prevention Planning

It is important to prepare the disaster prevention plan in case that this region may be attacked by some severe disasters, e.g. large-scale fire, heavy flood or great earthquake, etc. Land use map can provide the source data of damage estimation, be the basic map of arrangement of temporary refuges and refuge routes, or indicate the distribution of public facility areas.

1-2 Utilization for Academic Activity

In the fields of urban geography, regional science and urban civil engineering, subjects concerning to the processes of urbanization and urban structure are very popular for researches. Land use map can give accurate scientific quantitative data for the researchers of these fields.

1-3 Utilization for Private Sectors

For the private enterprises, land use map can be a useful information for their economic activities. For example, marketing research is one indispensable process of market extension planning, and it cannot give satisfactory results without the information on geographical condition of consumers, suppliers or transportation systems. In order to raise vitalities of private sectors, land use map should be spread widely to the public.

1-4 Combination with Other Informations

Land use map shows only one section of the complex land situation. In the plannings concerning with the land, various kinds of land informations,

natural conditions including the land condition, geology or climate, dynamic statistics of the inhabitants and socio-economic condition besides of the existing land use, should be considered in combination. It should be also considered that the existing land use is changeable in time series, therefore the information regarding to the past states or the changes of land use shall be treated as different land information sets from existing land use.

Numerization of land information, especially the land use, is very useful, for computers can rapidly and precisely tell the relations between existing land use and other conditions, and show the changes of these elements. Geographical Information System (GIS), consisted from various kind of geographical information database and usage system, has been researched in many countries for these purposes, and from an idealistic viewpoint, setting up of GIS of this region would be advisable in the future.

Examples of combined use of land use map and land condition map are shown as follows. These analyses would not necessarily be accomplished by using computer systems, though it is true that they can provide more detailed data and save our time for calculations.

(1) Evaluation of Land Use and Land Condition by Isometric Square Method

This example can give a quantitative analysis of the degree of reasonable land development under various local inherent conditions.

At first, land use map and land condition map shall be divided into proper size of lattices (isometric square). In the case of Metro Manila Region, the size seems to be determined by latitudinal and longitudinal extent of 5" x 5" or 10" x 10"; i.e. the land use and land condition of each mesh are evaluated for approximately every 150 m x 150 m or 300 m x 300 m respectively.

There are various standpoints in adopting evaluation items and evaluation criteria depending on the purpose of the evaluation of land use and land conditions. The example shown in Table 1 and 2 represents a case on the assumption of urban land use planning in the future.

According to the Table V-1 and V-2, grades read from the land use map and the land condition map shall be indicated as land use (U)/land condition (L) for each corresponding mesh, and a resultant value shall be used for the evaluation.

This indicated figures (U/L) shall be evaluated for 5 divided land

conditions shown in Table V-3. The concept of the table is illustrated in Table V-4 and Fig. V-1.

Criteria / Grade	Criteria for evaluation
Grade 5	Land use district where an unspecified large population concentrates and which is essential in daily life. Residential district, commercial district, and others.
Grade 4	Land use district where an unspecified large population use is fairly wide, or a specified population use in a high density and the productivity is high. Industrial district, transportation/public district, rural community, and others.
Grade 3	Land use district which has high productivity in agricultural land use, and has a rather low population density. Paddy field, plowed land, plantation, and others.
Grade 2	Land use district which has a rather low productivity in agricultural land use and a low population density. Forest, grassland, marine pond, and others.
Grade 1	District where population concentration is very unlikely as in rivers, lakes, and others.

Table V-1 Criteria for Land Use Evaluation

Criteria / Grade	Criteria for evaluation
Grade 5	District where the land form is flat, high and dried, with high ground durability and almost no potential danger of disaster such as earthquakes and landslides. Suitable for both urban land use and rural land use are plateaus, terraces, and others.
Grade 4	District where the landform is generally flat and dry, with ground durability and low risk of flood, earthquake, and landslide. Suitable in general for both urban land use and rural land use. Gentle hill slope, slightly rolled hill, fan, and others.
Grade 3	District where the landform is flat but with rather low ground durability and possible damage caused by big floods and earthquakes, such as lowland with relatively good drainage. Suitable for both urban land use and rural land use in general, but a tough disaster prevention facility is required in some places, such as natural levees, sand bars, and banked lands, with a ground level of higher than 2 - 3 m.
Grade 2	District with fairly rolled and sloped landform, and humid lowland with nearly no inclination. Suitable generally for agricultural land use, but for urban land use proper disaster prevention facility and measure are required depending on the land condition, such as embankment, breast wall, drainage works, and bank. General slope of hill, gentle slope of mountain, valley bottom plain, flood plain, and others.
Grade 1	District where the landform is very steep and development is difficult, and the district where the landform is low and humid and the ground is soft, with expected damage of flood and earthquake. Mountain, steep slope on a hill, delta, sand bar lowland, backmarsh, and others.

Table V-2 Criteria for Land Condition Evaluation

U/L	Type	Evaluation
1.0	Balanced	Area where land use fits the land condition; including high level land use for the excellent land condition, moderate level land use for the moderate land condition, and extensive land use for the poor land condition.
1.25 - 2.0	Developing restricted slightly	Slightly excessive land use for the land condition; control or improvement of land use, or tightening of disaster prevention measures are required.
More than 2.1	Developing restricted	This type means an area where extreme high-level land use is conducted in a relatively poor condition and regulation or improvement of land use or tightened disaster prevention measures are urgently required.
0.8 - 0.6	Slightly developing accelerating	Extensive land use for the land condition, and future development (for higher level land use) is fairly possible.
Less than 0.5	Developing accelerated	Extremely extensive land use for the relatively excellent land condition; future development (for higher level land use) is quite possible.

Table V-3 Evaluation Classification

5／5 (1.0)	5／4 (1.25)	5／3 (1.67)	5／2 (2.50)	5／1 (5.0)
4／5 (0.80)	4／4 (1.0)	4／3 (1.33)	4／2 (2.0)	4／1 (4.0)
3／5 (0.60)	3／4 (0.75)	3／3 (1.0)	3／2 (1.50)	3／1 (3.0)
2／5 (0.40)	2／4 (0.50)	2／3 (0.67)	2／2 (1.0)	2／1 (2.0)
1／5 (0.20)	1／4 (0.25)	1／3 (0.33)	1／2 (0.50)	1／1 (1.0)

Table V-4 Distribution of Land Use (U)/Land Condition (L) Values

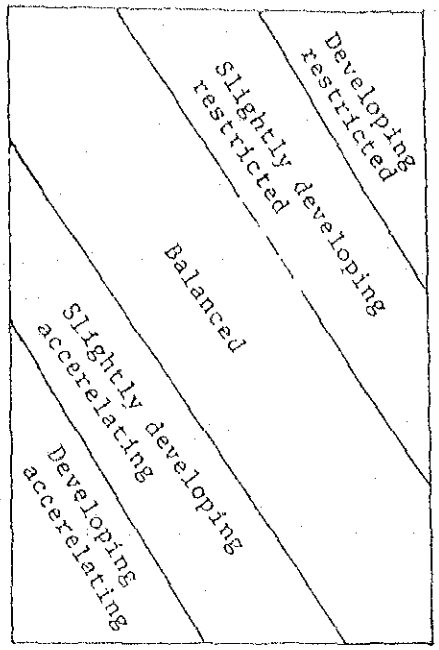

Fig. V-1 Types of U/L Value

This evaluation represents an evaluation of land use for the land condition for each mesh. Since the balanced type include various cases such as 5/5, 4/4 and 3/3, subdividing further can make the characteristics of the locality clearer.

Furthermore, other land information such as population, socio-economic condition and others can be subjected to digital processing to conduct numerical analysis.

(2) Evaluation of Land Use and Land Condition by Polygon Method

The polygon method makes available to employ actual appearance of each classification boundary on the land use and land condition maps for evaluation of particular area of both maps.

The example of the evaluation by this method for the same purpose explained in (1) is shown below:

On the basis of the criteria for evaluation shown in Table V-1 and V-2, a five-grade classification plate shall be prepared individually for both of the land use and land condition maps using respective boundary for land use classes or land condition units.

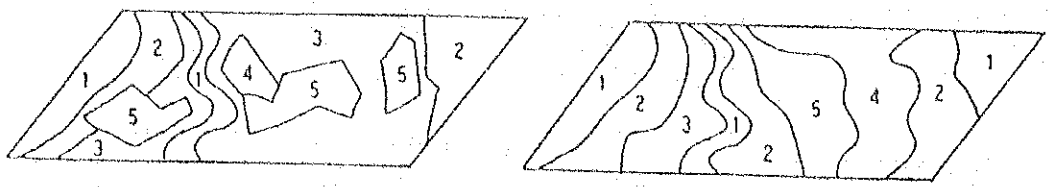

Plate for land use map　　Plate for land condition map

Fig. V-2 Preparation of Evaluation Plates

The numerical value of the evaluation shall be calculated by the equation as land use (U)/land condition (C) to represent each subdivided area that is delineated boundary by developing a composite plate of both five-grade classification plates.

The rated classes of the evaluation are explained in Table V-3.

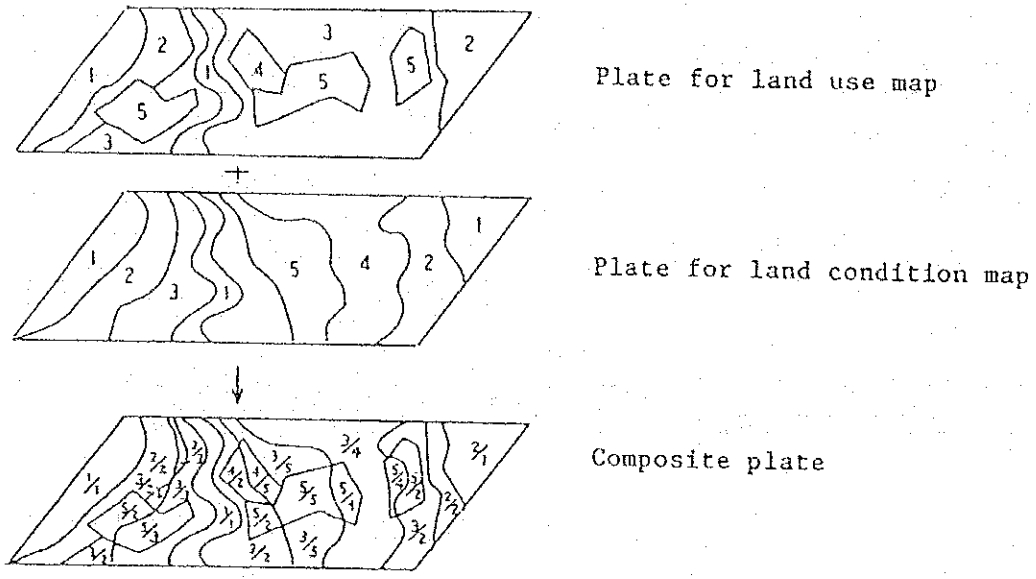

Fig. V-3 Development of Composite Plate

In this method, the evaluation of land use in each subdivided area can be conducted by comparing with corresponding land condition status as detail classification. The different point from the isometric square method is that it is possible in the polygon method to measure the areal extent of each subdivided small area quite precisely as well as to make a higher-level numerical analysis by digital processing of measured data with other information e.g. population, socio-economic condition, etc.

2. PRESENT PREPARATION STATES OF LAND USE MAP IN OTHER COUNTRIES

2-1 Japan

In Japan, various kinds of land use maps have been prepared by several organizations.

Representative land use map series in Japan is 1:25,000 scale land use map prepared by Geographical Survey Institute from 1974, covering about 100,000 km^2 of the most plains in the country. Land use patterns are classified into 34 categories, which are shown on the 1:25,000 topographic map as the base map (Table V-5).

The largest scale land use map that covers the whole country is 1:200,000 land use map, also prepared by GSI in 1983, with 18 classification categories (Table V-6).

As regards to the digital data, GSI has prepared digital land use data (about 100 m square gridded data) of the whole country, and also detailed digital land use data (10 m square gridded data) of the three large city areas, i.e. Metropolitan Tokyo and suburbs of Osaka and Nagoya (Table V-7, Fig. V-4).

