東南アジア諸国における
洪水防禦パイロットスタディー

—1983年度洪水防禦コース報告書—

1983．11．

建 設 省 河 川 局 ・ 土 木 研 究 所
国際協力事業団筑波インターナショナルセンター

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ま　え　が　き

本研修コースは国連台風委員会の長期計画に基づき総合的な水害防禦技術（構造物のみでなく非構造物対応を含めたもの）に関する国際的な研修コースとして設立されたものである。1979年10月にその第1回研修が開かれ，今年は第5回目の研修を実施した。

本研修コースの対象国は，国連アジア太平洋経済社会委員会（ESCAP）台風委員会加盟諸国のうち5カ国であるが，これら各国の河川の置かれている状況をみると自然条件も社会条件も大きく異っている。従って，各国における課題も異なり，各国共通の対策も少ないのが現状である。共通な点は治水対策を堤防・ダム等の構造物のみに絞るのではなく，土地利用，洪水予報を含めて検討しようということである。

この報告書には研修の成果である研修員の報告書も含まれている。研修員が提出した資料の状況にもより，その報告内容に大きな差がみられるが，これら報告書に呈示された各国の新しい情報は今後これらの国々の河川の認識について寄与するところ大であると考えるので，ここにこれらの報告を公表する次第である。

なお巻末には，「研修に参加した感想」として，研修員が参加した研修に対する抱負・意見を掲載し，今後の研修講義・研修旅行のあり方を考える一助となるようにした。

目　　次

1. 研修コース設立の背景

東南アジアにおいて，総合的な水害防禦に関する技術開発の問題に関心が高くなったことについては，国連アジア太平洋経済社会委員会（ESCAP）に所属する台風委員会の活動について述べることが分り易いと思われる。

台風委員会は，1968年に東南アジアの台風常襲地帯に位置する7ケ国が集まって，台風の発生のメカニズム，進路の予測，台風によってもたらされる被害の軽減を図る等を目的とし研究と調査など情報交換を主体とする国際機構をつくり上げたことに端を発している。活動は年1回の委員会において，その年の各国の台風に関する諸活動を報告しあい，討議を通じ啓発するとともに地域的なセミナーなどの開催を行ってきた。台風委員会への加盟国は1983年9月現在香港，韓国，マレイシア，フィリピン，タイ，ラオス，ベトナム，クメール，中国，日本の10カ国である。

1978年に委員会発足10年を迎え，これまでの委員会活動の成果を明らかにし，さらに台風に関する加盟国の抱えている問題点を把握し，今後の活動方針を探る意味で7ケ国を訪問し問題点を討議するレビューミッションが企画され，実行された。

レビューミッションの報告書は，1978年10月の台風委員会に提出され了承された。この報告書では今後の台風委員会の水文部門を重点とする活動として，これまで10年間の洪水予防警報システムに関するめざましい発展をふまえ，構造物対応に非構造物対応を加えた総合的な水害防禦対策を実施することの必要性が強調されている。

台風委員会は，この問題の重要性を認め，水文部門における今後の活動の主要な柱とすることとしたが，まず手はじめに各国それぞれ試験流域を設定し総合的な水害防禦の技術的な検討を始めることとした。河川改修や治水ダムの建設などいわゆるハードな治水対策は，各国での行政活動そのものであり，これらの問題まで組み込むことは，台風委員会の性格上あまり適当でないという判断があり非構造物対応の課題を中心とすることとし，また，代表流域で事例的に研究された手法は他の流域にも適用可能であり技術開発のやり易い方法として採択されたものと考えられる。

発展途上国に対する集団研修やセミナーの開催なども台風委員会の重要な活動の一つであり，日本で従来から実施している河川工学コース研修も台風委員会の活動の一環である。1978年の台風委員会では，総合的な水害防禦対策に関する調査・研究活動を提供するに当り，この新しい問題に関する研修の実施についても要望が出され，日本政府がこれに対応することを約束したわけである。これが1979年に初めて本集団研修コースが発足した経緯である。コースは河川工学コースと同様JICAベースで行われ，参加国は台風委員会加盟国に限らず，広く門戸が開放された。

2. 昭和58年度洪水防禦コース研修員名簿

No.	Country （国　名）	Name （名　前）	Age （年令）	Present Post & Place of Employment （現職・所属先）	Educational Record （最終学歴）	Mailing Address （本国の住所）
1	Philippines	Mrs. Ignacia M. Ramos	32	Senior civil engineer, Ministry of Public Works & Highways	1972–1976 Feati University (Civil engineering)	118.C Benitez ST., Cubao Quezon City, Philippines
2	Thailand	Mr. Rungsan Sirayayon	30	Hydrologist 4, Hydrology Division, Royal Irrigation Dept.	1974–1979 Ramkhamhaeng University (Statistics)	132/1 Mu.8, Soi Ladprao 71 Ladprao Road, Banghapi, Bangkok, Thailand
3	Thailand	Mr. Kangvan Deesuvan	28	Senior engineer, Dept. of Drainage & Sewage, Bangkok Metropolitan Administration	1977–1978 Adamson University (Civil engineering)	40/2182 Phachanivat 3 Monthaburi, Thailand
4	Malaysia	Mr. Chia Chong Wing	32	Deputy Director Drainage and Irrigation Department Ministry of Agriculture	1974–1976 University of Strathclyde, Scotland (Civil engineering)	Jabatan Parit Dan Taliair Kuala Terengganu, Malaysia

3. 研修プログラム

月日	曜	区分	内　容	講　師	(上)宿　舎 (下)研修場所
8. 1	月	AM PM	 建設省表敬		TIC 建設本省
2	火	AM PM	日本の河川 〃	横田 〃	TIC TIC
3	水	AM PM	土研表敬，治水と文化 (特)河川に関する災害の防止	山本，山口 植原	TBIC 土研
4	木	AM PM	カントリーレポートの発表 〃	総合治水 〃	同　上
5	金	AM PM	(特)河川地形論 〃	赤桐 〃	〃
8	月	AM PM	(特)沖積地形論と水害地形分類図 〃	赤桐 〃	〃
9	火	AM PM	(特)同上演習 〃	津澤 〃	〃
10	水	AM PM	(特) 〃 〃	津澤 〃	〃
11	木	AM PM	防災センター視察 国土地理院視察	末次 〃	TBIC 地理院 防災センター
12	金	AM PM	(特)アジアの河川の水害地形分類図 氾濫シミュレーション論	大矢 末次	TBIC 土研
15	月	AM PM	治水経済調査手法 土研の防災研究の紹介	金木 〃	〃
16	火	AM PM	(特)利根川流域の開発と治水 〃	大熊 〃	〃
17	水	AM PM	利根川，荒川流域視察 〃	渡良瀬遊水地 玉淀ダム	熊谷サンルート 利根川
18	木	AM PM	〃 〃	荒川上流 工事	大宮パイオランドホテル 荒川　他

月日	曜	区分	内　　　　容	講　　師	(上)宿　舎 (下)研修場所
8. 19	金	AM PM	利根川，荒川流域視察 〃	荒川下流 工事	TBIC 荒川　他
22	月	AM PM	洪水予測の手法と洪水防禦への応用 レーダー雨量計とテレメータシステム	早川 河関	TBIC 土研
23	火	AM PM	流域特性と流出予測 〃	寺川 〃	〃
24	水	AM PM	水文観測機器の説明とその操作方法 流出試験地の見学（裏筑波）	利根川 末次	TBIC 裏筑波
25	木	AM PM	総合治水対策の概要 水防工法	山本 末次	TBIC 土研
26	金	AM PM	都市化流域での流出抑制手法 耐水化工法	金木 本間	〃
29	月	AM PM	移動（筑波→大阪） 淀川の洪水予警報システム	大内 中尾	ホテル京阪 淀川
30	火	AM PM	淀川，寝屋川現地視察 〃	岸田	ビジネスホテル たかつじ奈良 淀川
31	水	AM PM	奈良：日本文化の理解 大和川視察	白神 萩森	セントラルイン 大和川
9. 1	木	AM PM	京都：日本文化の理解 〃		TBIC 京都
2	金	AM PM	パイロット河川の洪水防禦計画(案)の検討 〃	山本 〃	TBIC 土研
5	月	AM PM	(特)東南アジアの河川の洪水予報と洪水防禦 〃	木下 〃	〃
6	火	AM PM	移動（筑波→東京） 鶴見川総合治水計画（映画と説明）	宇塚 〃	水道橋グリーン TIC
7	水	AM PM	鶴見川現地視察 〃	宇塚 〃	水道橋グリーン 鶴見川
8	木	AM PM	洪水防禦計画調査の問題点 〃	土屋 〃	TBIC 水道橋 グリーンホテル

月日	曜	区分	内　　　　容	講　　師	(上)宿　舎 (下)研修場所
9. 9	金	AM PM	今後の調査課題とその手法の検討と討議 〃	総合治水	TBIC 土研
12	月	AM PM	最終報告書の発表 〃	総合治水	〃
13	火	AM PM	最終エバリュエーション，閉講式 〃	総合治水 芦田	TBIC TBIC
14 15	水 木		帰国準備		
16	金		帰　　国		

4. 講 師 名 簿

赤 桐 毅 一	国土庁土地局国土調査課専門調査官
大 矢 雅 彦	早稲田大学理工学部教授
植 原 茂 次	国立防災科学技術センター第3研究部長
木 下 武 雄	国力防災科学技術センター第1研究部長
大 熊 孝	新潟大学工学部助教授
津 澤 正 晴	国土地理院地理調査部地理第2課係長
土 屋 昭 彦	日本建設コンサルタント㈱取締役
大 内 忠 臣	近畿地方建設局淀川ダム統管広域水管理課長
中 尾 宏 臣	〃 電気通信係長
宇 塚 公 一	関東地方建設局京浜工事事務所調査課長
山 口 高 志	土木研究所河川部長
山 本 晃 一	〃 総合治水研究室長
早 川 信 光	〃 水文研究室
河 関 大 祐	〃 〃
寺 川 陽	〃 〃
利根川 誠	〃 〃
金 木 誠	〃 総合治水研究室
末 次 忠 司	〃 〃
本 間 久 枝	〃 〃

5. 使用テキスト一覧表

日	講師名	テキスト
8/ 2	横田	Rivers in Japan
3	山本	River Engineering and Culture
〃	植原	– Prevention of Disasters Related to Rivers – 災害写真年表 1978
5	赤桐	– Geomorphological Mapping For Prediction of Flooding
10	津澤	– Relationship between Landform and Flood in 1967 in the Northern Part of the Niigata Plain, Central Japan – 水害と治水地形分類
12	大矢	– Asian Profile – Geographical Study of Flooding Immediately down-stream from Pamong in the Mekong River Basin
	末次	– Flood Simulation – For Rational Land Use of Flood Plains – Study on Flood Prevention (5)
15	金木	Outline of Flood Prevention Economic Survey
22	早川	– Outline of Flood Disaster Prevention Technique – TOPEX Seminar on Hydrology and Warning Dissemination
	河関	Radar Raingange System, Telemeter System
23	寺川	Flood Estimation / Exercise sheets
24	利根川	– Hydrological Observation Explained in Pictures
	〃	– River Observation System in Japan
25	山本	– Some Morphologic and Hydrologic Characteristic of Alluvial Rivers in Japan – Comprehensive Flood Loss Prevention Measures – Short Summary of Hydraulics in Channels with Nearly Uniform Movable Bed Materials – General Principles of Flood Loss Prevention
25	末次	Flood Defenses / Reference Materials – Flood Fighting

日	講師名	テキスト
26	金木	Outline of Flood Prevention Economic Survey
	本間	On-Site Survey of Flood-Proofing of Buildings in Urban Lowland Areas and Review of Survey Result
9/5	木下	
6	宇塚	
8	土屋	– Report of the advisory Team for the Selection of Pilot Basins for Flood Loss Prevention & Management

6．研　修　員　報　告

6-1 COUNTRY REPORT

Name:	Ignacia M. Ramos
Country:	Philippines
Organization:	Ministry of Public Works and Highways (MPWH)
Position:	Senior C E

1. General Condition of My Country

The Philippines is an archipelago of 7,107 islands ranging in size from less than a kilometer across to 104,687 sq. km. It lies between 21°25′ North and 4°23′ North latitude and bet 116° East and 127° East longitude about 105 kms. to the North lies Taiwan and 50 kms. South is Borneo 1,200 kms to the west and across the south China sea lies Vietnam approximately 10,000 kms across the Philippine Sea and the Pacific to the Northwest is the United States of America.