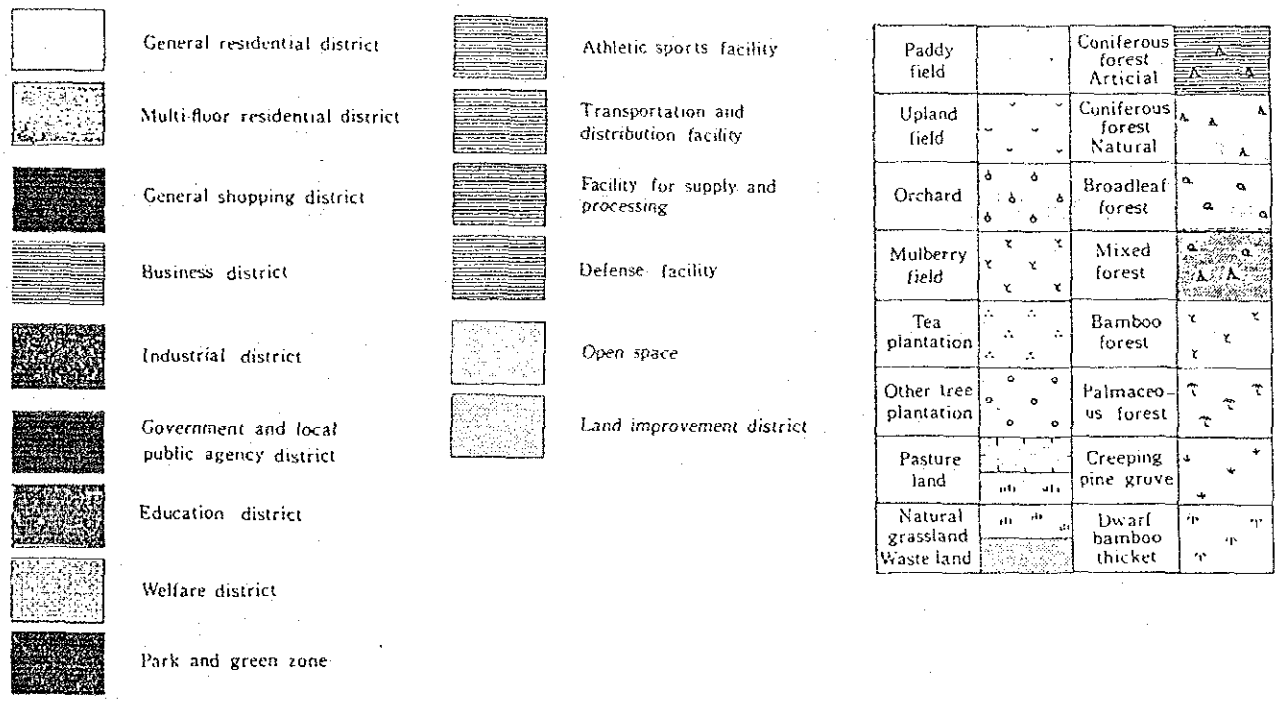

Table V-5 Legend for 1:25,000 Land Use Map in Japan

urbanized area

住宅地	commuting zone
商業地	commercial zone
工業地	industry zone
公共公益用地	public facilities and utilites
公園緑地	parks and urban forests
空閑地	open space

agricultural land

田	paddy fields
普通畑	dry fields
果樹園	orchards
茶畑	tea plantation
桑畑	mulberry fields
その他の樹木畑	other tree plantation
牧草地	pasture land

forest land

針葉樹林	coniferous forest
広葉樹林	broad leaf forest
混交樹林及びその他の林地	mixed forest
野草地	wild grassland
裸地	waste land without vegetation cover
水面・河川	water surface, river

Table V-6 Legend for 1:200,000 Land Use Map in Japan

Land use categories	Legend
1. Forest, wasteland, moorland, golf links, etc.	1 山林・荒地等
2. Paddy field	2 田
3. Upland field and other farm land	3 畑その他の農地
4. Land under development	4 造成中地
5. Open space (developed land)	5 空地
6. Industrial	6 工業用地
7. Residential (ordinary houses less than three stories)	7 一般低層住宅地
8. Residential (small crowded houses less than three stories)	8 密集低層住宅地
9. Residential (houses more than three stories)	9 中・高層住宅地
10. Commercial and business	10 商業・業務用地
11. Roads more than four meters in width	11 道路用地
12. Parks, green space, etc.	12 公園・緑地等
13. Areas for other public facilities	13 その他の公共公益施設用地
14. Rivers, lakes and other water surface	14 河川・湖沼等
15. Others	15 その他
16. Sea	16 海

Table V-7 Legend for Detailed Digital Land Use Data

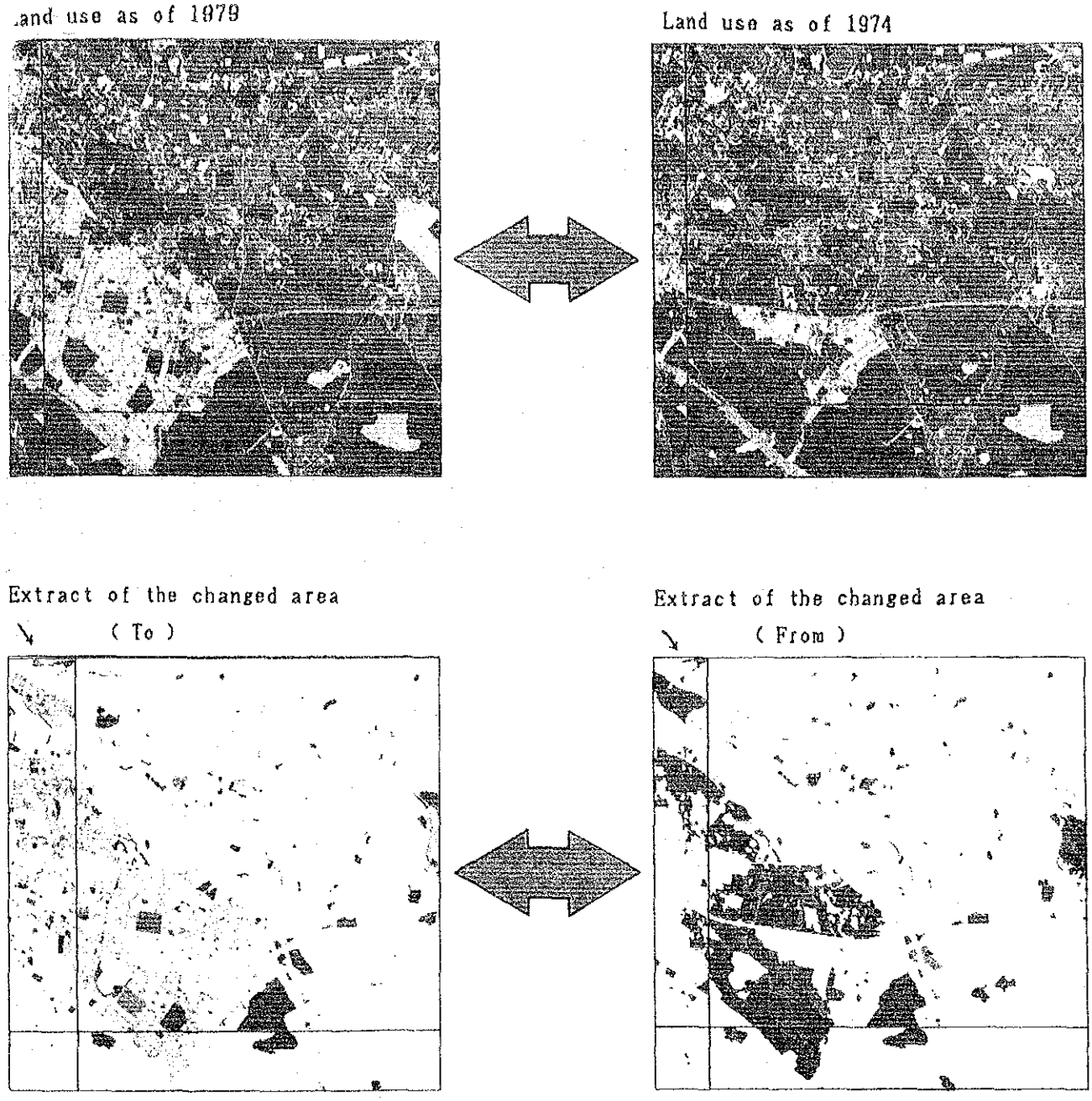

Fig. V-4 Examples of Output Images from Detailed Land Use Data Using a Computer System

2-2 Other Countries

In many countries, land use map has been prepared in various scales and with various categories.

The earliest land use map of the world is that of United Kingdom, which was made in 1930 to 1945 at a scale of 1:63,360, covered the whole country, and from 1960, 1:25,000 land use map has been prepared.

In most of larger countries, multiplex scales are adopted to express the situation of land use correspondingly to the areal differences of land use density, for example, in Canada 1:50,000, 1:126,720, 1:250,000, 1:500,000 and 1:1,000,000 land use maps are prepared.

Most cartographic researchers and map producing organizations in the world are paying attention to Geographical Information System, and land use information is one of the most important informations of GIS.

VI. APPLICATION OF THE LAND CONDITION MAP SERIES

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1. Introduction

This report is a general description how to use the land condition map series that JICA and BCGS have completed together this time.

2. A Land Condition Map

A land condition map is one of applied geomorphological maps for various purposes, especially, for prediction of flooding and better land use including regional planning. And it is also available to predict other natural hazards. The map is composed of three elements, as seen from the legend: 1) geomorphological land classification, indicating the terrain form and nature, 2) contourlines of ground elevation only in the lowland, and 3) organizations and installations concerned with disaster prevention, conservation of the environment and development. And this time, 4)additional legend on the shallow sea area were added for better use based on information supplied by BCGS.

M.Takasaki (the leader of this project, this time) compiled the first textbook on aerial photo-interpretation in Japanese in 1960. He referred to geomorphological mapping and its usages for engineers and urban-and-regional planners. M.OYA (Prof.Waseda Univ.) also edited a textbook on geomorphological mapping and its usage in 1983. And in the book, he showed seven fields for applied purposes for prediction of (1)surficial sliding, (2)flooding in extensive lowlands, (3)influences by land subsidence, (4)damages caused by earthquake including liquefaction, (5)ground water, (6) research of a lake and its surroundings, (7)flood damage in urban rivers. And these are effectively carried out using photo-interpretation.

3. Historical Background

3-1 The Recover and the Development in the Postwar Japan

After the Second World War II, many floods hit Japan every year. It was urgent for the Japanese society to decrease flood damages, to conserve the land and to fully use their natural resources because of the increased population on the narrowed territory. The government had to supply enough foods to people. In response to such social demands, some geographers studied river processes through drainage basins to make clear deposition in reservoirs, land collapses in the mountainous

areas and flood damages. Geomorphological mapping has been contributing to clarify characteristics of natural hazards and to make regional plans in the process of preliminary researches.

3-2 Flood Control from Breached Points and Embankment Lines to Unity of Drainage

Flood damages have been caused in various river drainages repeatedly and economic damages are seriously heavy loss through many countries. But, we cannot control floods perfectly still in the present. And new floods are caused in non-flooded areas in the past. Although the progress of civil engineering is noteworthy, the lowlands are not protected enough from flood damages. Traditional methods can protect spot by spot (breached points), or only along embankment lines, but never including the whole basin. Usually flood water comes from the whole basin.

The method to control flood damages was discussed in the Seminar on Flood Damage Prevention on Measures and Management at Thibilishi in Gruziya, U.S.S.R. in 1969. Thus the problem of flood control all over a basin gathered attention and basic studies have been requested by the world civil engineers. But there is no suitable references in civil engineering through the world, and physical geography can contribute to the problems.

In Japan, civil engineers and relating engineers have been trying to establish flood control on unity of the whole basin.

4. Various Geomorphological Mapping

4-1 Various Geomorphological Mapping for Applied Purposes

There are a few kinds of geomorphological mapping in Japan : (1) Geomorphological mapping called "land classification based on the land survey law by the National Land Agency under the Prime Minister's Office, (2)Geomorphological map series for prediction of flooding by the committee of the resources council under the science and technology agency, (3)The Land Condition Map Series by Geographical Survey Institute: M.Takasaki contributed to begin the project. The series has been being continued to prepare by GSI. (4)Simple geomorphological map series for prediction of flooding combined with landform classification and former topographic maps by the Main Office of River Work Bureau and GSI, Ministry of Construction. (5)geomorphologists compile various

geomorphological maps only for their academic researches.