Manila is the Capital and premier city, Metro Manila, and of which Manila is a part has the total land area of 636 sq. km. It is composed of 4 cities and 13 municipalities.

The Total land area is 206,908 sq. km. or a little smaller than Japan. It is nearly as large as Spain. It is ten times the size of Belgium, twice that of Greece. Eleven (11) islands accounts for 98% of this area of these, Luzon is the biggest. It is 104,687 square kilometers, approximately as big as Belgium, Denmark and Holland combined. Mindanao is the second largest island is 94,630 sq. kilometers. It is almost as large as Portugal. Directly south-southeast of Luzon lies the largest concentration of the archipelago's largest islands- the Visayas seven of the eleven largest islands belong to this region. They are Bohol, Cebu, Leyte, Masbate, Negros, Panay and Samar.

The Philippines has 10 active volcanos of these, perfectly the cone-shaped Mt. Mayon is perhaps the best known. It rises 7,943 ft above sea level as it straddles the eastern sea coastal towns of Albay in the Bicol Region Mount Apo, the highest mountain in the Philippines is 9,690 ft. high.

The Philippine coastline is irregular and stretches for 23,169 kms. It is more than twice than the coastline of the United States.

The Philippine Deep, 72 kilometers off the coast of Northern Mindanao, is the world second deepest region. It is 35,440 ft. deep.

CLIMATE

The climate is tropical, average temperature is 27°C, temperature is the mountain regions range from cool to chilly, humidity is 75% to 80%. There are two distinct seasons. The dry, cool months from November to mid February, when the Northwest monsoon bring cooling winds from Siberia and mainland china, followed by the dry warm months from March to May and the rainy months from June to October when Southwest monsoon bring to rain average rainfall is 92–95 inches a year.

LAND USE

The Philippines is considered as one of the green country of Asia due to its vast forest and tillable lands. The vast area is used as an Agricultural land, industrial and residential land. Some are used as commercial, non-commercial forest, fishing ground, mineral ground and many sub land use.

RIVERS

The Philippines has 12 water resources regions and major flood prone areas. There are about 422 principal basins including 78 sub-basins of big rivers scattered all over the Philippines archipelago. With an average of 19 typhoons occuring every year, causing intense rainfall, overflowing of waterways, inundation and deposition of sediment in the flood plain, extensive flood damages often result. Approximately there is an aggregate total of about 1,316,230 hectares susceptible to flooding nationwide.

Items / River Name	Location and the Water Resources Region	Basin Area (Km^2)	River Length (Km)	Geology
Cagayan	Northern Luzon Island W. R. Region 2	27,280	505	Tertiary Sedimentary rocks, alluvium
Agno	Central Luzon Island W. R. Region 3	5,697	206	Tertiary Sedimentary and intrusive rocks, alluvium
Pampanga	Central Luzon Island W. R. Region 3	10,503	206	Alluvium
Bicol	Southern Luzon Island W. R. Region 5	3,132	136	Quarternary Pyro-clastics, tertiary sedimentary rocks/ alluvium
Panay	Northern Panay Island W. R. Region 6	2,008	152	Tertiary sedimentary rocks, alluvium
Jalaur	Southern Panay Island W. R. Region 6	1,742	123	– do –
Ilog	Negros Island W. R. Region 6	2,104	124	Tertiary intrusive rocks/alluvium
Tagoloan	Northern Mindanao Island W. R. Region 10	1,778	106	Quarternary/intrusive rocks
Agusan	Northern Mindanao Island W. R. Region 10	11,700	350	Tertiary sedimentary rocks/alluvium
Mindanao	Southern Mindanao Island W. R. Region 12	20,260	373	Alluvium
Laoag	Northern Luzon Island W. R. Region I	1,353	73	Tertiary sedimentary and intrusive rocks alluvium
Amnay Patrick	Mindoro Island W. R. Region 4	586/407	58/42	Basement complex, alluvium

W. R. Region: Water resources region

HYDROLOGY

Data collection on streamflow has been conducted in the Philippines since 1908 by the then Department of Public Works and Communication when the Philippines was still in a territorial status. The number of stream gauging stations inventoried is now 336 and covers all the major or important rivers.

As of 1981, there are 142 existing stream gauging stations operated and maintained by National Water Resources Council (NWRC). In addition to the stations operated and maintained by NWRC, other agencies like the National Power Corporation (NPC) and National Irrigation Administration (NIA) also operate and maintain their own stream gauging stations NPC has 93 stream gauging while NIA has 101 stream gauging stations.

Streamflow records covering the 1908–1922 and 1945–1969 periods have been published as Surface Water Supply Bulletins by the then Bureau of Public Works. The records for the period 1923–1944 were completely lost during the World War II, while records for 1971 are presently published at NWRC.

PRIORITY POLICY

Under mo No. 27, Series of 1983 all the Central and Regional Offices must comply with the drainage planning principle:

The types of main drains, lateral and auxiliary structures scheme must a) prepared for easy and simple maintenance, b) drains should not be covered unless specifically required, c) work shall be designed for traffic loads, d) ditches must follow the slope of the ground with constant depth if possible.

The run-off is calculated by the so called Rationl Method, the relationship bet the run-off and the design storm is expressed by:

$$Q = \frac{CIA}{3.6}$$

where Q = peak discharge (m^3 sec)
C = coefficient of run-off
I = max intensity of rainfall for the time period (mm/hr)
A = catchment area (km^2)

Initial time of concentration can be assumed as 5 minutes or by formula:

$$Tc = \frac{8L}{(H/L)^{0.6}}$$

where L = length of the path of travel of water from the point/section where run-off is to be calculated to the head water (km)

H = the difference in elevation (km)

Rainfall intensity duration are released by the Hydrology and flood Forecasting (PAGASA).

The hydraulics design be based on Manning's equations for open channel flow.

$$V = \frac{-Q}{A} = \frac{1}{V} = \frac{1}{N} R^{2/3} S^{1/2}$$

where V = mean velocity (m/sec)

A = area of flow (m^2)

Q = flow (m^3/sec)

N = roughness of coefficient

R = hydraulic radius (M)

S = Slope

The roughness coefficient depends on the characteristics of the internal lining and obstruction to flow.

ROUGHNESS COEFFICIENT

Channel Characteristics	C
Closed Concrete Conduit	0.015
Lined Concrete Canal	0.015
Concrete bottom with Riprap sides	0.025
Earth bottom W/ Riprap sides	0.035
Plain earth canal, Straight	0.040
Natural Channel, Weedy	0.080
Natural Channel, with Obstacle, very weedy	0.100

Maximum permissible velocities should be applied in the design to prevent erosion:

Unlined canal, without vegetation	1.2 m/sec
Unlined canal, with grass	2.0 m/sec
Riprap canal	2.5 m/sec
Concrete lined canal	3.0 m/sec
Concrete Conduit	3.5 m/sec

Drainage benefit can be computed in a drainage project is reduction of inundation damage. Inundation damage are direct and indirect. Direct inundation damage is the destruction of properties, while indirect damage is the loss of business and production profit due to inundation.

DRAIN TYPES

All components in the drainage system shall be standardized, with a limited number of different drain types. This will facilitates the design and construction of future extension as well as maintenance Annex Fig. 1).

The design of the proposed standard drains shall be based on the following features:

- Construction cost
- Good hydraulic characteristics, i.e., roughness of lining
- Simple and easy maintenance
- Available materials and local construction traditions
- Soil conditions
- Provisions for possible cover for open drains to be used, s.g., as access to plots or along commercial streets.

The recommended drain types are given in Annex three, viz:

Type A. Tropezoid section
- Type E. Rectangular section
- Type C. Box culvert
- Type D. Cylindrical section.

A_1, A_2 and A_3 all have their invert concrete slab. This is a very important feature. The main advantages are:

- The invert levels which generally have a small gradient due to the flat terrain can be clearly defined avoiding stagnant pools at places with no or negative gradient.

- Cleaning and dredging of the canals and easier to carry out when the bottom levels are fixed by lining, i.e., concrete.

- The hydraulic characteristics are improved, i.e., bigger capacity.

Type A_1 is based on the sides with plastered reinforced hollow blocks or concrete for depths bigger than 1. 2m. The slope of the lining is $2.1._2$.

Type $A_2 0^2$ is lined with grouted rip-rap. This is most commonly used lining in the existing drainage system. The side slope is 2:

Type sides of type of type A_3 are lined with planted grass, Type A-4 is an earth channel with grass at the bottom and on the sides. The slope of grass planted sides is 1:1.

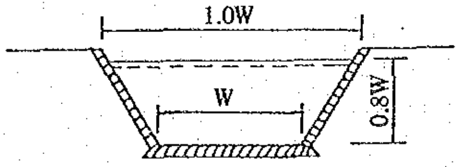
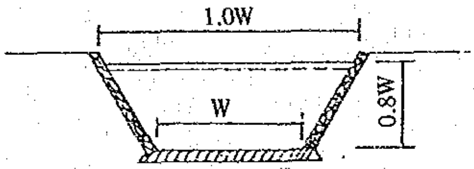
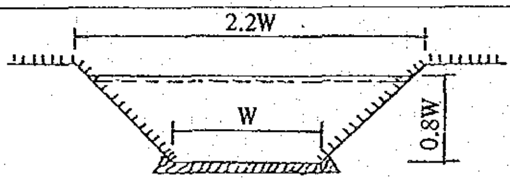
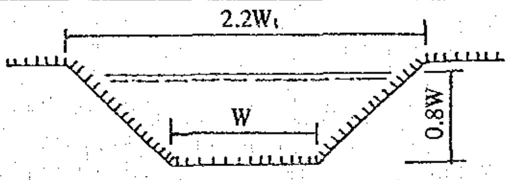
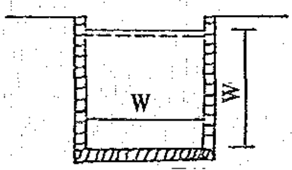
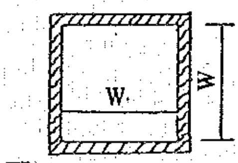
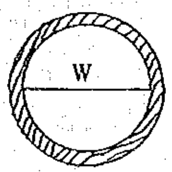
Type B is a channel with concrete bottom and vertical sides.

Type C-1 is a reinforced concrete box culvert.

Type D-1 is made of refabricated concrete drain pipes. The average cost (1982) of construction for different types and flow capacity this shown in Annex 4, Figure 10-16 (Land acquisition is not included). Type A_4 (the grass lined open channel) is the most economical drain in respect of capital costs. Open drains are more economical in construction and maintenance cost than closed conducts. Hence, Types C-1 and D-1 should only be used where land requirements or aesthetical reasons dictate the use of covered drains. Pipes should be used whenever closed drains are required due to this lower cost.

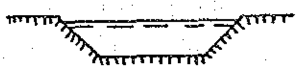
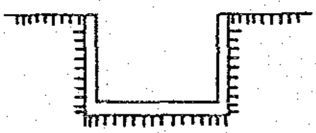
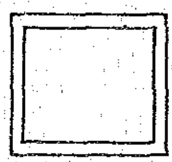
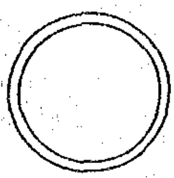
Annex 1.

Fig. 1

Type NR	Section	Width
A-1		W≥1.0M
A-2		W≥1.0M
A-3		W≥0.5M
A-4		1.5≥W≥0.3M
B-1		2.0≥W≥0.6M
C-1		3.0≥W≥0.6M
D-1		1.8≥W≥0.3M

Legend:
- Reinforced Concrete
- Hollow Blocks
- Rubble Masonry
- Cut Cross

DRAINAGE – FLOW VELOCITIES

Drain Type	Dimension W in M	Gradient %	Velocity m/sec
A 	1.0 – 3.0 M	0.05	1.0
		0.10	1.5
		0.20	2.4
	3.0 – 5.0 M	0.05	1.5
		0.10	2.2
		0.20	3.2
B 	0.5 – 1.5 M	0.05	0.8
		0.10	1.0
		0.20	1.4
	2.0 – 2.5 M	0.05	1.2
		0.10	1.6
		0.20	2.3
C 	0.5 – 1.5 M	0.05	0.6
		0.10	0.9
		0.20	1.3
	2.0 – 2.5 M	0.05	1.0
		0.10	1.4
		0.20	2.0
D 	0.5 – 1.0 M	0.05	0.5
		0.10	0.7
		0.20	1.0
	1.5 – 2.5 M	0.05	0.9
		0.10	1.3
		0.20	1.9

2. Organization Dealing with Water Administration

1. National Irrigation Administration (NIA)

The primary objective is to effectuate an economical means of achieving the maximum and diversified use and control of water by undertaking multipurpose water resources projects. Every water project is developed for multiple uses ranging from irrigation to power, domestic and industrial water supply and flood control.

2. Farm Systems Development Corporation (FSDC)

Assist all irrigation association whose aim is to improve farming and communal works.

3. Metropolitan Waterworks and Sewerage System (MWSS)

Control all waterworks and sewerage systems in the metropolitan manila area.

4. Local Water Utilities Administration (LWUA)

Promote, develop and finance of local water utilities. LWUA prescribes minimum standards and regulation in all matters pertinent to the development and operation of water districts in the country. It also undertakes financial, technical and manpower training and monitors and evaluate local water standards.

5. Metropolitan Manila Flood Control Development Council (MMFCDC)

This office formulates and implements an integrated Flood Control and Drainage program for Metro Manila.

6. National Water Resources Council (NWRC)

This council coordinates and integrates the water resources development and activities of the country. It reviews and approves the appropriate use of surface ground water.

It reviews and approve the water resources development plans and program of any agency conducts river basin and hydrologic surveys.

7. Pasing River Development Council (PRDC)

Coordinates the planning of, and provides continuing direction for, the integrated development of the Pasing River and all projects that may be approved in connection with beautification, improvement and gainful utilization of its facilities.

3. Outline of Pampanga River Basin

1. Location	:	Central Luzon Island
2. Basin Area	:	10,503 km.^{3}
3. River Length	:	260 km.
4. Flood Prone Area	:	220,000 Ha.
a) Affected river reach	:	66 km.
b) River Slope	:	1/15000 to 1/3000
c) Major Land Use	:	Rice
d) Carrying Capacity	:	2,200 (1,800 to 2,500) m^3/sec.
e) Present 2-yr. run-off	:	2,600 to 2,350 m^3/sec. (5-yr. run-off)
5. Forest in Mountaneous Area	:	Partly Denuded
6. Geology	:	Alluvium
7. Population		
a) Basin Total	:	4,054,000
b) Flood Prone Area	:	1,220,000
8. Annual Flood Damage	:	114 x 106

Present River Condition

The Pampanga river originates on the Caraballo mountains and on a southerly direction to its mouth is Manila Bay joining major tributaries the Chico-Talavera river near Arayat and the Angat River-Sulipan. At Masantol, the Bebe-San Esteban diversion channel from Pampanga and joins the Pasig River, while the Angat directs its flow to the Labangan Floodway at Calumpit.

The Pampanga River Basin has area of 10,503 $km.^2$ which 6,660 sq. km. are level areas, less than 2,000 sq. km. are cultivated areas.

It is characterized markedly of its two swamps, the Candaba Swamps lying between the Angat and Pampanga Rivers and San Antonio Swamps lying between the Rio Chico and Pampanga rivers.

It is divided into three (3) kinds of topo; mountain, hill and plain.

The watershed mountains are well dissected highland with 1,500 to 2,000 on in latitude and mainly composed of Cretaceous to Paleogene metavolcanics and metasediments introduced by diorite in Caraballo and Sierra Madre Mountain and by periodotite in Zambales mountain.

4. Problems of Pampanga River Basin

4.1 Land use of the Pampanga River Basin

4.1.1 Rice Field
4.1.2 Residential Equipment
4.1.3 Non Commercial Forest
4.1.4 Agricultural Land
4.1.5 Livestock

1. Major Causes of Floods in the Basin area Varied they are:

   1.1 Excessive Sediment Transport
   1.2 Siltation at Mouth of Waterways
   1.3 Inadequate Bank Stabilization Works
   1.4 Protection of Existing Dikes

Annual sediment transport capacity of the main Pampanga river upstream from Pampanga/Rio Chico junction is about 1.1 x 10^6 m^3/yr., while the Rio Chico transports about 0.3 x 10^6 m^3/yr. A total of around 1.4 x 10^6 m^3/yr. of sediment is transported into the Pampanga river at Arayat. Most of the sediment seems to be deposited in the middle reaches downstream from Arayat remaining around 0.3 x 10^6 m^3/yr. estimated out Sulipan.

The river bed at San Antonio (on the Pampanga) river just upstream from Peñaranda junction) shows rising tendenct, while those at other stations show even or some lowering tendencies including the middle reaches of the Pampanga river downstream from Arayat. This lowering tendencies probably is partly due to the deposition of sediment on the swampy areas and partly due to channel improvement works carried out so for.

4.2 Flood Prone Areas

The overall flat topography and the rapidly developing and agriculturally productive flood plain of the Pampanga river basin make them very vulnerable to flood damages during intense storm runoff: The lands subject to flooding involves an area of 2,200 $km.^2$ and 221 sq. km. in the Porac-Gumain and Pasig Potrero River basins Urban centers and rural settlement areas comprise 405 sq. km. of the areas subject to flooding Municipalities directly affected include 41 in the Pampanga river basin.

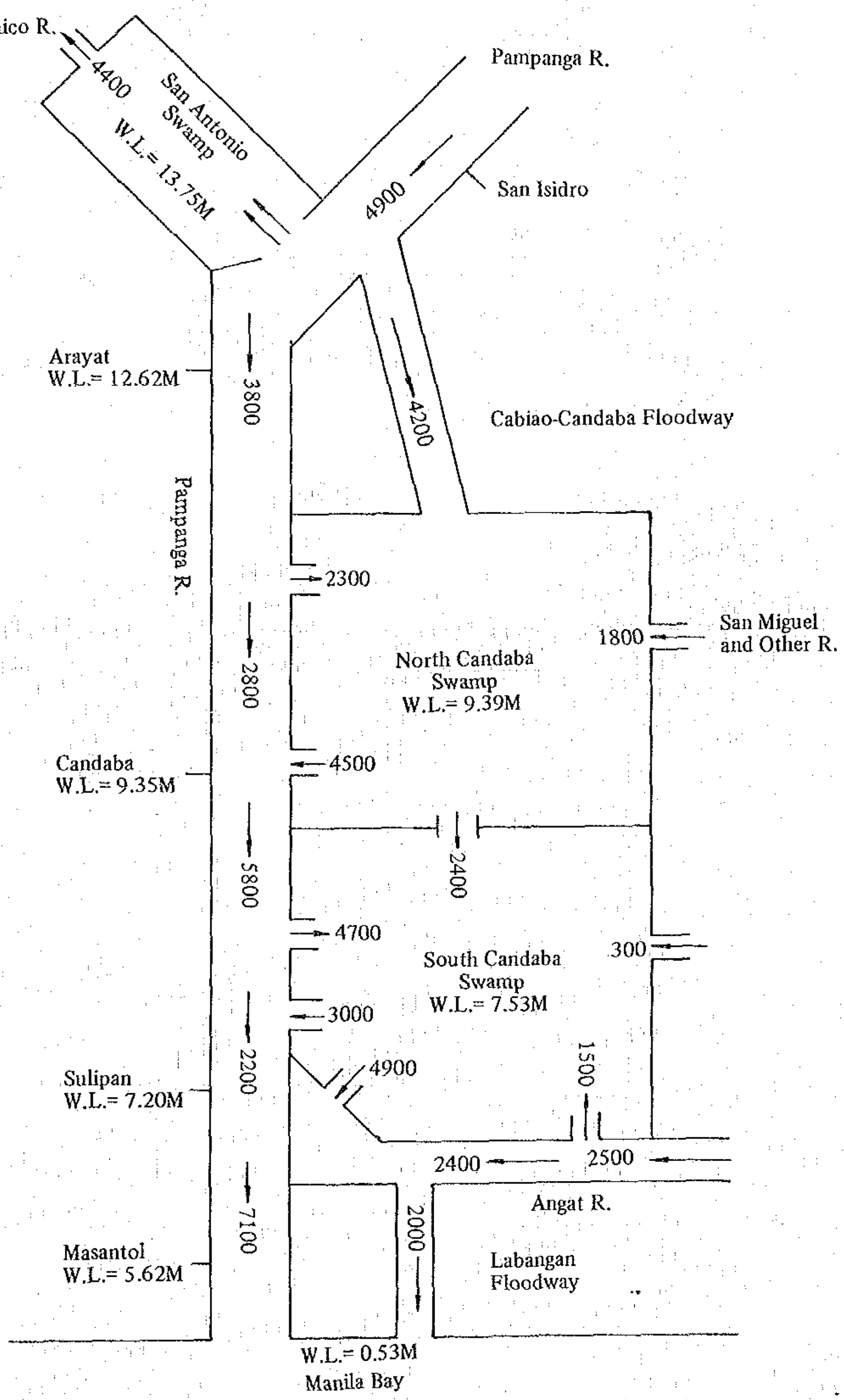
Dangerous Place From Flood

Flood Water Stage against the elevation of barrios in the candaba swamp as well as in the eastern and western parts.

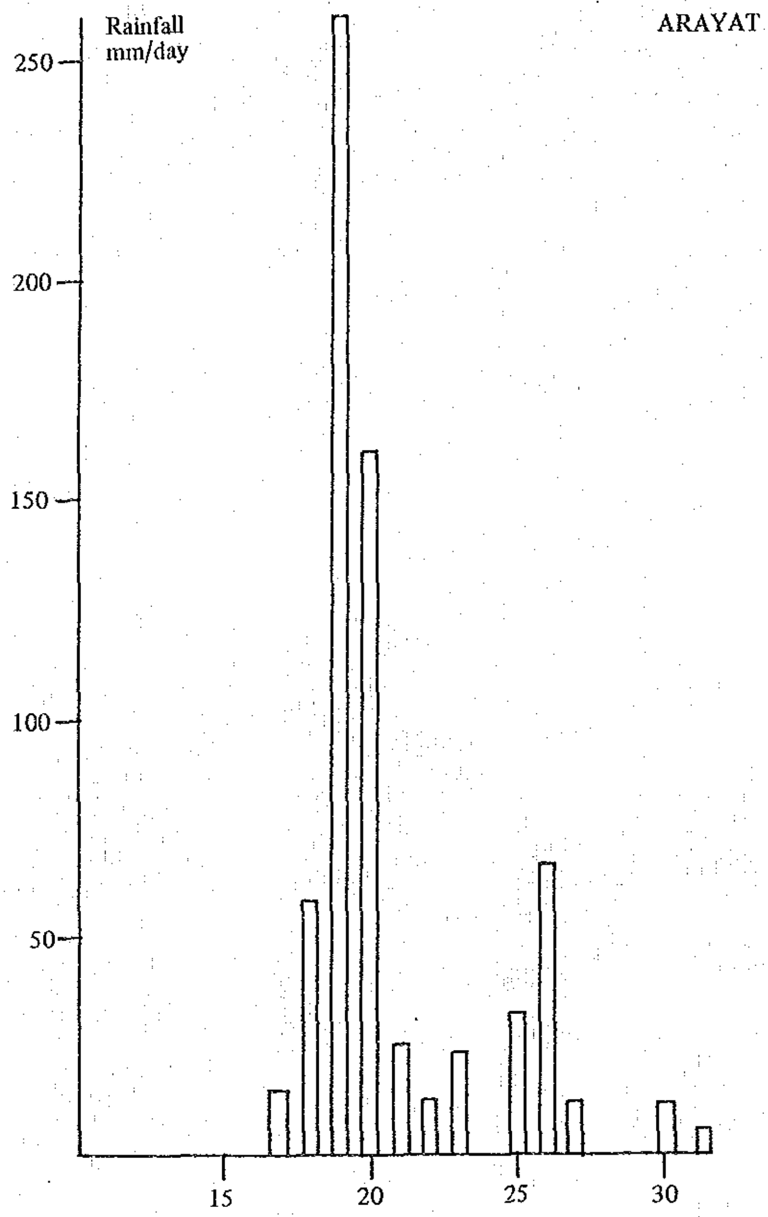
Flood Water Stage against the height of the Arnedo Dike between Apalit and Arayat and the ground elevation of candaba town.