Most of these maps are compiled to contribute to solve various problems. Prediction of flooding is one of them easy to understand and apply. Legend system must be the most suitable for each purpose and the objective area, for practical purpose, especially, a specified purpose.

4-3 Land Classification Survey by the National Land Survey Law

To prepare geomorphological maps by the National Land Survey Law has been being conducted since 1954. The law aims to provide fundamental information of the land for making better plans of land use, land conservation and preventive measures of natural disasters. Rapid economic development in Japan in 1960'-70's requested information of the land urgently. The National Land Agency (NLA:the Law was moved to NLA from EPA) promoted to prepare information of the land in response to such strong social requests.

The series are (1) about 50 sets of fundamental land classification survey maps at a scale of 1:50,000 with explanatory texts by governmental bodies. Each set consists of three kinds of maps: geomorphological map, surface geological map and soil map shown with each explanatory text, (2)1:200,000 scale land classification map series covering the whole country, (3)the new series at a scale of 1:50,000 in co-operation with prefectural offices and university staffs. Every year 30-40 sheets, and (4)land conservation map series.

4-4 Geomorphological Map Series for Prediction of Flooding at a scale of 1:50,000 by the Resources Council under the Science and Technology Agency (fig.VI-1,2)

If it rains heavily, it does not always cause flood damage. Flood damage is caused in combination with: (1)rainfall, (2)aspects of the land, and (3)social regimes including pattern of people's behavior in emergency and way of thinking on habitation. Flood damage is caused in contact with people and nature.

In Japan, plains have been formed by fluvial process. Sedimentation developed in flooding remarkably and repeatedly in the same area. And micro-relief of the plain surface and distribution of depositional material show the historical results of flooding in the past. And relief and landform complex in the drainage basin do not change for a long period. Consequently, if we classify the distribution of micro-

landforms, it must be possible to interpret characteristics of the past floods and future floods in the same drainage basin.

Based on the point of view, in the Committee of Landform and Flood in the Resources Council, M.OYA compiled the micro-landform classification map of the Nobi plain in the lower drainage of the Kiso river showing the relationships between landforms and flood aspects on the basis of the analysis of the micro-landforms a few years before the Isewan typhoon hit Nagoya and its vicinity. This series is called "geomorphological maps for prediction of flooding (suigaichikei bunruizu)". Map scale is 1:50,000.

Isewan typhoon hit the area in September in 1959 and caused the largest and severest high tide flood which drowned over 5,000 persons in the coastal lowlands in the Nobi plain along the Isewan bay. In Nagoya and its vicinity, it was reported that about 530,000 million yen (estimation at that time)in properties were damaged. The highest level of flooding by high tide has been used as the most important standard value against high tide flood in Japan still in the present.

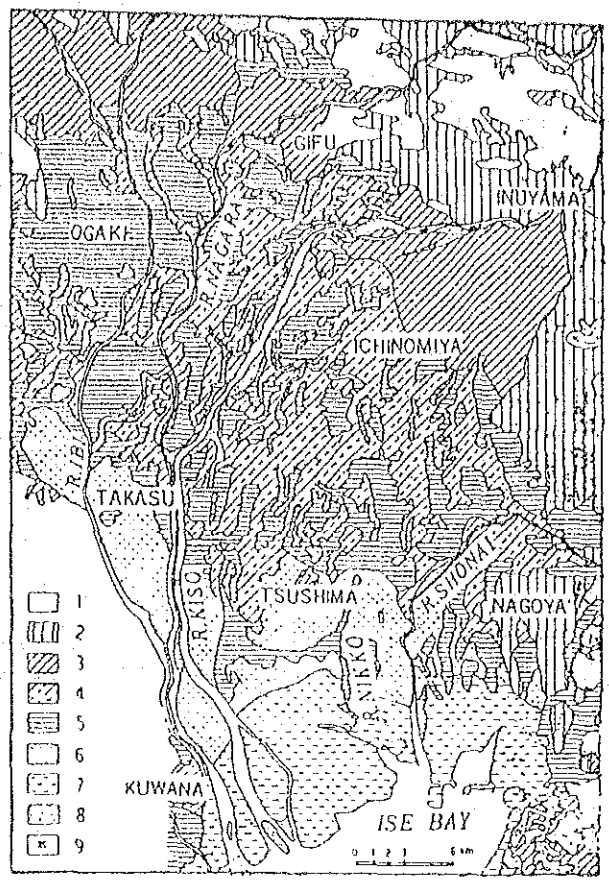
The flooded area and depth of stagnant flood water by the high tide almost coincided with the predicted area deciphered on the map, and it was proved that this map could be used to predict the type of flood and fundamental characteristics. It was terribly expensive and tragic experiment to prove the effect of the geomorphological map. (fig.VI-1,2)

And Oya has been continueing to compile geomorphological maps in the main river drainage basins in Japan and in large rivers in Asian countries.: In Bangladesh, Thailand, Laos, Indonesia and Taiwan.

4-5 The land Condition Map Series by Geographical Survey Institute

After the Isewan typhoon, the effect of the geomorphological map for prediction was discussed and evaluated in the National Diet. The Finance Ministry recognized the worth and included the preparation of the same kind of map series as the above mentioned map in the budget. M.Takasaki contributed to get budget and to establish the land condition mapping as a project for GSI. GSI started to prepare geomorphological map series, two sheets in a set in cut sheet. It is called "land condition maps for prediction of flooding at a scale of 1:25,000" in 1960.

The legend consists of (1)geomorphological units, (2)ground



1. mountain, 2. terrace, 3. fan, 4. natural levee, 5. back swamp, 6. delta, 7. reclaimed land, 8. dry river bed, and 9. tidal limit.

fig. VI-1 Geomorphological map of the Nobi plain

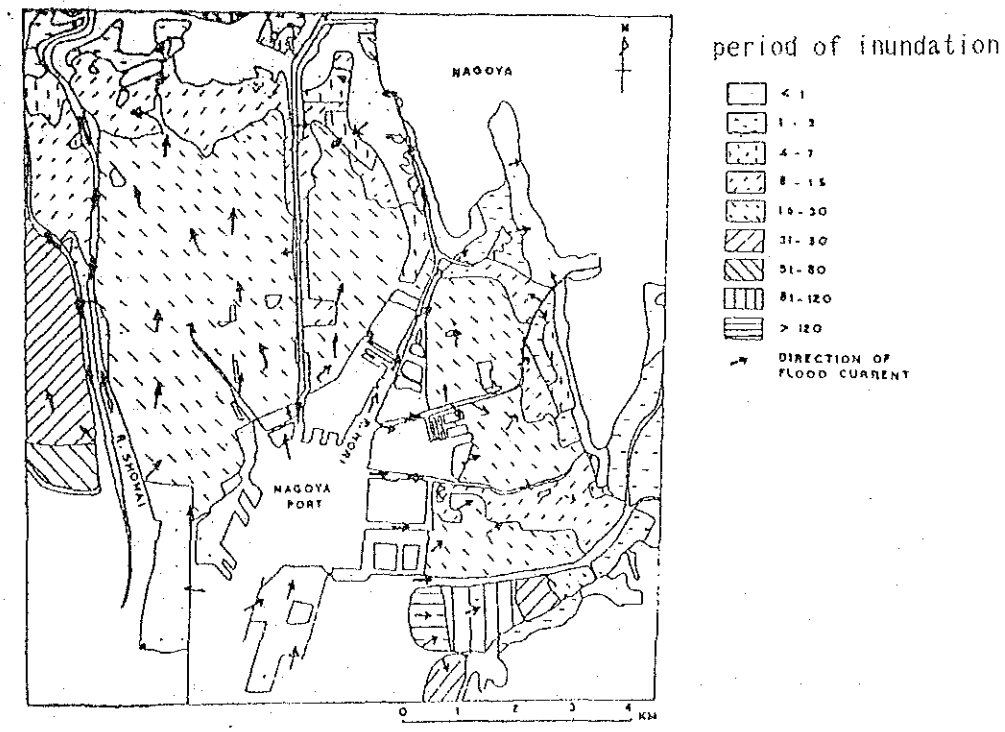


fig. VI-2 Map showing inundation around Nagoya port

level distribution using contour lines and (3)relating organizations on flood control. The objective area was only plain areas and the purpose of the project was only on flood control at the beginning.

But, in a few years, this map set of two sheets was compiled into one sheet together and its name was changed into "the land condition map (tochi joukenzu)". And the purpose was also changed into the development and conservation of the land and measurements against natural hazards. And the research area includes important plains.

In the present, the preparation of the series has been being continued in the following areas: the Kanto plain (Tokyo and its surroundings) via Nagoya, Kyoto, Osaka to Hiroshima continuously, and many other spot areas. This series is published and is on sale to the people. And supplementary explanations are distributed to the governmental and other public bodies. Map scale is 1:25,000. A few sheets have been added every year. This series is the model of this project.

4-6 Basic Survey Map Series on the Land and Shallow Sea Area

Similar series was established on the coastal area in 1972. It is the Basic Survey Map Series of Land Condition Including the Coastal Land and the Shallow Sea Area. Through the world, we have very poor information of the belt between the coastal land and the shallow sea area, for example, lagoon, because sea charts show the depth of the sea from the low tide level for the safety of ships' navigation and topographic maps show the information from the highest level of high tide. As a result, the narrow belt is remained as non-information zone. But the zone is very important for people to use as the extension of the land. The series aims to connect with information of a topographic map and a sea chart.

4-7 Simple Geomorphological Map Series Covering the Whole Important Drainage Basins by the River Bureau and GSI

The River Bureau of Ministry of Construction prepared about 950 sheets of simple geomorphological maps for prediction of flooding of the lowlands in the most important river drainages throughout the country in cooperation with GSI. The legend is remarkably simpler than the ones of former series. Former river courses were picked up from the former topographic map series published from 1888 to 1912 by

GSI. Map scale is 1 :25,000. Not for sale and only for administrative use.

5. Landforms and Flood Damages

These maps are available for evaluation of danger area against natural hazards, especially on flooding, and usually it is possible to read danger areas against earthquake damages and land subsidence, and to evaluate suitability of sites for regional planning.

It is very easy to understand how to use the land condition maps for prediction of flooding. And subsequently it is easy to understand for other uses. Here, characteristics of flood aspects through the basin is described.

5-1 Landform Complex in the Mountainous Area of the upper and middle drainage basin influence to geomorphological development in the plain of the lower drainage basin (fig.VI-3,4)