4.3 Daily Rainfall (mm in unit) – May 1976

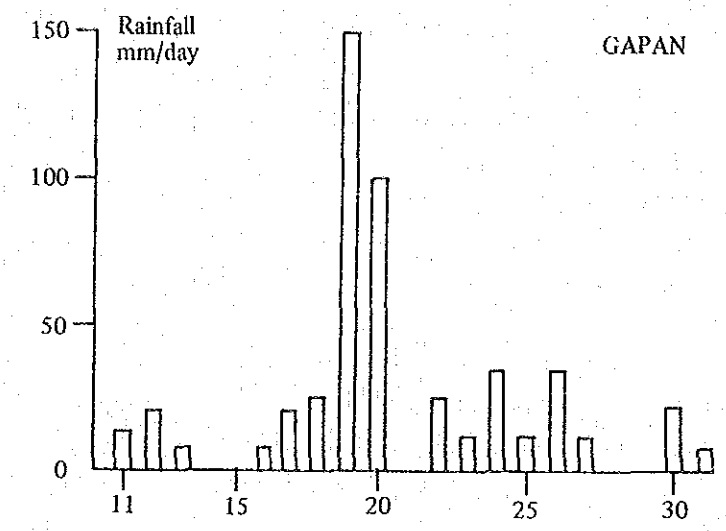
Date/ No. of Sta.	4	5	7	11	31	30	34	35
1.	10.4	0.0	0.0	0.0	0.0	N	10.4	0.0
2.	10.1	0.0	0.0	0.0	0.0	N	0.0	0.0
3.	2.7	0.0	0.0	0.0	0.0	N	10.2	0.0
4.	0.0	0.0	0.0	5.5	315	N	28	2.0
5.	0.0	0.0	0.0	0.0	0.0	N	0.0	0.0
6.	40.3	0.0	0.0	0.0	1.3	N	40.1	25.9
7.	1.5	0.0	26.6	0.0	27.9	N	9.6	2.0
8.	9.6	0.0	53.3	2.0	1.3	N	9.6	2.0
9.	4.0	16.2	3.8	46.7	26.7	13.0	4.1	0.0
10.	26.4	14.7	40.6	35.5	25.1	46.0	26.4	43.1
11.	41.9	0.0	0.0	0.0	27.9	0.0	41.9	3.1
12.	0.5	0.0	10.1	0.0	10.2	0.0	0.5	19.3
13.	0.0	11.1	0.0	20.8	0.0	0.0	0.0	1.5
14.	0.0	10.1	0.0	0.0	0.0	0.0	0.0	0.0
15.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16.	6.0	0.0	0.0	5.5	2.8	0.0	96.1	0.5
17.	98.2	0.0	0.0	14.2	3.6	7.9	98.3	18.1
18.	99.0	0.0	2.5	44.7	31.0	56.1	99.1	30.2
19.	81.7	134.8	27.9	183.1	197.4	266.4	132.0	152.2
20.	103.6	113.2	12.7	108.4	105.9	170.4	103.7	104.1
21.	23.1	84.0	78.7	2.0	0.5	22.9	23.1	31.0
22.	22.6	76.2	180.3	25.9	0.0	4.8	22.6	10.4
23.	134.8	64.0	60.9	5.3	29.0	16.0	134.9	35.5
24.	3.0	11.1	0.0	0.5	0.0	0.0	3.1	0.0
25.	34.5	9.3	7.6	17.7	8.6	23.1	34.5	12.9
26.	80.0	10.6	17.0	50.5	31.3	62.8	80.1	35.0
27.	35.0	11.6	5.0	4.5	19.0	14.5	35.1	16.0
28.	10.4	0.0	0.0	0.0	0.0	0.0	10.4	0.0
29.	11.6	9.1	0.0	0.0	0.0	0.0	11.7	0.0
30.	0.0	10.6	3.0	0.0	3.3	14.2	0.0	18.8
31.	0.0	0.0	19.0	1.7	2.5	2.0	0.3	1.5



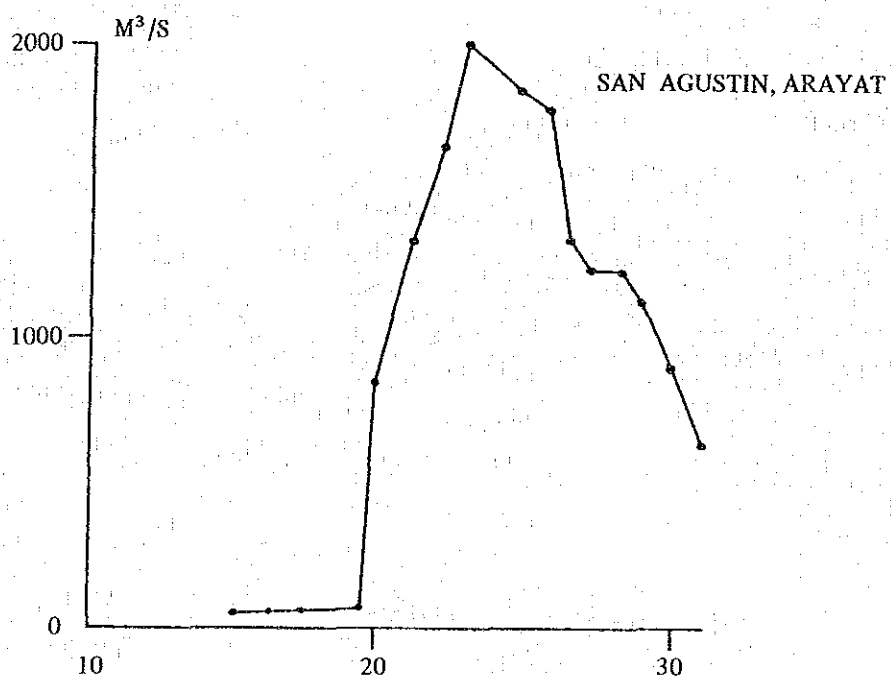
Flood Runoff Distribution Under Present Condition For 100-Yr Flood



Flood Hyetograph



Flood Hyetograph



Flood Hydrograph

Flood Hyetograph and Hydrograph of Pampanga River Basin

Flood Water Stage against the height of Fuse dike erected between Candaba and Arayat.

Combined effects of the tidal movements of Manila Bay and Flood Discharge on the Lowland in the Lower Delta Area.

5. Flood Forecasting System

1. Observation and Collection of Data
2. Analysis of Flood estimation
3. Issuance and Dissemination of flood Forecast and warning
4. Instruction for Flood Damage Prevention Measure such as flood Fighting, evacuation of residents etc.

Classifications of Flood Forecasting and Warning

1. Flood caution – for showing the extent of the estimated scale of a possible great flood to the gen. residents and the person concerned, in order to call their attention to make necessary preparation for the flood.

2. Flood warning – Warning the general residents and the persons concerned to take the measure against the flood, by showing the estimated dimension and time of occurence of the coming great flood.

3. Flood Information – For showing the present condition of a flood and its estimated change regarding the time thenceforth, so that measures can be taken against the flood.

6. Several Measures in Flood Loss Prevention

Brief descriptions of the major flood control works are given below:

Arayat–Apalit–Masantol setback levee: About 42 km long continuous levee on the right bank of the Pampanga river. The levee was constructed in 1975.

Calumpit–Plaridel–Bustos levee: A continuous levee on the left bank of the Angat river. The construction was completed in 1975.

Bebe–San Esteban diversion channel: A diversion channel to link the Pampanga with the Pasig river diverting at Mansatol. The channel was completed in 1975.

Cabiao-San Isidro levee: A levee on the left bank of the Upper Pampanga river. The work was completed in 1978.

Arayat–Cabiao ring levee: A ring levee enclosing the area of 45 km^2 to protect it from floods. The heightening works of the levee are on-going.

Layos–Bagong Sikat Cut-off Channel: A cutoff channel to normalize the alignment of the Pampanga at Cabiao. The channel was constructed in 1975.

Labangan floodway: A floodway to divert the flood flows of the Angat river directly to Manila Bay. The floodway is expected to case the flow constriction at Calumpit. The first stage was completed in 1979 except dikes. The second stage works in which the channel is widened are on-going.

Flood control works of tributaries: The Rio-Chico, Parua, Quitanguil, Abacan and Pasig-Potrero river control works, and Gumain-Porac diversion channel works are on-going.

In the Pampanga river basin, the Pantabangan and Angat multipurpose of exist. The Pantabangan dam has 330 x 10^6 m^3 of flood control space the Angat dam has no specified flood control space. These two dams on well as flood control facilities.

6-2 COUNTRY REPORT

Name:	Mr. Rungsan Sirayayon
Country:	Thailand
Organization:	Royal Irrigation Department, Ministry of Agriculture and Cooperatives
Position:	Hydrologist

1. General Conditions of My Country

A. Location

Thailand lies in the tropical zone with in the latitude 21° and 6°N and longitude 98° and 106°E. The length from north to south is about 1,643 kilometers and its greatest width is about 780 kilometers. The coast lines contain roughly 1,875 kilometres on the Gulf of Thailand and about 740 kilometres on the Indian Ocean. Listed clockwise, countries bordering on Thailand are the Laos and Cambodia on the north and the east, Malaysia on the south and the Socialist Republic of the Union of Burma on the northwest and the north.

B. Topography

The total land area of Thailand is about 513,115 square kilometres with 50 million inhabitants. Thailand is divided into four regions, namely: Central, Northeastern, Northern and Southern. Bangkok Metropolis is the capital and also the principal city of Thailand. Area of Thailand is divided show in the Table 1.

Physiographically, Thailand has three types of land forms highland, plains and plateaus. Highland including several mountain ranges mostly covered with forest extend from the northern part to the Peninsula through the entire western length of the country the coastal area east of the Gulf of Thailand is another piece of highland. The central part is occupied by an extensive alluvial plain down to the Gulf. The plateau with undulating surface form the northeastern of the country, see Fig. 1.

Table 1 Area of Thailand

Region	Area in Sq. Kms.	Percent
Whole Kingdom	513,115.0	100.0
Central	103,901.0	20.2
Northeastern	168,854.4	32.9
Northern	169,644.4	33.1
Southern	70,715.2	13.8

Source: Royal Thai Armed Forces Survey Department, Ministry of Defence.

C. Climate

Thailand lies within the tropical monsoon zone of Southeast Asia. The climate of much of the country is dominated by the monsoons. In most regions, there are three seasons summer takes place from middle of February to middle of May, rainy season takes place from the middle of May to the middle of October and winter season takes place from the middle of October to the middle of February. Map of Thailand and Air Streams Dominating the Climate Conditions shown in Fig. 2.

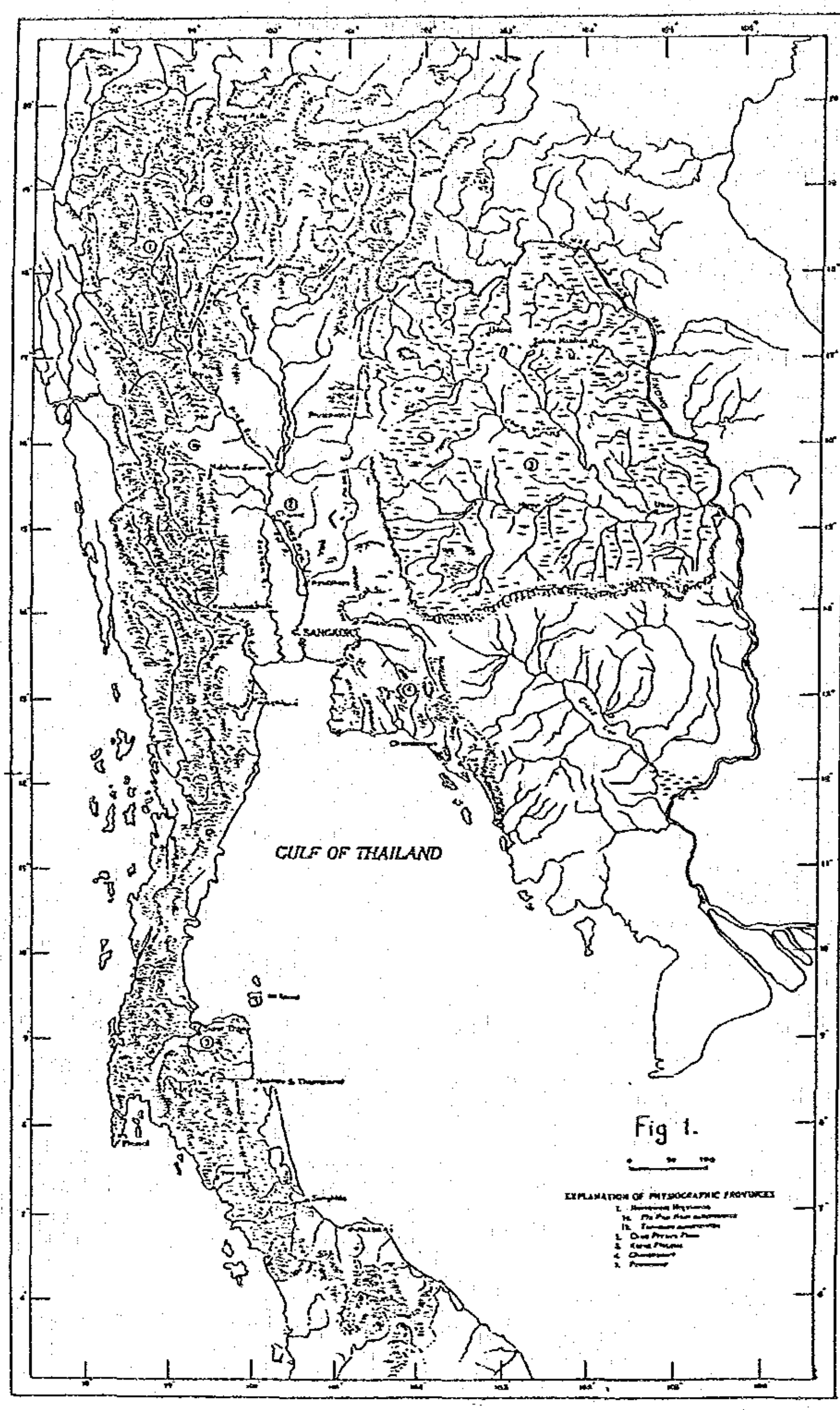


Fig. 1 Diagrammatic Sketch of the Physiographic Provinces of Thailand

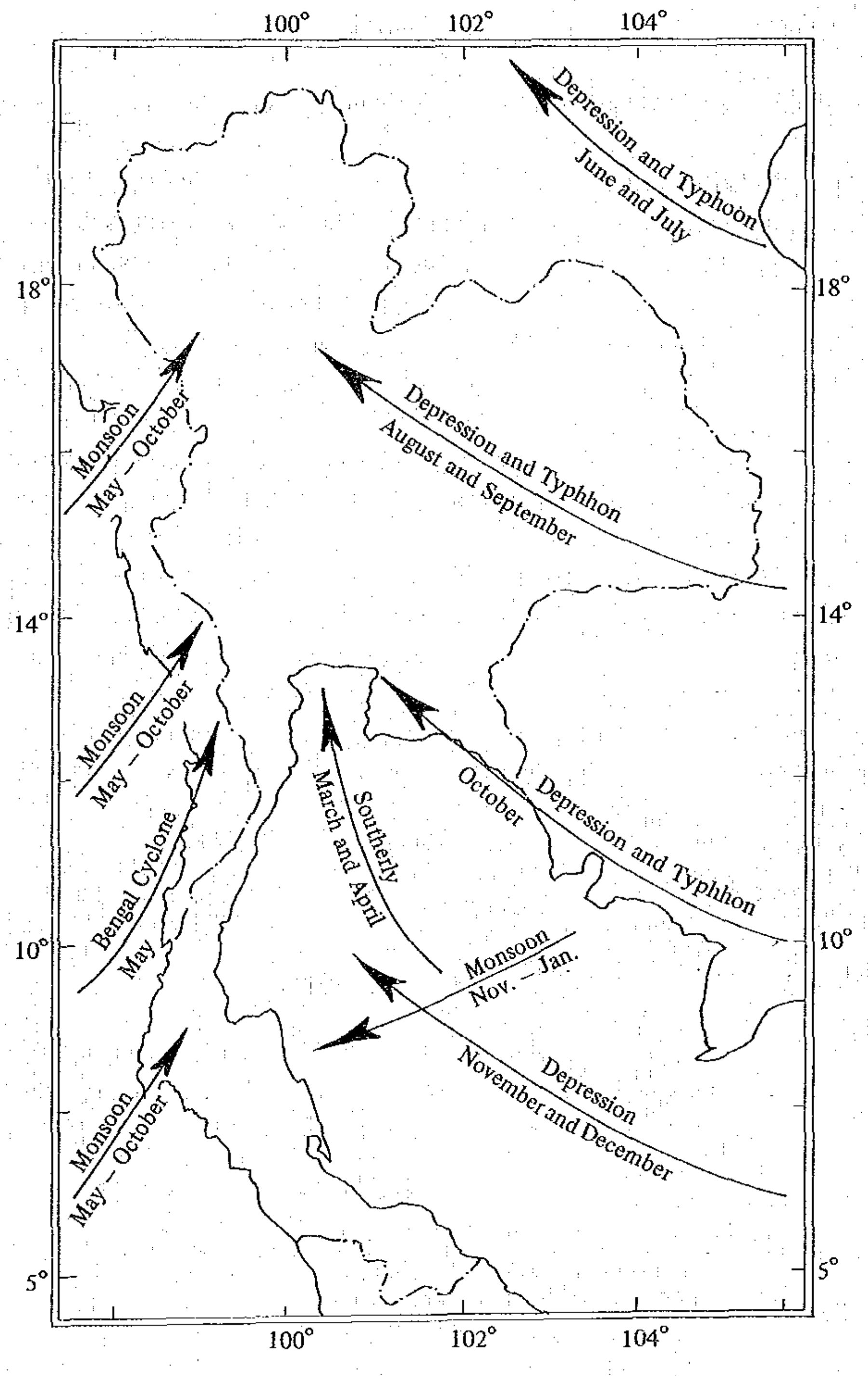


Fig. 2 Map of Thailand and Air Streams Dominating the Climatic Conditions

D. Geology

The top soil of the various plains in Thailand are as follows:

(a)	In Northern Part	–	Sandy Clay and Sandy Clay Loam.
(b)	In North Eastern Part	–	Sandy Loam and Lateristic Soil.
(c)	In Central Plain	–	In the upper reach Nakhon Sawan above Ayuthaya – Sandy Loam, Sandy Clay Loam then South of Ayuthaya Silty Clay.
(d)	In Southern Part	–	Sandy Clay and Sandy Loam.

As the soil of Thailand composes of deteriolated materials of the various ranges of hills in the Part, which are mostly Sandstone, down at a certain depth, between one metre to five metres, there is a layer of partically impervious slippery bluish clay, which if being near the surface and having been bleached through by heavy rain of the rainy season and baked by the hot tropical Sun in the dry season, becomes lateristic in character, called Lixivium, in the Peninsula and Southeast Asia Island. This layer of clay, with thickness between one to four metres helps to retain water to make the land most suitable for Rice cultivation, as rice requires submergence right through its life. The Soil, both of surface and of under stratum, of the central plain, is most suitable for rice cultivation and, on its upper reach, also suitable for other agricultural products.

E. Hydrology

The larger part of Thailand has an average rainfall 1,100 to 1,500 m.m. The only large low rainfall zone is found in the rain shadow of the western continental highlands. Major high rainfall zone are peninsular Thailand, with maximum precipitation on the west coast, and the southeast coast. High rainfalls are also observed in the northeastern part of the northeast plateau. The larger part of the country has a pronounced dry season with 3 months or more during with little rainfalls, during which time water losses by evaporation surpasses precipitation. Only in the southern part of peninsular Thailand and possibly in the extreme southeast, is the dry season less pronounced and mostly of shorter duration.

F. Rivers

In the Northern Part of the country the mountain ranges form the 4 principal basins drained off by the Ping, Wang, Yom and Nan Rivers. The rivers are confluence at Nakhon Sawan (upper of the central land) to be Chao Phraya River.

Coming to the central Plain, the Chao Phraya River flow down the Central Plain and confluence Pasak River at Ayuthaya (old capital of Thailand). Pasak River rises in the divide between the alluvial plain and the Northeast Plateau.

In the Northeast Plateau the wavy land forms several small watersheds draining into the 2 principal rivers, the Chi and the Mun, emptying into the Mae Khong River.

On the West there are the Mae Klong and Nam Phet Rivers draining into the Gulf. The Mae Klong River rises in two tributaries, Kwae Yai and Kwae Noi. The combined stream flows towards the Gulf.

On the Southeast of the Chao Phraya River there is Bang Pakong River which rises in two tributaries, Nakhon Nayok and Prachinburi, flowing into the Gulf.

Traversing down south the mountain ranges extending from the north as a backbone of peninsula form continuous small watersheds from which rivers flow east and west towards the Gulf of Thailand and Bengal.

The length of principal rivers are shown in Table 2.

G. Land Use

Most of the total area in Thailand is rice paddy, which the main crop and most important food of Thai peoples and also be the most important export of the country.

The other is: Forest cleared.
Low open forest.
Partically cleared paddy.
Mixed open forest.

The cultivated land crops, rice paddy about 64.9% upland food crops 11.8%, oil seed 5.3%, fibre crops 5.3%, green crops 1.9%, fruits 2.8%, rubber 7.5%, and tobacco 0.5%.

Table 2 Length of Principal Rivers

Region and River	Out flow	Length in Kms.
CENTRAL		
Chao Phraya	Gulf of Thailand	365
Pa Sak	Chao Phraya River	513
Bang Pakong	Gulf of Thailand	294
NORTHEASTERN		
Chi	Mun River	442
Mun	Khong River at Khong Chiam	673
NORTHERN		
Ping	Chao Phraya River at Pak Nam Pho	590
Wang	Ping River at Ban Pak Wang	335
Yom	Nam at Ban Koei Chai	555
Nan	Chao Phraya River at Pak Nam Pho	627
Kok	Khong River	285
Southern		
Ta Pi	Gulf of Thailand	214

Source: Royal Thai Armed Forces Survey Department, Ministry of Defence.

H. Priority Policy

To support the conclusions relative to suitability of the lands for irrigation specific high projects to improve yields and product quality as well as to accelerate production and marketing of important agricultural commodities will be initiated appropriate single and multiple cropping system will be promoted in rain fed and irrigated areas respectively consist with production and marketing potentials.

In order to achieve the agricultural development targets stipulated in the Development Plan, the Government puts more emphasis on raising productivity of agriculture through the development of irrigation system including on-farm development as well as water resources development. And small scale irrigation projects will be implemented according to long terms.

I. General Problem

In order to improve the economic situation in the country, the efficient use of available water is essential. How we will water to support the agricultural areas enough, and one of the fact is the improvement of rivers and natural canals for higher efficiency in the irrigation.

The other important problem, how to protect the paddy land from flood. The example case of such flood was as that of flood in 1978, the country was hit by a series of cyclonic storms in form of depression which caused a heavy rainfall in the river basin and serious flooding occurred on September, particularly, in the Northeastern and the vast area in central plain of lower Chao Phraya River Basin. As regards the flood damage in 1978, the subcommittee for Water Resource Development under the National Economic and Social Development Board has established a survey team to survey the damages in all aspects. It was reported that besides more than 300,000 families were affected by flood the total damages due to serious flooding in September 1978 was not less than US$170 million.

2. Organizations Dealing with Water Administration

In my country the organizations dealing with water administration have

(i) Royal Irrigation Department
(ii) National Energy Administration
(iii) Meteorological Department
(iv) Electricity Generating Authority of Thailand

3. Outline of the Pilot River Basin

Thailand has selected the Mae Klong River Basin for establishing a pilot flood forecasting and warning system which were adopted in the first session of Typhoon Committee held at Bangkok in 1968.

The Secretariat of Typhoon Committee has prepared a preliminary report entitled "Development of pilot flood forecasting in the Mae Klong River Basin" in November 1970. The report suggested the network of observation stations and computed method for flood forecasting and recommend to carry out the case study on past flood and trial flood forecasting of the current years by adopting the method and procedure suggested by TCS.

As of progress development has to be carried out in the Mae Klong river basin, the large reservoir has been built in the main tributaries. Srinagarind Dam on the Khwae Yai was completed 1979. Another dam at Khao Laem on the Khwae Noi is under construction. Therefore, the pilot basin had to be changed, and the Pasak River which is one of the Chao Phraya river, was selected to be a new pilot basin.

The Pasak River basin was selected as the pilot area for flood loss prevention and management since 1980. For the descriptions are follow:

A. Physical Characteristics

The Pasak River is a major tributary of the Chao Phraya River joining the Chao Phraya River at Ayuthaya. The stream flow down from north to south. The Pasak River slenderly extends north to south along the Pasak River with an average width about 45 kilometres. The basin has a long shape draining the eastern slope of the Phetchabun Moutain range and the western slope of Khorat Marginal Moutains.