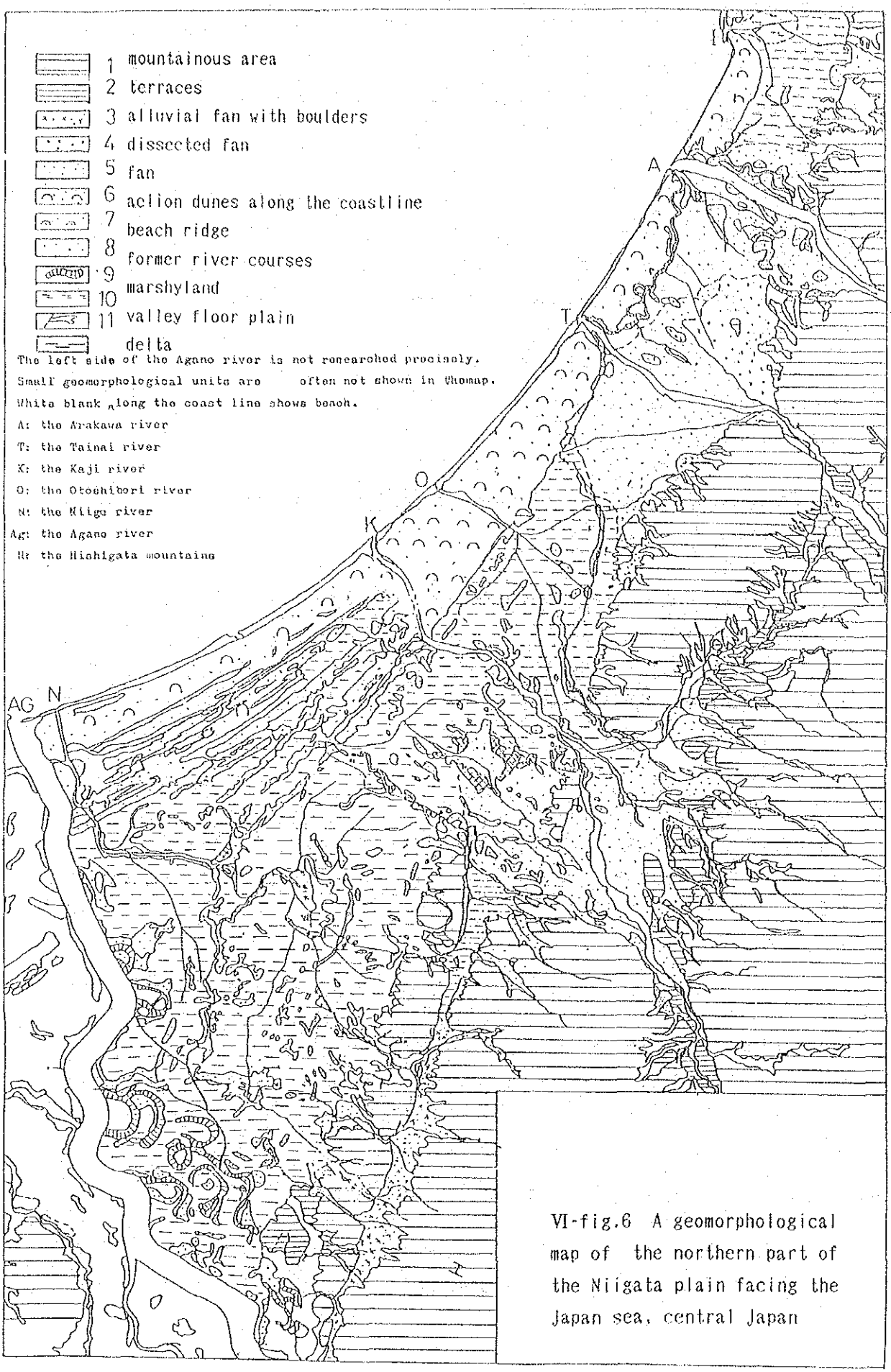
Landforms in the lower drainage basin have been formed by the deposition of transported materials from the upper drainage basin mainly.

Here, schematically considering the mountainous areas in the upper drainage basins as shown in the figure. There are two drainage basins which have almost common physical conditions, for example, geology, areal extent, plane form and so on, except distribution of basins.

Drainage basin A has very few or no branch in its upper basin, subsequently also very few places where to deposit. While, drainage basin B has many small basins in the upper basin. Evident difference between drainage A and B is distribution of small basins in the upper drainage basins.

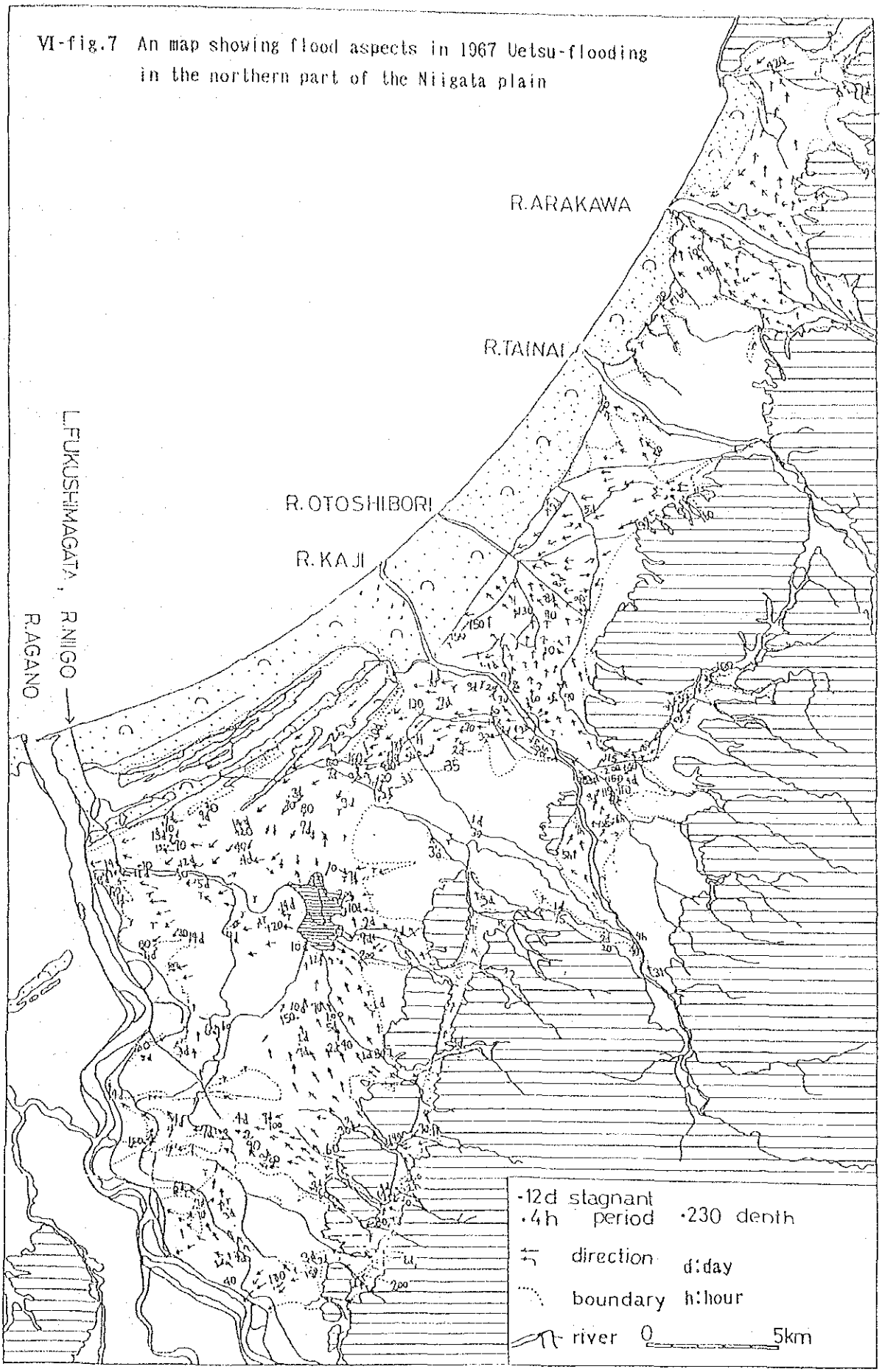
In the drainage A, rainwater and supplied materials flow down via v-shaped valleys to the plain relatively in a short period without any obstruction to flow. And the flood water hit the lower basin as severe and powerful flood with boulders and various materials. Hydrograph shows quick-increase pattern. Consequently it forms well developed fan very easily at the exit to the plain. And in the delta surface, flood water covers the area extensively, easily is stagnant for a pretty long period and subsequently much finer material deposited.

While, in the drainage basin B, rainwater and supplied materials flow down to small basins soon, but, in those basins, flood water



VI-fig.6 A geomorphological map of the northern part of the Niigata plain facing the Japan sea, central Japan

VI-fig.7 An map showing flood aspects in 1967 Uetsu-flooding in the northern part of the Niigata plain



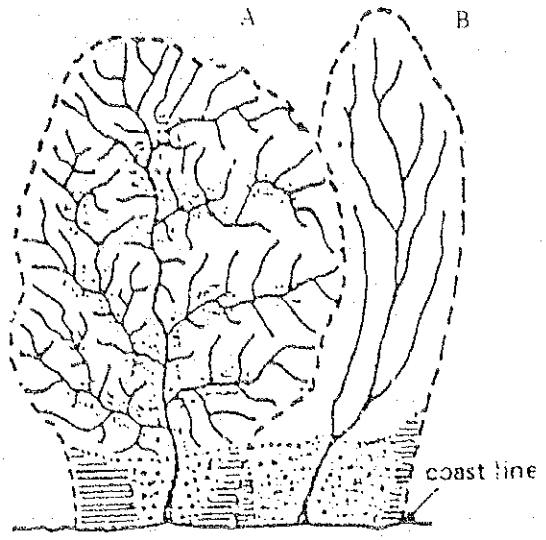
VI-tab.2 Relationship among landform complex in the upper drainage basin, the distribution of micro-landforms in the lower drainage basin and flood aspects in the lower drainage basin, case of the northern part of the Niigata plain

	MORPHOLOGY							
	UPPER AND MIDDLE DRAINAGE BASIN					LOWER DRAINAGE BASIN		
	PEAK OF HEADWATERS	TRIBUTARIES	distribution of lowlands BASIN VALLEYFLOOR PLAIN LARGE	SMALL	A. RESERVOIR B. WEIR C. BASIN TO DEPOSITE	GRADIENT	DIAMETER of GRAVEL cm	CHANGING OF RIVERBED
ARAKAWA RIVER	Mts.Asahi Ainichidake 1870 m Mts.Iide Jizodake 1539 m	many	Oguni Sekikawa	many	A, Akashiba Iwafune B. Arakawa C. many	1.3/1000 lower	Arakawazeki 40 Arakawa bridge 32 Asahi bridge 12	a few
TAINAI RIVER	Mts.Iide Monnsidake 1892 m	a few	Kurokawa	have not	A.Tainaigawa B. have not C. have not	6/1000 higher fan 5/1000 lower fan 1/1000 Kinodto-dainichi-gawa	Kurokawa bridge 200 Takano bridge 52	top of the fan raising end of the fan lowering
KAJI RIVER	Mts.Iide Nishidake 2102 m Sakai river (Tertiary Himeta river (1421 m)	many	lowland originated from faults valley of Sakai fan of the Main Kaji	a few	A. Iidegawa 1st,2nd B. upper reach of the main river valkley floor of the Sakai river C. fans in the middle drainage	2/1000 lower 1/900 backmarsh	Kaji-oohashi 14 Mano sand	raising
LAKE FURUSHIMAGATA	Mts. Hishigata Shoheiyama 954 m Hishigatake 974 m etc.	many	lowlands originated from faults	have not	A. have not B. weir for sandflow C. lowland originated from faults	1/1000 Oriigawa r.	lower sand silt	raising

This table shows the relationship between one landform unit and one flood aspect in the lower drainage basin and it shows the relationship between landform complex in the unified drainage basin and complicated flood aspects in the lower drainage basin in the northern part of the Niigata plain facing to the Japan sea in the central Japan.

				FLOOD ASPECTS					
				LOWER DRAINAGE					
SHORT CUT CHANNEL TO SEA	GEOMORPHOLOGICAL DETAILE	DEPOSITED MATERIAL	GROUND HEIGHT (m.s.l.)	CAUSE OF FLOOD	DIRECTION OF FLOOD WATER	DEPTH OF INUNDATION	RISING SPEED OF FLOOD WATER	STAGNANT PERIOD	SPEED OF FLOOD CURRENT
none	deltaic fan	sand, silt	1-16	river flood	top A and B	100-200 cm	fast	1 - 2 days	3-6 km/h
	natural levee	sand	3-15	river flood		160-200			3-6
	delta	silt	2-15		D	100-200	slow		3-6
	reclaimed lagoon	silt	-0.1-+2	from neighbour drainage	B	400	slow	3 -5 days	3-6
	dunes	sand	3-16	rain water					
present rivermouth	higher fan	gravel,sand	13-60	rain water and boulders	A		slow,sudden		
	lower fan	gravel,sand	9-40	riverflood and boulders	B		slow		
	delta	silt	2-5	riverflood		80-100	quick		
	dunes	sand	3-25	rain water					
present rivermouth	fan	sand,silt	10-15	riverflood	B	road		2-6 hours	1-6
	delta	silt	3-10	riverflood and rainwater	B,D	80-200		1 -7 days	1-6
	natural levee	sand	5-12			0-120		0-5 days	1-6
	remnant of lagoon	silt,clay	0-5	from neighbour drainage	B	200-400	slow	10-14 days	1-6
	lowland between beach ridges	sand,silt	1-2	from neighbour drainage and rainwater	B,D	80-100	slow	3-5 days	1-6
	beach ridges anddune	sand	3-31						
present rivermouth	delta	silt	below 5 generally 2-3	riverflood and rainwater	D	0-100		2-7 days	1-3
	lake and lagoon reclaimed	clay,silt	2- below 0	from neighbour drainage overflow beyond divide line	B	above 300	slow	10- 20 days	1-3
	natural levee	sand	2,5-8	from neighbour drainage rain water	A	0- 30	slow	0-12 hours	1-3
	lavland between beach ridges	sand,silt	1-2	same	B,D	60-200	slow	3-14 days	1-3
	beach ridge	sand	2-15	same					

A spreading, B gathering, C sudden flood from small valleys, D overflowing from the neighbour drainage basin beyond the divide line



1 delta and coastal plain
2 fan
3 river channel and depositional places (valley floor, small depression)

fig.VI-3 Map showing two drainage basins to compare drainage A and B

reduces its speed and most of supplied materials are left there. And flood water flows down to the plain with few materials except finer material. In this case, a very poor fan is formed at the exit to the plain. Flood water has not strong power to transport coarse materials to the plain and it is relatively mild flooding.