The upper part of the basin up-steam from Saraburi Province is hilly. The plain extending over the left bank of the Pasak River is broadly divided into terrace, alluvial fan and recent alluvial flat. The lower part from Saraburi to Ayuthaya is a fertile flood plain suitable for rice cultivation. The catchment area above Kaeng Khoi stream gaging station is about 14,520 sq. km. The river basin covers part of the areas of four provinces namely Phetchabun, Lopburi, Saraburi and Ayuthaya.

B. Climate

The climate of the Pasak River basin is similar to climate of the country which is under the influence of the Northeast and Southwest Monsoon. During the Northeast Monsoon lasting from November to April, dry and cool conditions prevail over country. Southwest Monsoon lasting from May to October is moist and warm. Widespread rainfall occurs during the Southwest Monsoon season.

Atmospheric disturbances in the form of depressions originate in West Pacific and the South China Sea usually affect Thailand during July to October. Sometimes depression-caused rainfall is superimposed on the normal storm rainfall over the basin. These conditions produce the most serious flood conditions produce the most serious flood potential in the Central plain. Such cases occured in 1964 and 1978 which resulted in severe damage to the rice crop and other public facilities.

C. Description of Major Historical Floods

Observation of climatic data is carried out by the Meteorological Department. Rain gauges were installed at each district or provincial office and the data transmission is made by telegram and postal service. A synoptic station is located at Petchabun provincial office. Flow measurements at Lom Sak, Wichianburi and Bua Chum are also carried out by the Meteorological Department while the station at Kaeng Khoi is operated by the Royal Irrigation Department. The transmission of data from those stations is made by SSB except at Kaeng Khoi. Observation of river stage in the flood plain area is carried out by the Royal Irrigation Department. Irrigation development in the flood plain areas has been made with the Rama VI diversion dam built at Tha Luang and supplies water for rice cultivation in the left bank area. Additional development in the upper flood plain area near Saraburi Province has also been implemented. Normal flooding conditions with small depth in the lower flood plains area has normally been experienced in wet years and is sufficient for rice cultivation. Severe flooding condition is likely to occur whenever the widespread and continuous torrential rainfall from a depression occurs.

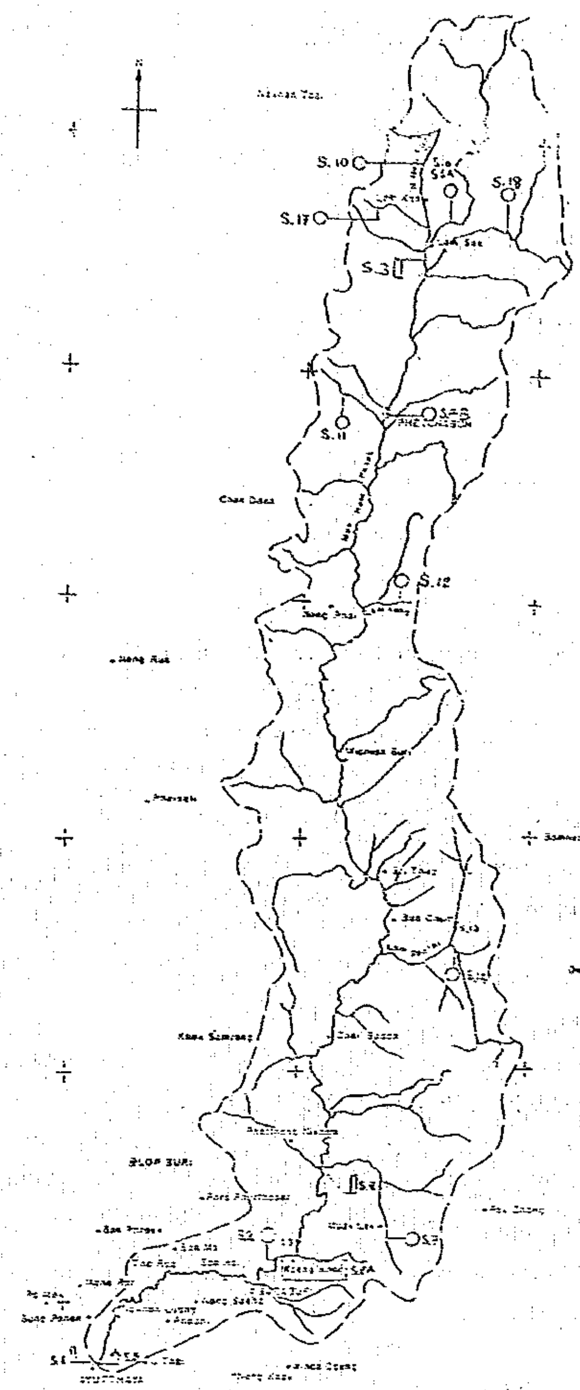
Severe flooding was observed in September–October 1978. The seasonal rainfall in the basin as a result of active southwest monsoon was higher than normal. Continuous rainfall was observed at the upper basin stations during September with 23 to 27 rainy days. Intense rainfall due to Depression "Kit" entering the country during 27–29 September generated a surplus runoff from the upper basin causing severe flood damage along the flood plain from Saraburi down to Ayuthaya. The maximum peak discharge of 3,200 m^3/sec at Kaeng Khoi station located at the head of flood plain was about 3 times greater than normal peak flow. The river stage at Rama VI Barrage of + 10.90 m. (m.s.l.) was the maximum recorded since 1914.

The flood event was recorded as the most severe in the history of the basin and caused extensive damage to paddy fields, houses and public facilities. As regards the damage by flood, it was reported by the Centre of Assistance of Flood Victims under the Ministry of Interior that within the two provinces, Saraburi and Ayuthaya, 47,921 families suffered, 11 persons died and 754,375 rai (1,207 square kilometres) of agricultural land were completely damaged.

Map of Pasak River Basin and stations show in Fig. 3.

4. Problems of the Pilot River Basin

Hydrological, Flood Forecasting, Precipitation Forecasting are important data in designing the flood loss prevention Modern techniques of Forecasting which has been developed in Japan should be useful to increase the efficiency of my job.



LEGEND

Steamflow Gaging
Staff Gage
Recording

Streamflow Gaging Station
Province
District

Fig. 3 Map of Pasak River Basin Showing Network of Rain Gage

6-3 COUNTRY REPORT

Name: Mr. Kangvan Deesuvan
Country: Thailand
Organization: The Bureau of Drainage and Sewerage
Position: Engineer 4
Flood Loss Prevention and Management In 1983 – 1984
By the Government of Japan (JICA)

DESCRIPTION OF THE AREA

The physical aspects of the surrounding area of a municipality have a considerable effect en the sewerage, drainage and flood pretection facilities with which it is to be provided. Topography dictates the balance between flowing by gravity or constructing pumping stations, and the possible subjection of the area to repiodic flooding. Geology affects the conditions of construction for the majority of these facilities which are built below the surface of the ground. Climate directly affects the design of drainage facilities and exerts a control over the periods of the year in which construction programs can more readily be carried out.

TOPOGRAPHY

The deltaic area upon which Bangkok Metropolitan was built was formed by the Chao Phya River. The delta is somewhat triangular in shape with a 120 kilometer (75 mile) base along the Gulf of Thailand and a length extending to the north about 200 kilometers (124 miles) to Chainat as shown in Figure 1. This area is extremely flat, extensively irrigated and very rich agriculturally. It is surrounded by low rugged mountains which are an extension of the Himalaya range.

The center of Bangkok Metropolitan is about 50 river kilometers (31 miles) north of the Gulf of Thailand. The municipalities of Bangkok Metropolitan presently occupy a total of 303 square kilometers (118 square miles). Ground elevations at Bangkok are a maximum of about 2 meters (6.6 feet) above mean sea level and at Chainat the elevation is only 15 meters (49 feet) above mean sea level.

GEOLOGY

Geologic History. The mountains surrounding the Ghao Phya Plain were formed during the late or Post Miocene orogeny. The present Chao Phya river basin was possibly the result of the development of structural basins in the late Tertiary epoch followed by heavy alluvial depositions during the Quarternary epoch. These first deposits, consisting of layers of fine gravel, sand, and sandy clay, are now located at a depth of 300 meters (984 feet) or more below the surface. A thick layer of grey, relatively homogeneous clay was later deposited after the major movement of the earth's curst had stopped.

The delta steadily advanced into the Gulf waters to the south. About 500 years ago the present site of Bangkok was at the shore of the Gulf of Thailand. Recent flood control and irrigation projects have caused most of the silt to precipitante before it reaches the Gulf but the southward growth of the delta, although slowed, is continuing.

Ground Water. The ground-water level in Bangkok is very close to the surface during the wet season. Even during an extreme dry season the ground water is rarely more than a meter below the surface. The average elevation of the ground-warer table varies approximately from 35.5 to 36.0. The mean sea level is 35.0 and the mean water level in the Chao Phya at Bangkok is about 35.3.

CLIMATE

Thailand has three different seasons: The "Cold Season", which includes November, December and January; the "Hot Season", extending from February through May, and the "Wet Season", covering the other five months of June through October. The relatively dry period extends from November through April with practically no rainfall in December and January.

The mountains around Bangkok dissipate the forces of the typhoons or cyclones that create such havoc breezes of more than 1.5 kilometers per hour prevail about two thirds of the time these breezes seldom exceed 12 kilometers per hour. Maximum winds up to 122 kilometers per hour (76 mph) have been recorded, however. The prevailling winds are either from the north or the south.

Table summarizes the climatic conditions in Bangkok, including temperature, relative humidity, evaporation, days of rain and rainfall, and wind velocities.

HYDROLOGY

Thailand's climate is tropical. Generally the cool season is from late-October to mid-February, the hot season from mid-February to mid-May and the rainy seaosn from mid-May to mid-October. The Central Plain (including Bangkok) rarely has temperatures below 21°C or above 38°C. Humidity in the rainy season is high.

The heaviest rainfall normally occurs during August to September as the result of heavy monsoon rains and the torrential rainfall caused by tropical storms and depressions. As a consequence, flash flooding usually takes palce frequent.

Tropical storms, depressions and a few typhoons which weaken into storms or depressions, move into Thailand every year. The statistics of 28 years (1947 – 1974) showed that the storms moved into Thailand at an average rate of 3.7 storms per year. As shown in Tabel below, the historical storms occurred more frequently during the months of September to November, with the maximum frequency recorded is the month of October.

Table Climatic Conditions in Bangkok

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature, °C												
High	33.3	33.9	35.0	36.1	35.0	33.9	33.3	33.3	32.8	32.8	31.7	31.7
Low	18.9	21.2	22.8	24.4	24.4	24.4	24.4	23.9	23.9	23.9	21.6	19.4
Avg.	26.2	28.0	29.3	30.1	29.7	29.0	28.5	28.4	28.1	27.7	26.9	25.6
Temperature, °F												
High	92	93	95	97	95	93	92	92	91	91	89	89
Low	66	70	73	76	76	76	76	76	75	75	71	67
Avg.	79	89	85	86	35	84	83	83	82	82	80	78
Relative Humidity,												
percent	71.4	74.1	73.6	74.3	78.6	79.4	79.4	80.1	82.1	82.7	79.3	73.5
Evaporation,												
millimeters	185	169	195	170	140	141	130	119	100	125	153	182
inches	7.3	6.7	7.7	6.7	5.5	5.6	5.1	4.7	3.9	4.9	6.0	7.2
Days of Rain,												
per month	1	3	4	6	17	18	19	19	21	17	7	3
Average Rainfall,												
millimeters	8	31	35	84	179	163	167	187	313	245	53	6
inches	0.3	1.2	1.4	3.3	7.1	6.4	6.9	7.4	12.3	9.7	2.1	0.3
Wind Velocities,												
Max., Km/hr	47	61	58	97	122	76	76	72	83	72	54	50
Avg., Km/hr	7	13	13	11.5	8.5	7	6.5	7	7	6.5	6	3.5

Mean annual rainfall 1,482 millimeters (58.4 inches). Period of record (1937 to 1966)

Table Monthly Distribution of Tropical Storm Occurrence in Thailand

Month	Number of Storms
January	0
February	0
March	0
April	1
May	1
June	4
July	7
August	10
September	24
October	29
November	20
December	7
Total	103

Period: 1947 – 1974 Source: Meteorological Department

The rainfall is unevenly distributed in time as well as in space. Generally, heavy rainfall occurs on the western flanks of the mountain ranges or on the coasts.

Conventive and orographic rains cause most of the rainfall during the wet season. More widespread rainfall of longer duration can be caused by occasional tropical cyclonic disturbances, which are classified according to wind speed as tropical storms or depressions.

The average annual rainfall in the Chao Phya and Mae Klong river basins varies from just below 1,000 mm on the western side of the Chao Phya river basin to more than 2,000 mm in the north western rim of the MAE Klong river basin. About 85% of the annual rainfall occurs during the months of May to October, with some variation in the monthly pattern form north to sorth.

In Bangkok Metropolitan Area, high intensity rainfall is a bigger problem than flooding caused by overflow from the Chao Phya River. If the rainfall intensity exceeds 30 mm/hour, the existing internal drainage system fails, resulting in widespreade flooding and damage to roads, traffic, etc.

The Chao Phya basin comprises most of the mountainous areas and valleys in Northern Thailand and Central Valley. It extends from the Tahi-Burma border in the north down to the Gulf of Thailand in the south, with the whole catchment area of roughly 177,550 km², or about 31% of the total area of the Kingdom. In the Central Valley an alluvial plain has been formed by the Chao Phya river system. South of Chainat the alluvial plain is called the "Bangkok Plain", which is (for the greater part) the real delta of the Chao Phya River. Here the river overflows its banks regularly and the Bangkok Metropolitan Area and other adjacent areas are frequently inundated.

HYDRAULICS

The Chao Phya River is a seasonal river. The river stage usually starts to rise in May following the onset of the wet season and reaches its highest water levels in September – October. In the wet season a high discharge of 4,000 m^3/s was measured near Chainat and in the dry season a low discharge of 50 m^3/s.

After the storage dams were built on the Ping and Nan rivers of the Chao Phya River system, navigation programmes were developed in the river reaches below the dam. At present, the minimum release downstream of the Chao Phya dam of 75 m^3/s can maintain a minimum draft of 1.40 m throughout the Chao Phya river reaches.

Salinity intrusion in the southern portion of the Central. Plain has been detrimental to the extensive orchard and vegetable area along the Chao Phya river for a long time, especially when the flow is low. The extent of salinity intrusion can be controlled and the area protected cab be increased with increased flows. At present a minimum flow of about 80 m^3/s is released for salinity control in the Chao Phya river. However, about 20 m^3/s is assumed to be used for water supply in the vicinity of the Bangkok Metropolitan Area.

Some 2,000 public and private production wells have been constructed for human consumption and sanitation in the Bangkok Metropolitan Area and adjacent areas. In the Bangkok Metropolitan Area, one third of the total public water supply, some 92 million gallons per day, comes from aquifers.

Parts of the city area already protected against floods by partially completed polders. Emergency measures including sand bags, temporary cofferdams and mobile pumping units are also used when floods arise, as in the significant floods of October, 1978 and 1980.

Dredging of the Chao Phya River up to Nakhon Sawan by Inland Waterways Project of which the design has been completed by BCOM, might affect the hydrological and hydraulic

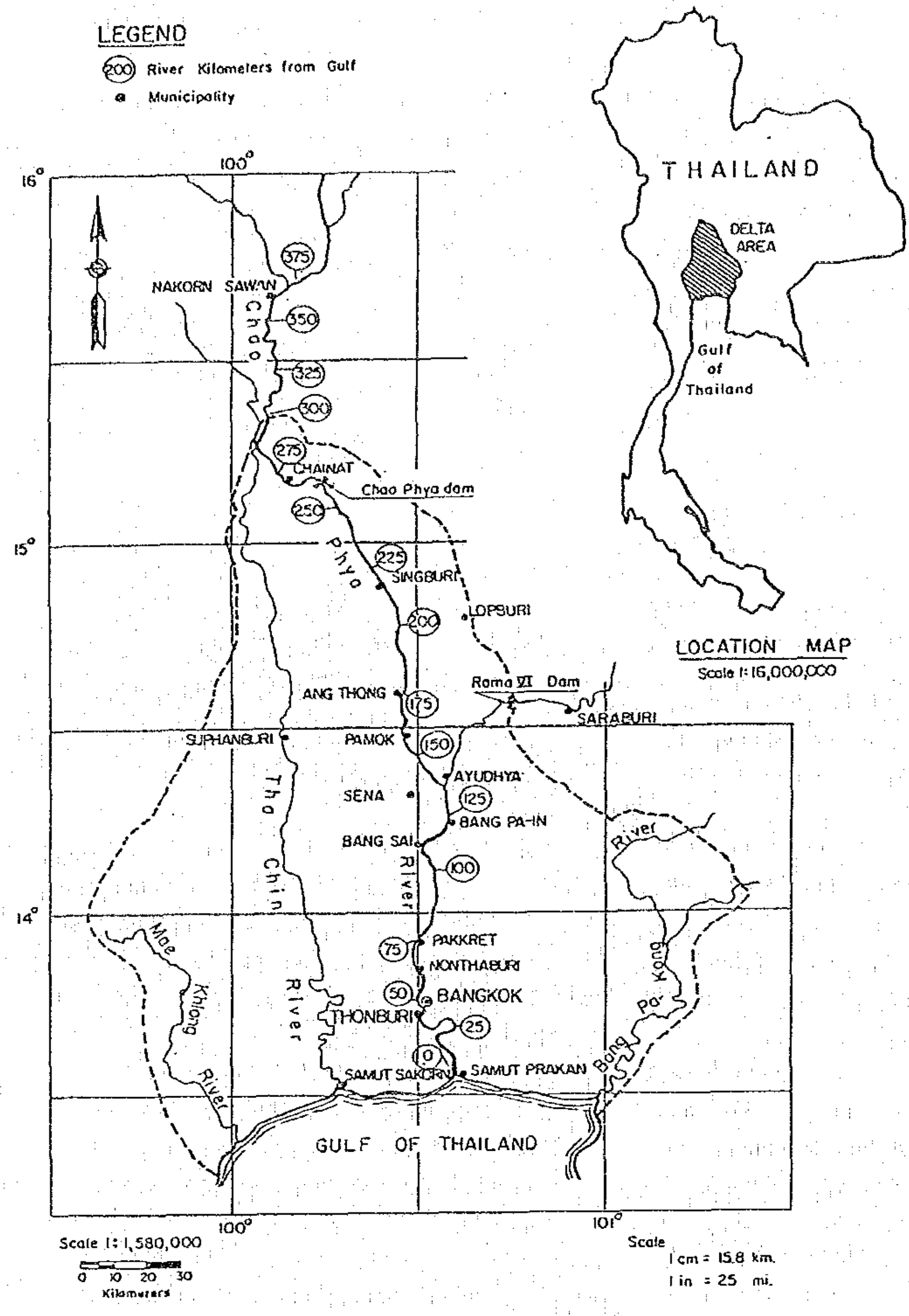


Fig. 1 Chao Phya River Delta

aspects of Bangkok flood control and drainage project.

The general topography of the area is flat. The lowest and highest land elevations do not differ more than about one metre. The area is laced with canals (known as klongs) which were built for tansport and defence purposes when Bangkok was founded two hundred years ago. During the monsoon seaion, rainfall and high water levels in the Chao Phya River cause flooding to depths of 70 cm on the roads.

The factor which most importantly affects consideration of sewerage, drainage and flood protection systems for Bangkok Metropolis is the Chao Phya River, together with the canals in the area which are connected to the river.

THE RIVER

The Chao Phya River drains an area of about 177,000 square kilomiters (68.500 square miles) (see figure 2.) In the delta area south of Ayudhya, where Bangkok is located, the land is very flat. The main stream normally flows in a well defined channel below Ayudhya. When the river is in flood it inundates adjacent lands, with the water moving slowly toward the Gulf of Thailand. A small rise of the flood level extends the waters over extremely large areas. Fortunately the flood waters rise gradually and do not normally reach great depths.

The overall slope of the Chao Phya River is about 5.5 centimeters per kilometer (3.5 inches per mile). Below Bangkok the slope is at its minimum of about 2 centimeters per kilometer. At Bangkok the river has a minimum width of 180 meters (590 feet), with depths of as much as 20 meters (66 feet) or more. Downstream the width increases to 500 meters (1640 feet) at river kilometer 10 (distance from the Gulf), and to more than 1,000 meters near its mouth.

RIVER FLOWS

Until recently, during the period from January to July, the average river discharge at Bangkok was somewhat less than 100 CMS (3,530 cfs) with a minimum of 25 to 50 CMS around April. The discharge normally exceeds 1,000 CMS during the period from August to December with a maximum of 3,000 to 4,000 CMS in October. A typical discarge hydrograph is shown in Figure 3.

Records maintained at Ayudhya show that during the 126 year period from 1831 to 1957 there were 21 years of moderate drought, 35 years of severe drought and 5 years of