If the total quantity of supplied materials in the upper and middle basin of each drainage basin is similar through drainage basins, the total quantity of transported materials at the top of each fan varies depending on the distribution of slopes and depositional basins in each upper and middle basin, because most of materials are left in depositional basins.

Consequently, it can be said that quantity of transported materials to the lower plain is decided by the distirbution of landform complex in the mountainous area of the upper and middle drainage basin. It is easily shown by the distribution of drainage patterns and basins.

5-2 Micro-landforms in the lowlands (fig.VI-5, tab.VI-1)

As above-mentioned, the distribution of micro-landforms is the result of fluvial process for a long time. Deposits by one-time flooding, that is, the newly developed landforms work as existing relief at next flooding. The phenomena repeats in the same area many times for a long period and micro-landforms developed and characteristics are emphasized gradually. Thus, to clarify the distribution of

micro-landforms is to clarify the characteristics of flooding which were caused in the past and will be caused in future.

In addition to these natural landforms, artificial landforms are formed: reclaimed land by draining and by landfill by sand pump, thick banked-up unit, excavated area and flattened area for cultivation.

In flooding, slightly higher micro-landforms than the surroundings, for example, natural levees, dunes in the delta, fan-surface except former and present river courses, are relatively safe against inundation. But, slightly lower micro-landforms than the surroundings, for example, former river courses, coastal lowlands, delta surface, are easily inundated and often flood water is stagnant for a pretty long period. This relationships between flooding and micro-landforms are seen in relatively large plains. And the name of geomorphological unit is correlated to flood aspects.--- Flood types can be distinguished very clearly.

VI-tab.1 Simple relationship between landforms and flood aspects

geomorphological unit	flood	depth of flood water	period of stagnation	velocity of flow	transport deposit	destructive intensity
valley floor	sudden flood	shallow	short	fastest	coarse material	strong
	overflow	shallow	short	fast	coarse material	weak
fan	overflow	shallow	short	fastest	coarse to fine	weak
	spreading at breached point	deep	short	fastest	coarse to fine	strongest
delta	overflow	deep to shallow	long	slow	fine	weak
	spreading at breached point	deep	short	fastest	coarse to fine	strongest
	inland inudataion	shallow	short to long	slowest	very fine	weak
lagoonal lowland	all kinds of floods	deep	longest	slowest	very fine	weak
former river course	various types	deep	longest	slow to not move	very fine	weak
sandy mounds natural levee	various types	shallow or none	shortest	various	coarse to fine	weak

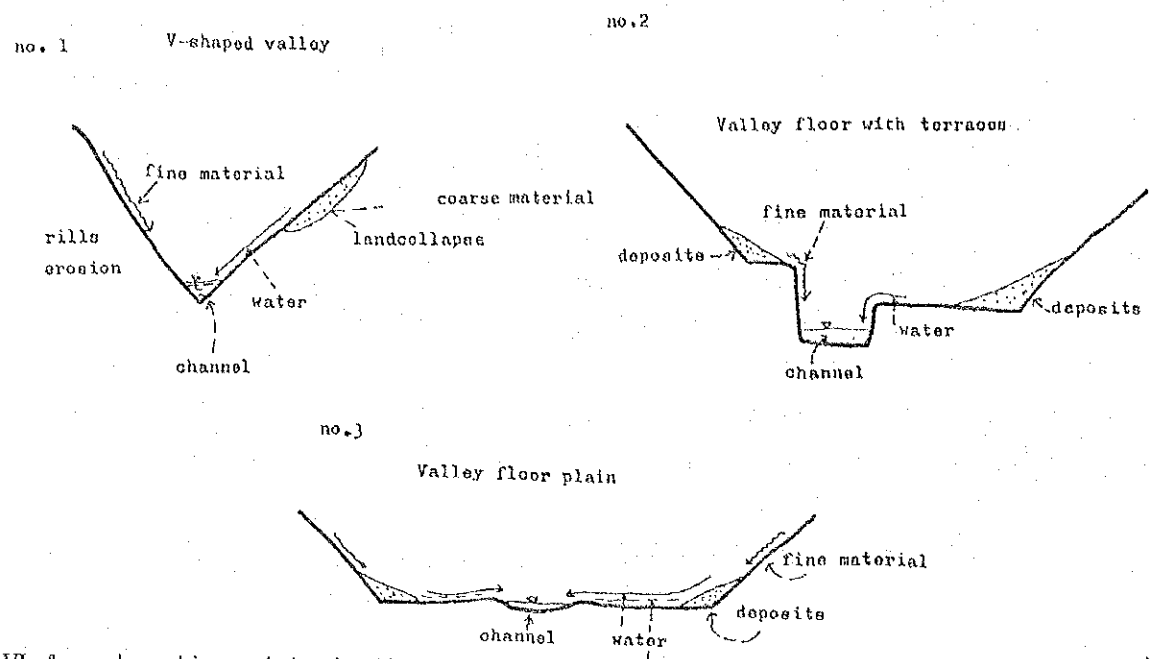


fig.VI-4 schematic models in the depositional places in the mountainous area

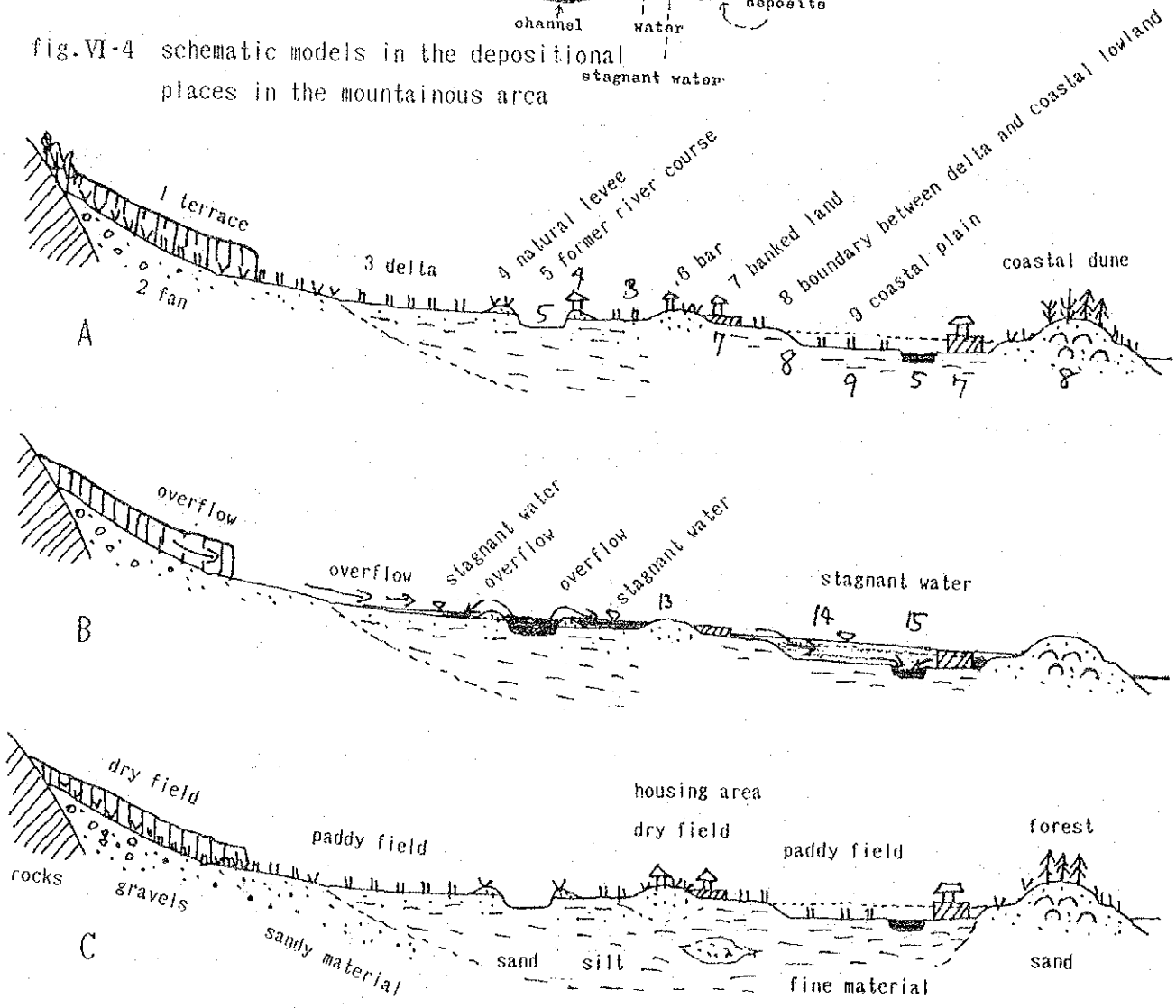


fig.VI-5 schematic models in a lowland

5-3 Overspilling from the Breached Point

At the breached points of the embankment, sudden flooding can be seen and it is not explained eveidently using micro-landforms. Flood water suddenly spreads over the lowland from the point with strong power to destroy and much material and flood water excavates a pond at the point closely to the breached point and deposits thick sand and gravels in the outer side of the pond.

5-4. The Relationships Between Landforms and Flooding(fig.VI-1～7)

Based on above mentioned description, typical flood types are seen in plains shown in the followings. An example is shown in fig.VI-5,6.

1) Flood type seen in boulder fan : At the foot of the mountainous area, fans are easily hit by boulder flow with sudden and strong flood water with intensive erosion and deposition.

2) Flood type seen at the fan: This type can be seen at the fan. Short time overflowing with materials. Channels are easily changed. Deposition of gravels and sand can be seen often.

3) Flood type seen in the natural levee zone: This type can be seen in a valley floor plain, natural levee zone and delta. In the surroundings, flood overflows repeatedly and leaves much material and develops natural levees. Usually, few flood can be seen on the natural levees except breached point. At the breached point and its surroundings, much sand deposits a little higher sandy unit----called newly formed natural levee---.

4) Flood type seen in former river courses: From 2-3 days to 10 days stagnant period. Stagnant water often forms marshy area. Most dangerous against flooding.

5) Flood type seen in backmarsh:This type can be seen in the lowlands inter-natural-levees. Flood water and rainwater in the protected lowland concentrates to this area. And a long stagnant period, deep depth, very slow flood flow. Silt and clay deposit.

6) Flood type seen in delta: Flood water from the upper drainage basin, or from the breached points flows down in slow speed, and is stagnant for a long period.

7) Flood types seen in a coastal plain and reclaimed land by draining: The area is the most easily inundated for a long period longer than several ten days.

8) Flood type seen in reclaimed land by landfill: In this area, each unit have been formed in different period, then, individual unit of the area has various distribution of ground level. Sometimes, land subsidence and artificial change of land surface formed various ground level. And lowered part of the area is often inundated.

9) Flood type seen at the exit of mountainous basin of the upper side of the narrowed gorge: While flood water drains away, it is stagnant for several days. Fine material is left after draining away.

6. How to Use the Map Series for Prediction of Flooding

6-1 Procedure to Interpret the Map Series

Based on the above mentioned explanation, the users can read and interpret the map for prediction of flooding.

1) Please unfold the map series with topographic maps including the whole drainage basins of the rivers which pour into or flow through the objective area. And read topographic maps to hold fundamental characteristics of each drainage basin on flooding, especially, on the upper and middle basins that you can know whether each drainage basin carries much material to the lower basin or not, and whether past flood water caused active and destructive flood flows or not. Please compile these elements into a table. And you can know whether the river transported much materials and caused severe flooding or not at the top of the fan.

2) Read the distribution of micro-landforms in the lower drainage basins. In the lower plain, flood flow are dominantly influenced by micro-landform units: fan, delta, dunes, former river courses, natural levees, reclaimed land by landfill or draining, former pond, artificial change including embankments, roads, highways, bridges, railways, housing area and various structures for public facilities.

3) Distinguish higher landform units and banked units from the other units. Higher units are slightly higher than the surroundings and relatively safe against flooding. If flood overflowed the units, the period is usually very short. If flood water overspilled on the fan, the flooding period is very short, but sudden floods or strong floods often carry much boulders and sandy material on the surface of the fan. And sometimes flood water will change its river courses temporarily or permanently. Stagnant period is also shorter than several hours.

4) Distinguish the lower units from others in the same manner as 3).

In lowlands, former river courses, ponds, reclaimed land by draining are usually inundated very easily and the stagnant period is also very long. In the example of Isewan typhoon in Nagoya, the stagnant period is one month to three months or more. In the case of the Uetu flooding, in the northern part of the Niigata lowland, two weeks to three weeks. Depths of flood water is usually deep than the surroundings: 2m to 3m. In general, deltaic surfaces are usually very flat and used marshy paddy fields. Flood water flows slowly and mildly, and stagnant period is pretty long. Depth of flood water is rather deep.

5) Coastal dune area is usually safe from flooding. Terraces are also safe from flooding if they are distributed broadly, but sites near the foots of mountainous slopes, the sites are perhaps often dangerous against sudden flooding including boulder flow from the mountainous slopes, small valleys located in the upper basin of the sites.

6) Intersects with river embankments and former river courses must be remarked enough whether the point beneath the embankment consists of consolidated soil or not. If the site consists of loose material, the site is very dangerous against flooding. Flood water can easily breach the embankment at such a point. Usually former river courses remain for 300 to 400 years in Japan and former topographic maps show changes since recent several ten years.

7) When you read the maps, if you find various landform units, the highest units are the safest usually. And gradually the lower units become to more dangerous against flooding. Lower landforms are easily inundated by flood water. For example, as above-mentioned, the lower plain in Nagoya was easily inundated by high tide flood. Especially, stagnant area after the peak of hydrograph was evidently showed by the map.

8) Now, you can read danger area against flooding in the map, and interpret the best location for habitation, house building, construction of roads, bridge and others.

9) Overlay a transparent paper on the map, and write and draw your result of reading and interpretation from the map series.

10) If possible, draw the past inundation areas and sites by the past flooding onto the map. And compare with 9) and 10). Consider common characteristics of flooding in the research area.

7. Damages caused by Big Earthquake

7-1 Liquefaction (fig.VI-8)

As well known, the San Francisco earthquake caused severe damages and liquefaction in the coastal reclaimed area. And we Japanese have many experiences of earthquake damages and liquefaction caused by past big earthquakes. According to Japanese experiences, these are easily caused in cities facing the coastline at which ground consists of alluvial layers, especially, artificial banked ground.

A big earthquake causes various kinds of damages. They are sudden or slow slide of slopes, collapses of landfilled earth, liquefaction of soil ground, destruction of buildings and other kinds of damages. People have selected to live in better sites through many generations.

But, recent years, population has been increasing quickly and people also move through the country very often and have extended to live in lowlands where are very dangerous against earthquake. And houses, roads, embankments, port facilities and others are constructed in soft ground in lowlands which are weak against earthquake, that is, these are man-made earthquake damages.

Coastal lowlands have been formed by the sea level change of fluvial and marine processes after the last ice age during about 20,000 years. Thus, lowlands usually consist of very soft or weak geology against earthquake. And if people live in such lowlands, earthquake damages will be caused very easily and severely. When we consider earthquake damages, if we discuss the problems based on the past experiences through generations, the results will be effective.

Liquefaction by earthquake is usually caused in the soft ground. Loose subsoil saturated with water changes its property from solid material into liquid material by the sudden increase of pore water pressure by the shock of earthquake. Shock of earthquake destroys subsoil structure. And soil grains must float in water and water with soil grains spouts via weak cracks out of the ground surface as sand volcanoes. After water spouts higher than 2m, subsoil layer is compacted very quickly and ground surface often subsided down. This phenomenon is a liquefaction. This makes buildings, houses, and telegraph poles sink down into the ground, and pipelines and boxes float out of the ground surface.

The author observed that liquefaction in Chiba near Tokyo by 1987 Chibakentouhou-oki earthquake was caused in many sites of the former river courses which were reclaimed using sand pump about 30 years ago

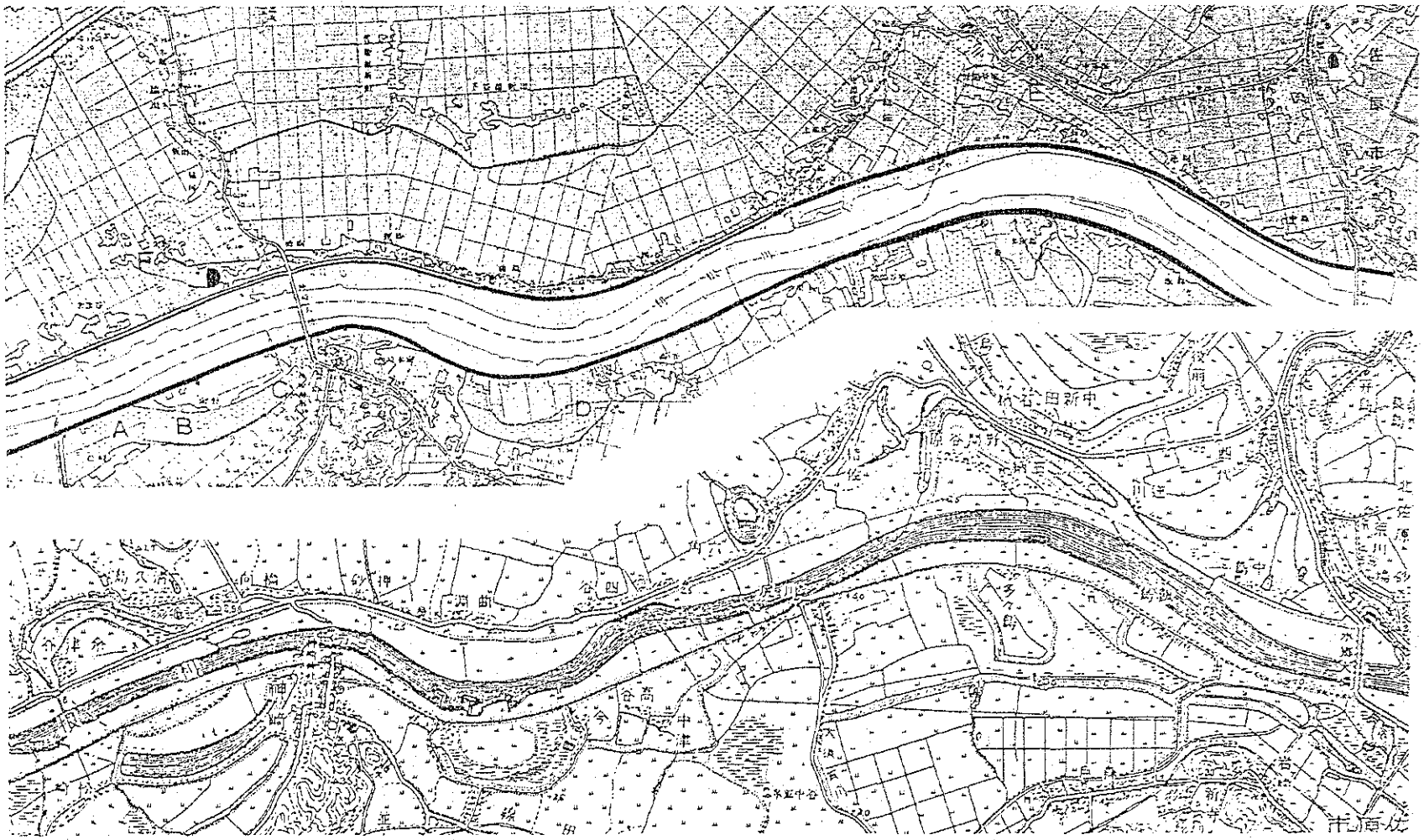


fig.VI-8 A-F are sites where liquefaction was caused. All the points belong to former river courses.
upper: 1:25,000 land condition map "Sawara" ×0.5, lower: 1:50,000 topographic map "Sawara" in 1960 ×1.0
by Akagiri(1988):a report on damages caused by the Chibaken-touhou-oki earthquake and land condition in the lowland GSI jihou (in Japanese)

in the Tone lowland in the lower drainage basin of the river Tone. And Nihonkai-chubu earthquake in 1983 caused liquefaction in many sites which had fundamental conditions to cause liquefaction: at the end of dunes, landfilled sites, embankments, former river courses, and artificial grounds.

Factors which influence to liquefaction are as follows: (1) strength of earthquake and continuation of period, (2) density of soil (void ratio, relative density, N value), (3)distribution of grain size of subsoil, (4) groundwater level and (5)structure of layers (geologic structure of the objective layers including depths of sand layer).

These are relating to surface soil distribution and sub-surface geology. And these are also shown using geomorphological maps pretty well because soil and sub-soil distribution are dominantly influenced by the distribution of landforms. Landform distribution also relates to surface geology, soil distribution, ground water level in shallow layer and land use. And geomorphological maps are used as preliminary maps to research and compile soil maps.

Geomorphological maps are available to know the property of the ground at every landform and consequently to predict the damages preliminarily. The maps can show distribution of micro-landforms very precisely. Users can interpret landform units to make clear danger sites against liquefaction based on the relationships between landforms and occurrences of liquefaction as above-mentioned past examples.

7-2 Procedure

1) Distinguish former river courses from other units. And if those are reclaimed by landfill, make sure whether the work was done ①using sand pump or ②by man-power or by dumptruck. Subsoil and sub-surface geology is well sorted in landfilled units using sand pump. And if such units are saturated with water, earthquake easily causes liquefaction. In such cases, consider the measurement against liquefaction in the objective area.

2) Interpret the map based on the the followings: ①artificial landform units, former river course, evidently saturated units, edge of sandy units, embankments, paved banked up roads, reclaimed land by landfill using sandpump. If these are saturated with water, the units are the area where liquefaction are caused easily. Especially, units which consist of well sorted sandy material, the most dangerous against

liquefaction. ②delta surface and similar units. units except ① and ③. ③terraces, fan and other dry and hard group. Usually liquefaction is not seen.

3) Draw boundaries of three groups above-mentioned on the map and color them. If it is possible to draw the past liquefaction sites, also plot the sites on the same map superimposedly. And compare with the past damages and the results of evaluation using ①, ② and ③, and draw dangerous places against liquefaction.

4) If artificially ground level lowers down and the area becomes wet or marshy, subsequently land condition on liquefaction will also change.

8. Land Subsidence

8-1 Land Subsidence

Land subsidence is a phenomenon which ground surface lowers down quickly in a short period and which the consolidation of geologic layer is caused by over-extraction of ground water including natural gas water. This is artificially caused by people's active behavior and seen in the lowlands facing the coast lines and large intermontaine basins with lakes and abundant groundwater in Japan.

A big city uses an enormous amount of ground water every day, and total quantity of ground water use reaches often more than one million cubic meters per a day in a limited lowland of several ten square kilometers. Also a group of factories in modern industrial area usually use a great deal of ground water every day.

And if one of such landscapes or phenomena are seen in the objective area, we must pay much attention to the cause of phenomena whether they are land subsidence or not. Earth movement is usually less than 1 to 2mm in alluvial lowlands. Over 5 to 10 mm per one year is usually too large as earth movement.

Land subsidence is usually caused by the consolidation of geologic layers by the over-extraction of groundwater. Aquifers are mainly in the alluvial formation for daily use (shallow), in the diluvial formation for industry 200-500m(deep), and over 1,000-2,000m for natural gas and iodine(deepest).

Lowlands consist of flat and low surface and soft sub-surface geologic layers. Geologic layers consist of grains and pore(air and water) and the porosity (ratio : the whole pore / the whole volume in

the objective geologic unit) is 44% to 50% in the case of loose sand layer, 60% to 71% in soft clayey layer and large value in unconsolidated sediment layer, but small value in rock.

Pore of geologic layers are saturated with water under the ground water level. When this kinds of soft layers are pressured by heavy buildings, landfill and so on, structures of soft ground layers are easily destroyed and deformed plastically and subsequently the porosity decreases and geologic layers are consolidated.

Thus, such compaction of geologic layers is called the consolidation which are classified into a few types: 1)by the decrease of buoyancy (aquifer of free groundwater), 2)by the decrease of the ground water pressure in the aquifer of confined water, and the similar phenomena of natural gas water in the deepest layer(1,000m to 2,000 m).

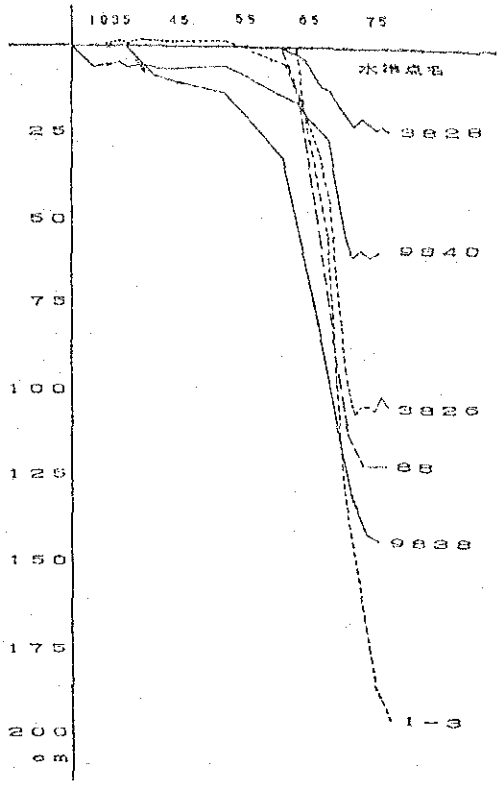
People can see only a result, which is the lowering of ground surface, as land subsidence. In saturated geologic layers, structures of grains exist in groundwater and the over extraction causes the decrease of buoyancy and the weight of geologic layers increases and subsequently consolidation is caused.

Extraction of groundwater from the saturated layers causes the decrease of groundwater pressure. And groundwater is supplied from the surroundings which keep higher groundwater pressure. In the case of confined water, this supply relates to the extraction from the surrounding layers. The decrease of confined water pressure causes the difference of the surrounding water pressure.

And groundwater of the surroundings is extracted and moves toward the lower pressure point. It takes pretty long period, subsequently consolidation of the movement of the groundwater continues more than ten years.

Administrative countermeaures to stop land subsidence is often delayed in time, it means that an enormous amount of extraction by industrial factories has been continueing while land subsidence has been developed remarkably till the mechanism is proved in the objective area.

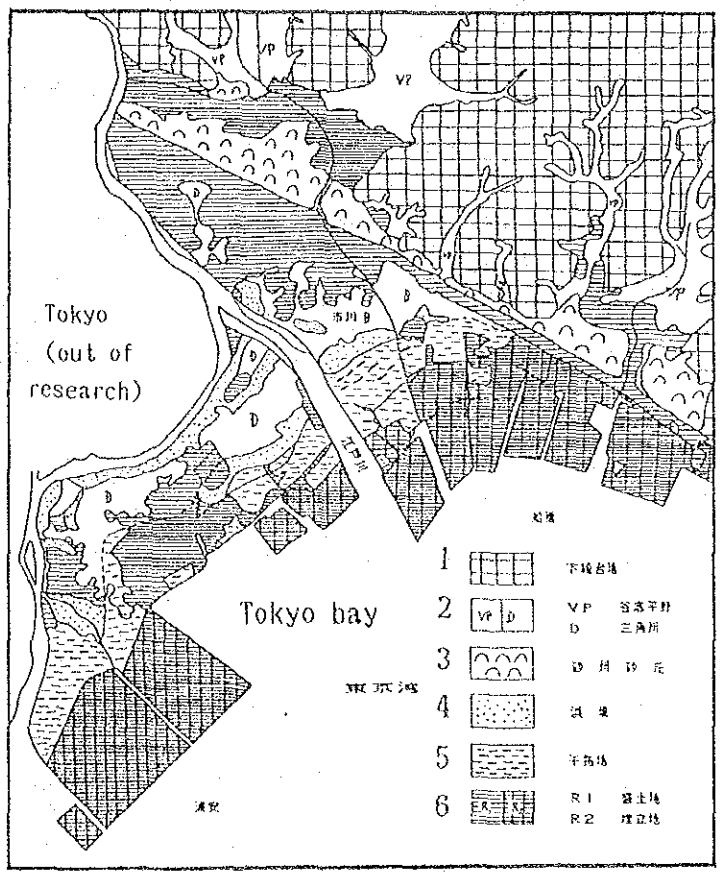
Characteristics of various damages by land subsidence are 1)slowly being continued, 2)difficult to find the damages easily, and usually people do not know such damages clearly. 3)when people find that the changes of surroundings have been caused by land subsidence, the phenomena have developed remarkably. 4)subsided ground surface and con-



VI-fig.9 Historical change of land subsidence in Chiba prefecture near Tokyo

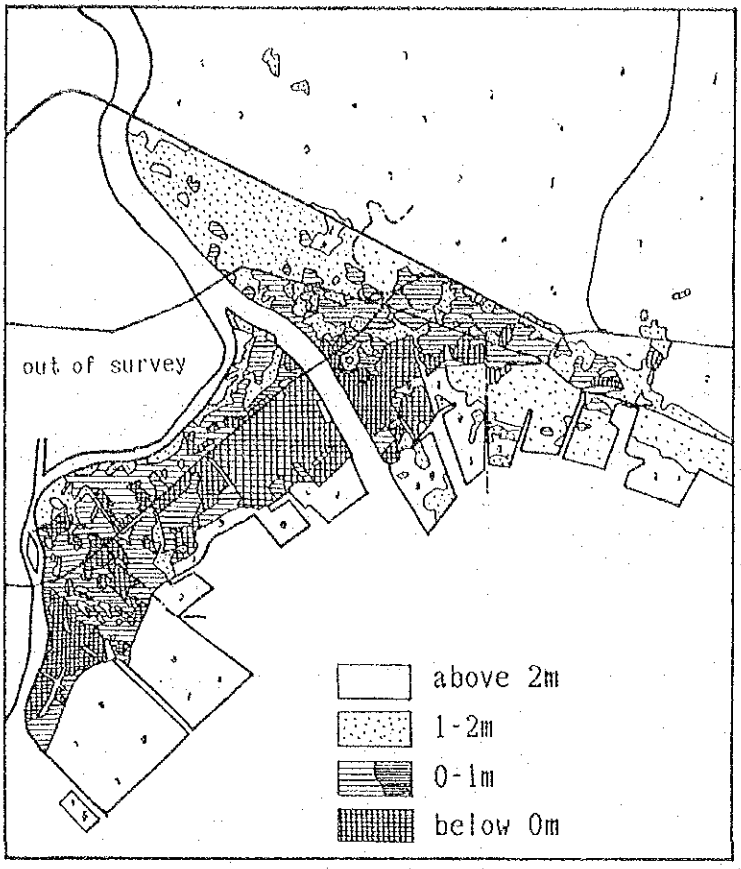
In this area, land subsidence had been caused by the over-extraction of ground water from shallow layer for daily use, 300m-500m for industries, deep layser for natural gas water. In the present, it is almost stopped by the prohibit of extraction of ground water.

fig.9-11:Akagiri(1988):Charge of land condition caused by land-subsidence in the Katunan area

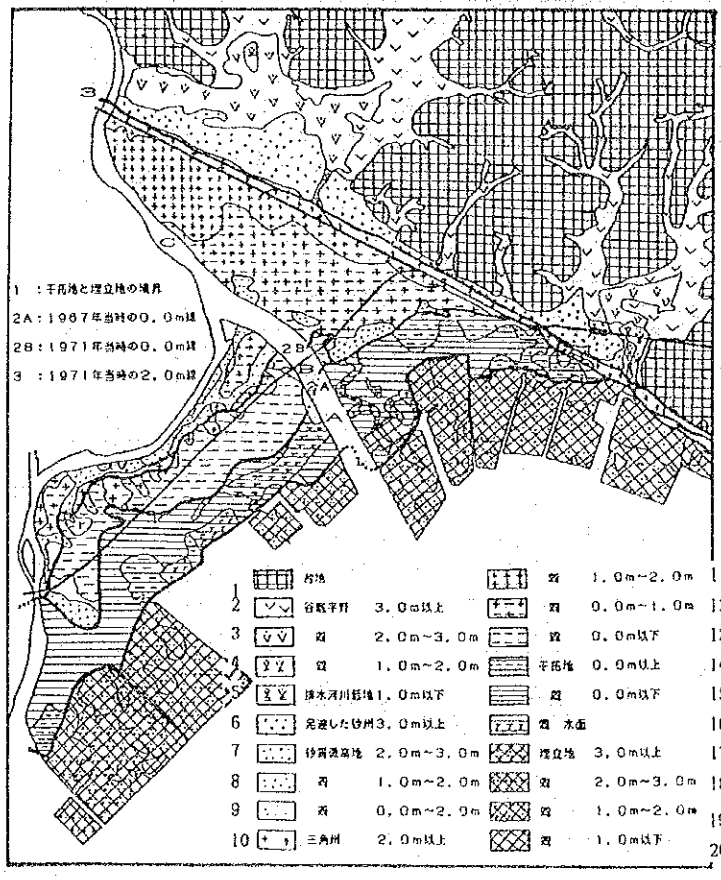


1 Shiusa hilly land
2 VP:valley floor plain
D :delta
3 dune and bar
4 beach ridge
5 reclaimed land
6 R1:banked area by dump truck
R2:reclaimed land using sand pump

VI-fig.10 A simple geomorplogical map of the Katunan area



VI-fig.11 Distribution of ground level



1 hilly land
2 valley floor plain >3.0m
3 2.0-3.0m
4 1.0-2.0m
5 lowland (channel) <1.0m
6 developed dune >3.0m
7 dry sandy unit 2.0-3.0m
8 1.0-2.0m
9 0.0-1.0m
10 delta >2.0m
11 1.0-2.0m
12 2.0-3.0m
13 (below sea level) <0.0m
14 reclaimed land by draining >0.0m
15 (below sea level) <0.0m
16 water surface
17 reclaimed land by landfill >3.0m
18 2.0-3.0m
19 1.0-2.0m
20 <1.0m

1 boundary between reclaimed land and banked area
2A 0.0m line in 1967
2B 0.0m line in 1971
3 2.0m line in 1971

VI-fig.12 land condition in combination with ground level

solidated geologic layers do not recover again usually except slight rebound.

Damages by land subsidence are shown as in the followings:

1) consolidation of geologic layers ①exposures of foundations of buildings and constructions (bridge, roads, and so on) by quick consolidation of layers, ②tilting, cracking distortion of buildings and constructions by unequal land subsidence,

2)lowering of ground level:①spreading of the lower area than the sea level (this has two standards:sea level, and high tide level), ② damages of irrigation facilities, ③increase of flood damages (inland flooding, spreading of stagnant water through non-flooding period, flooding by rivers, high tide water, tunami and so on, ④change of suitability for land use, ⑤deterioration of the land condition,

3)aquifer:①destruction of recharge system from the surroundings and the decrease of recharge storage, ②occurrence of air which has not enough oxygen in the subground space, ③the development of saline water phenomena, pollution of ground water caused by the lowering of the ground water level, insufficiency of supply of ground water,

8-2 Procedure to Use the Maps

There are several reasons which cause land subsidence in the lowlands.:1)over-extraction of ground water, 2)consolidation of geologic layers, 3)over-extraction of natural gas from the deepest layers and 4)mining. spot lowering. The land condition maps are available to predict land subsidence in the the cases of 1) and 2) for preliminary researches. But, not available to 3) and 4). Because these have not enough relationships between landform units.

The maps are also available to interpret changes of land condition by land subsidence.

1) Read and distinguish the lowlands from the maps.

2) Collect boring data as possible as many.

3) Make cross profiles of the lowlands with N value or index values showing the hardness of the layers using boring data and the distribution of geomorphological units.

4) Plot ground water level on the cross section and the land condition maps.

5) Interpret the depth and zones of soft ground. Especially, peaty area, layers showing low N values, layers saturated with water. And

draw a map showing these conditions.

6) If possible, the best way is to make clear collect quantity of extraction of ground water. And plot the value onto the land condition map and 5)map. If impossible, plot distribution of factories and others which use ground water.

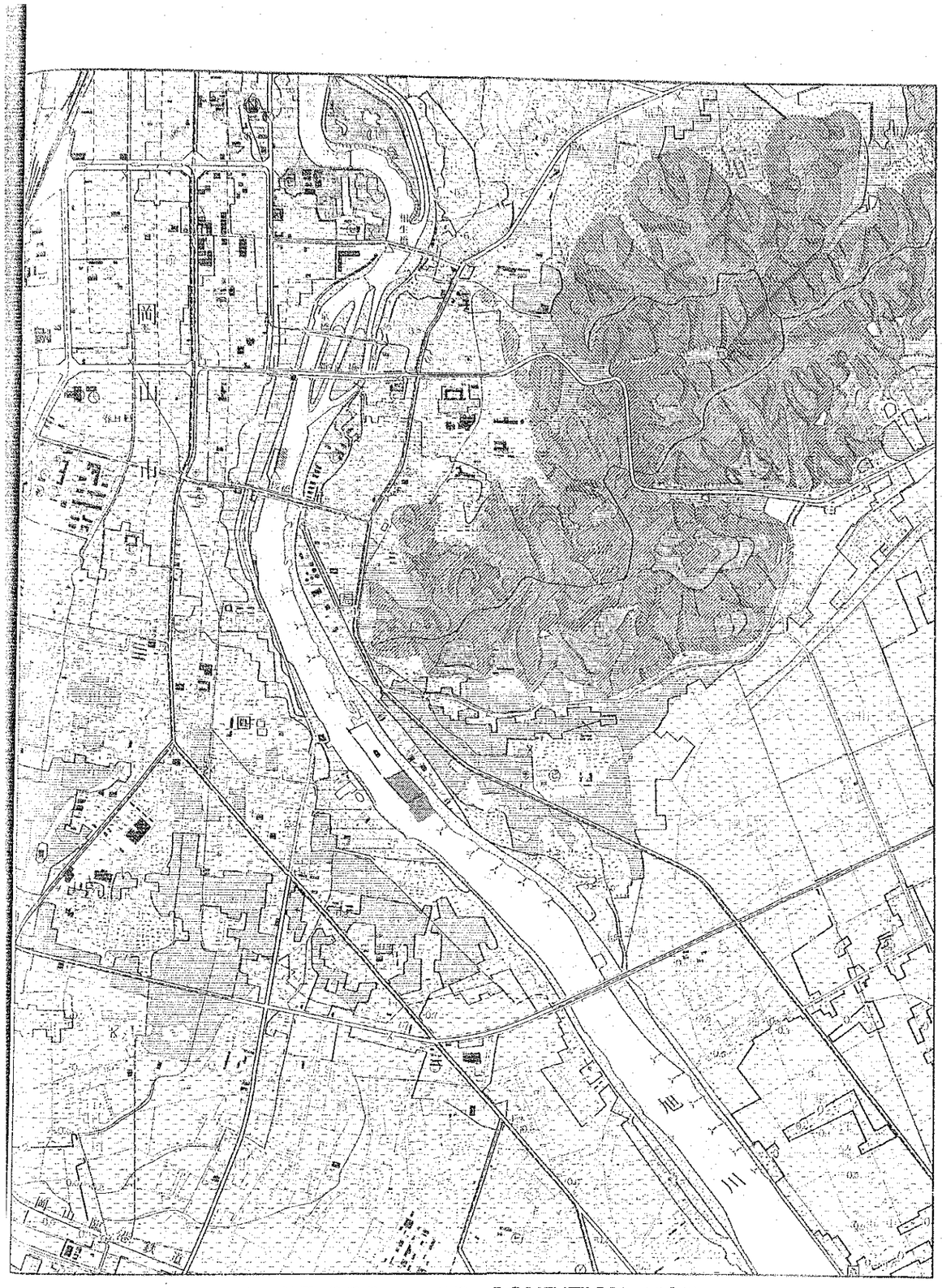
7) If possible, survey stable bench marks based on the standard of the first order leveling using stable bench marks and survey ground level distribution based on simple leveling.

8) Consider whether the phenomena are caused over-extraction of ground water or not.

9) Changes of the location for habitation is easily interpreted using the land condition maps. Lower units are disadvantaged than the surroundings because of possibility of flooding and liquefaction. In back marsh unit, even if surface is banked enough, surface soil has very soft and saturated and consequently it will consolidate gradually after construction.

9. Others

As shown in the previous chapters, geomorphological maps are available to predict various natural hazards. And it is also used to know the suitability for specified purposes, for example, regional planning, to select the best location for housing area, industrial area, the best location for constructing a bridge, roads and others. It is possible for users to use this map series for various purposes.



1 : 25,000 LAND CONDITION MAP

I. LANDFORM CLASSIFICATION

Mountain slope

	Ridge type	Valley type	Linear and other type
Gentle			
Steep			
Very steep			

Unstable slope

- Main watershed
- Ridge
- Cliff
- Precipice rock
- Collapse
- Baldness and bare rock
- Land slide (proceeding)
- Land slide (fixed)

Terrace and table land

- Upper
- High
- Middle
- Low
- Lower

Piedmont aggraded slope

- Colluvial-like piedmont slope
- Talus
- Debris avalanche
- Alluvial fan

Lowland, relatively higher and well drained

- Gentle frontage of fan
- Natural levee
- Sand dune
- Sand (gravel) bank or sand bar
- Heightened bank along Tenjo-gawa
- Dent or shallow valley

Lowland, general surface

- Valley plain or Flood plain
- Coastal plain or Delta
- Back marsh or interlevee lowland
- Former river bed
- River bed of Tenjo-gawa

Submersible land surface

- High water river bed
- Low water river bed
- Marsh or area poorly drained
- Pool dug by flood stream

Water sphere

- Tidal flat
- River and shore line, and water surface

Artificially deformed area

- Cut and rolled surface
- Cut and rolled farm-land
- Cutting
- Steep edge of banked up surface
- Banked up surface (higher)
- Banked up surface (lower)
- Filled up surface
- Reclaimed land by drainage
- Excavation
- Area under construction

Boundary

- Indistict boundary of landform
- Boundary of landform

II. GROUND ELEVATION

Datum plane is the mean tidal level in the Bay of Tokyo. TP±0.000m

- Bench mark
- Spot height
- Contour (every 1 meter)
- Contour (every 5 meters)
- Zero level line
- Contour line below zero level
- Depth Contour (every 1 meter)
- Depth Contour (every 5 meters)

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- Depth Contour (every 5 meters)

Profile of Lecturers

Name: Masayoshi TAKASAKI

Date of Birth: 22 July, 1924

Present Position: Director General, The Japan Map Center
President, Japan Cartographer's Association

Specialty: Geography, Cartography, Photogrammetric, Urban Planning

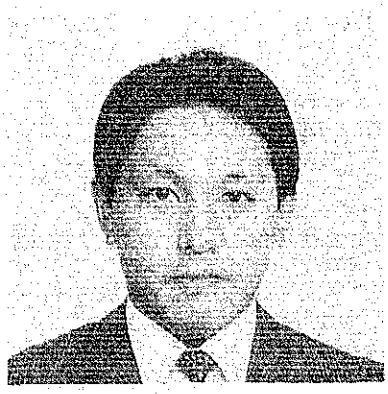
Final Education: Department of Geography, Faculty of Science, University of Tokyo, graduated in 1948

Employment Record and/or Major Involvements:
1948-1961 Planning Department, Ministry of Construction
1961-1979 Geographical Survey Institute (GSI), Ministry of Construction
(1978-1979) Director General, GSI
1979-1989 The Japan Map Center (JMC)
(1980-1986) Managing Director, JMC
(1986-1989) Director General, JMC

Publications or Theses: Thematic Maps of Japan, "Recent Progress of Natural Science in Japan", Vol.5 pp.141-151, 1980.
Regional Planning Atlas of Japan, "ICA Conference, at Perth, West Australia", 1984.
Chizugaku (Cartography) [published in Japanese language], Asakura Shoten (Asakura Bookstore), 1988.

Qualification: Consulting Engineer (Urban Planning)
Registered Surveyor

Name: Atsushi OKUIZUMI



Date of Birth: 6 May, 1957

Present Position: International Department,
Aero Asahi Corporation

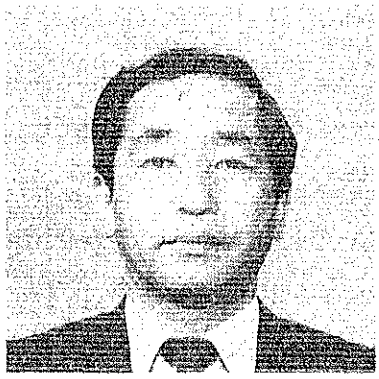
Specialty: Geography, Applied Geomorphology

Final Education: Division of Geography, College of Humanities and Sciences,
Nihon University, graduated in 1985

Employment Record and/or Major Involvements:

1980-1982	1:25,000 NATIONAL BASE MAPPING IN CAGAYAN VALLEY AREA (Philippines)
1984	1:25,000 NATIONAL BASE MAPPING IN SATIPO AREA (Peru)
1985-1987	Establishment of Graphic Information Base Project of NCR (Philippines)

Name: Tomotaka KAMAKURA



Date of Birth: 27 August, 1944

Present Position: Manager, Surveying Department,
Aero Asahi Corporation

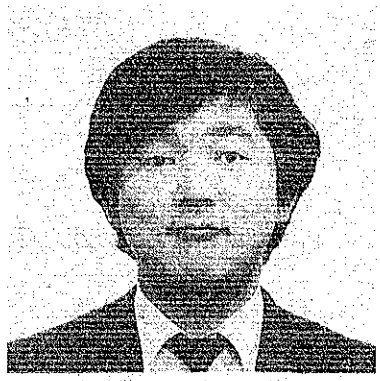
Specialty: Geology, Geomorphology

Final Education: Division of Applied Geology, College of Humanities and Sciences, Nihon University, graduated in 1968

Employment Record and/or Major Involvements:

1969	Underground Water Survey (S. Korea)
1971	1:25,000 Land Condition Mapping (Japan)
1976	Geological Survey in Kanzoku-nanbu (-do-)
1981	Geological Information Mapping (-do-)
1986-1987	Establishment of Graphic Information Base Project of NCR (Philippines)

Name: Hiroshi UNE



Date of Birth: 11 July, 1958

Present Position: Deputy Head, Second Geographic Division, Geographic Department, Geographical Survey Institute, Ministry of Construction

Specialty: Cartography, Applied Geomorphology

Final Education: Department of Geography, Faculty of Science, University of Tokyo, graduated in 1981

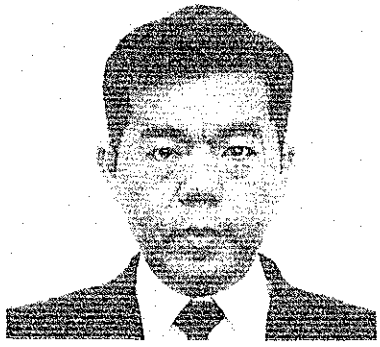
Employment Record and/or Major Involvements:

1981- Geographical Survey Institute
Compilation of Land Use and Land Condition Maps.
Research for prevention of disasters by slope failure and avalanche.
Geomorphological research for tectonic movement.

1986- Environment Agency
Administrative measures for land subsidence.

1989- Geographical Survey Institute
Collection of digital geographic data, especially land use data.
Compilation of topographic maps and land condition maps of coastal area.

Name: Takekazu AKAGIRI



Date of Birth: 3 October, 1945

Present Position: Head of Geographic Research Office, Geographic Department, Geographical Survey Institute, Ministry of Construction

Specialty: Physical Geography, Applied Geomorphology

Final Education: Department of Geography (Master Course), Graduate School of Science Research, University of Tohoku, graduated in 1970

Employment Record and/or Major Involvements:

1970- Chiba prefectural Institute for Pollution
Research for land subsidence.

1978- Geographical Survey Institute
Compilation of topographic maps and land condition maps of coastal area.

1981- National Land Agency
Administrative measures for land survey especially water use and land classification

1989- Geographical Survey Institute
Modern geographical researches

Qualification: Registered Surveyor
Consulting Engineer (Applied Science)