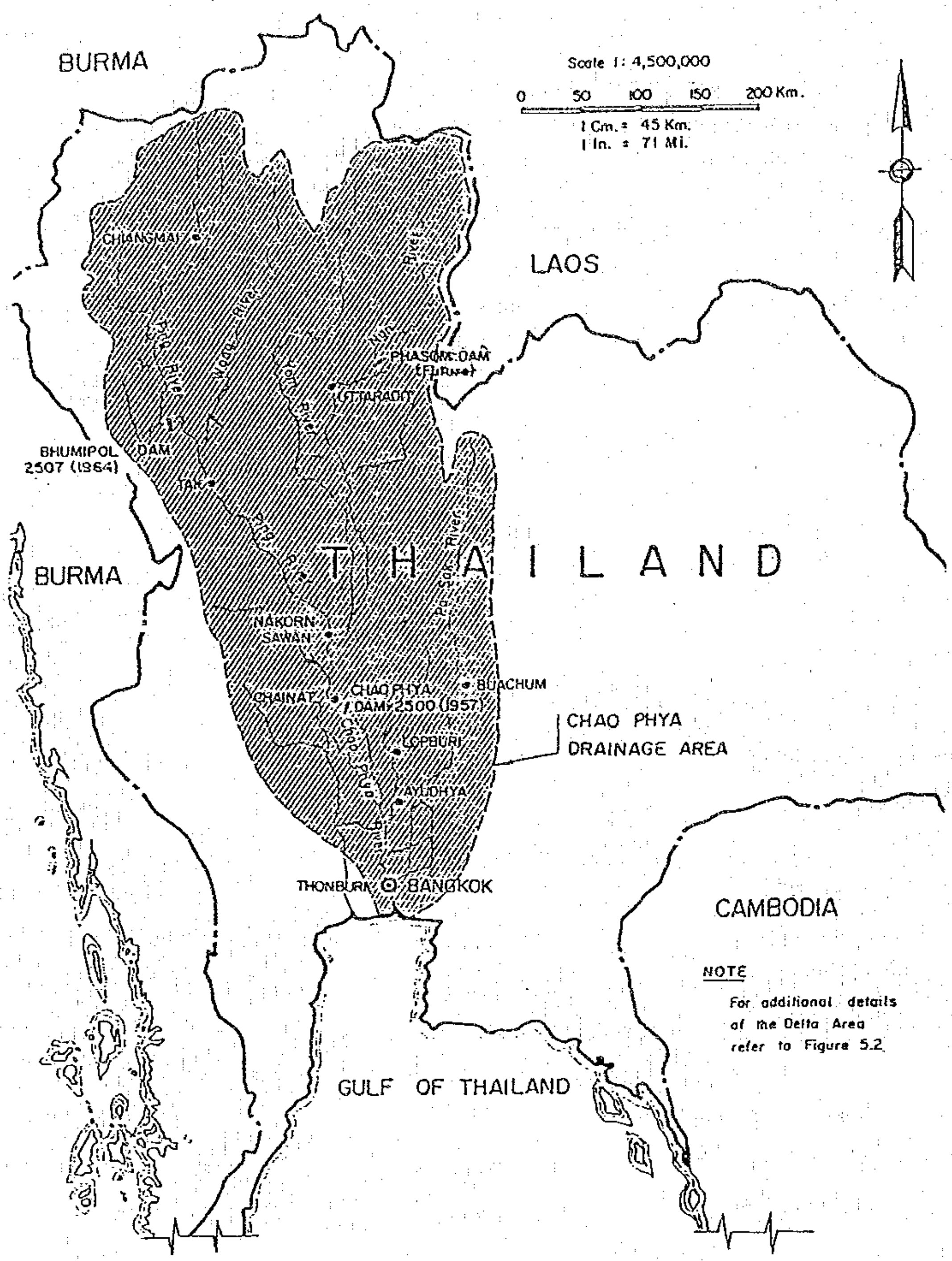


Fig. 2 Chao Phya Drainage Area

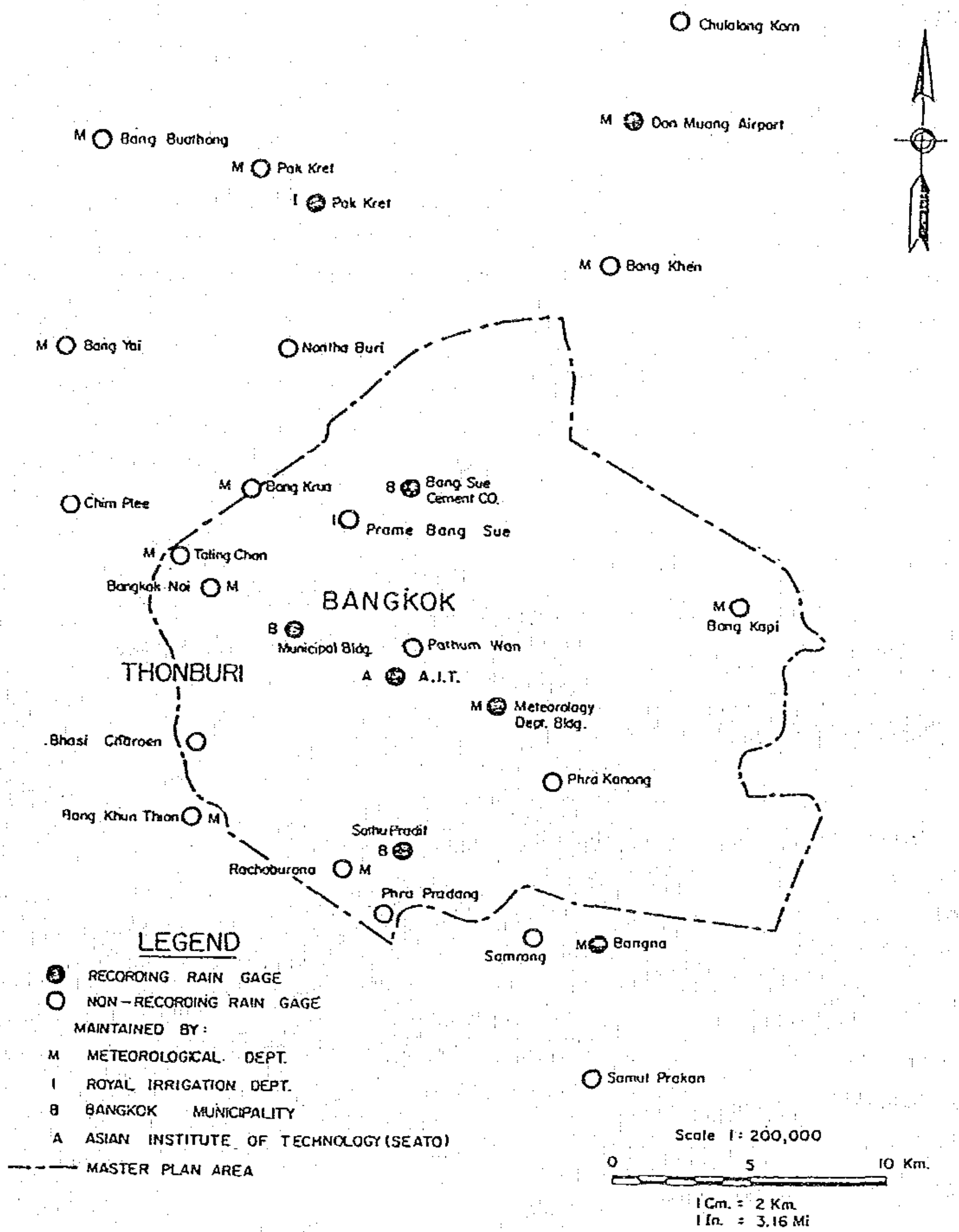


Fig. 3 Rain Gage Locations Bangkok and Thonburi Area

extreme drought. They also show that 11 years had moderate floods, 4 years had severe floods and 2 had extreme floods.

THE KLONGS (THE CANALS)

In the lower reaches of the delta the land is traversed by many klongs. Some of these klongs are natural but by far the majority are man-made. In the earlier days several of the klongs around Bangkok were constructed for defensive purposes. Later, others were added for navigation, drainage and irrigation needs. Additional kongs were dug to furnish fill material for road construction or to provide outlets for urban storm-water runoff, as the city continued in its rapid growth the utilization of these klongs also changed. In the last decade many of the klongs have been converted into highways. Klongs which were originally constructed for irrigation purposes now often receive combined storm water and waste water to the point where many klongs in the central municipal area have become severely polluted and offensive. Navigation and the movement of farm products by water has decreased considerably in recent years within the fully developed parts of the city.

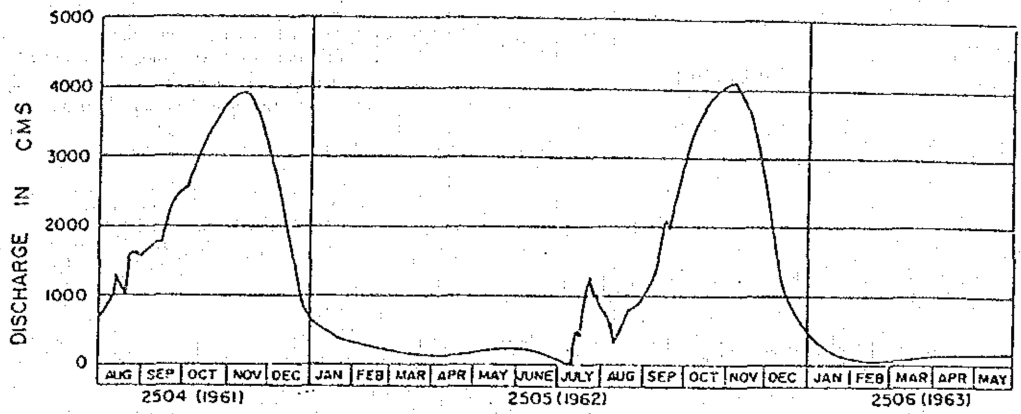
Before 1900 most of the homes were built next to the klong because the basic means of transportation was by boat. Outside the larger urban areas the practice of locating houses adjacent to klongs it still widespread throughout the delta.

The major irrigation and navigation Klongs, is well developed in and around Bangkok Metropolitan. Many of the major klongs have navigation locks or regulators built for the purpose of controlling irrigation water levels. The policy of conservation of irrigation water towards the end of the flood season results in high water levels in the klongs which adversely affects the requirements for better and faster drainage of the urban lands.

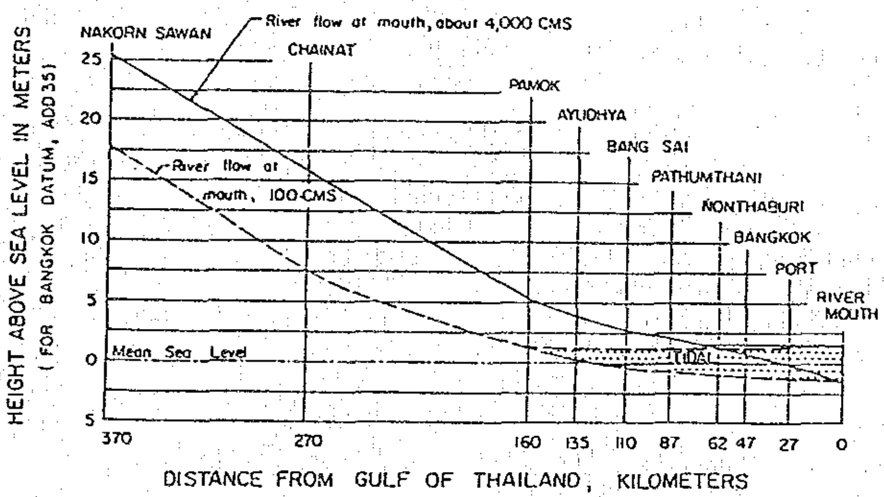
The primary responsibility for maintenance of the major existing klongs is delegated to the Royal Irrigation Department. The smaller klongs within the city limits are maintained by the Municipality.

In 1966 the Road and Sewerage Improvement Committee of the Ministry of Interior recommended that a number of the existing klongs be kept open and maintained for the purposes of navigation, irrigation and drainage. The more important of these klongs are shown on Figure 4.

An increasingly important use for the klongs in the city has been their use as a major source of water to fight fires. As the area has become more densely populated, the municipal water distribution system growth has not kept pace and and now the needs for water supply



DISCHARGE HYDROGRAPH CHAO PHYA RIVER AT MOUTH



LEVELS OF WATER SURFACE IN CHAO PHYA RIVER

Fig. 4 Discharge Hydrograph and Water Surface of Chao Phya River

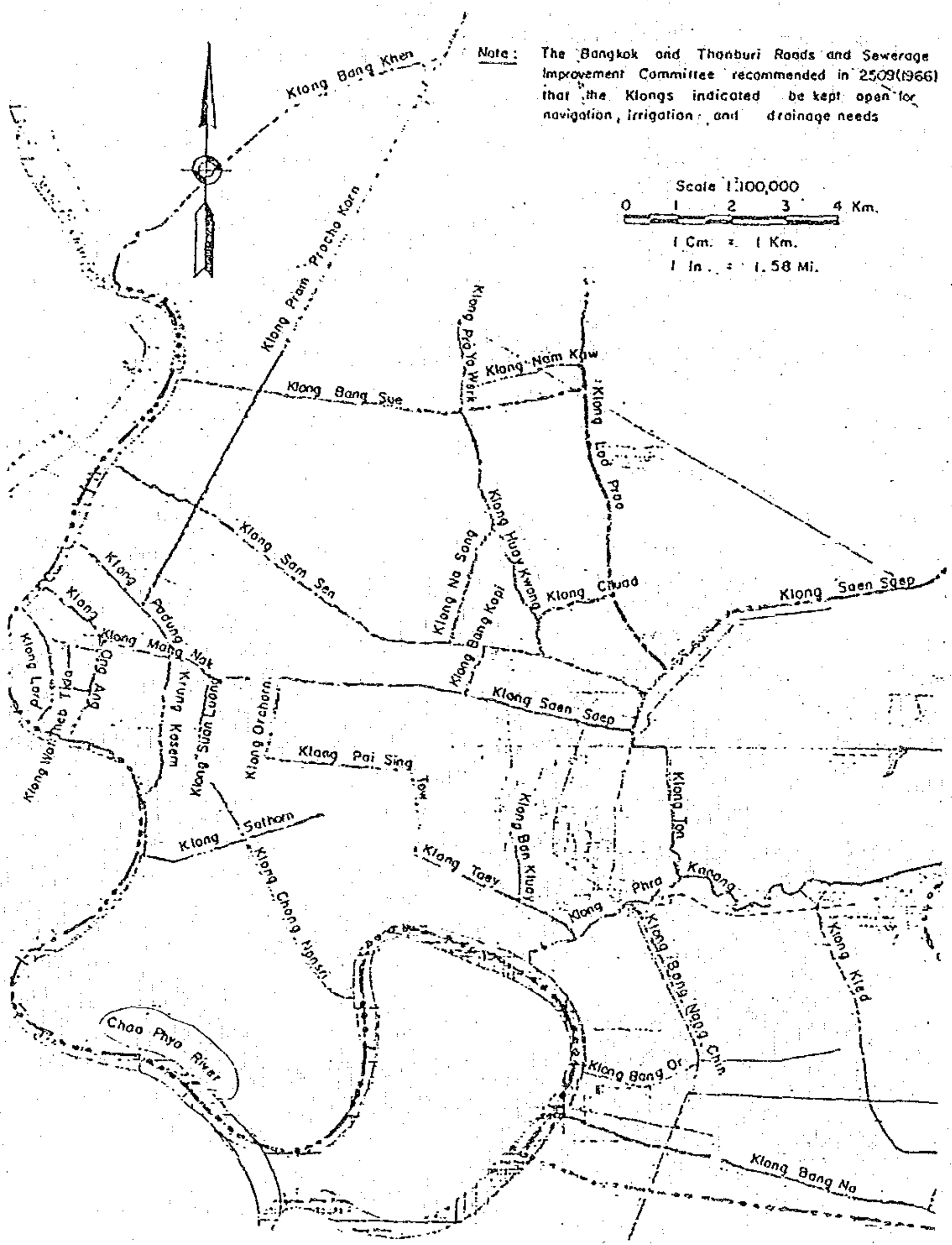


Fig. 5 Major Klongs Recommended for Retention by Government Agencies

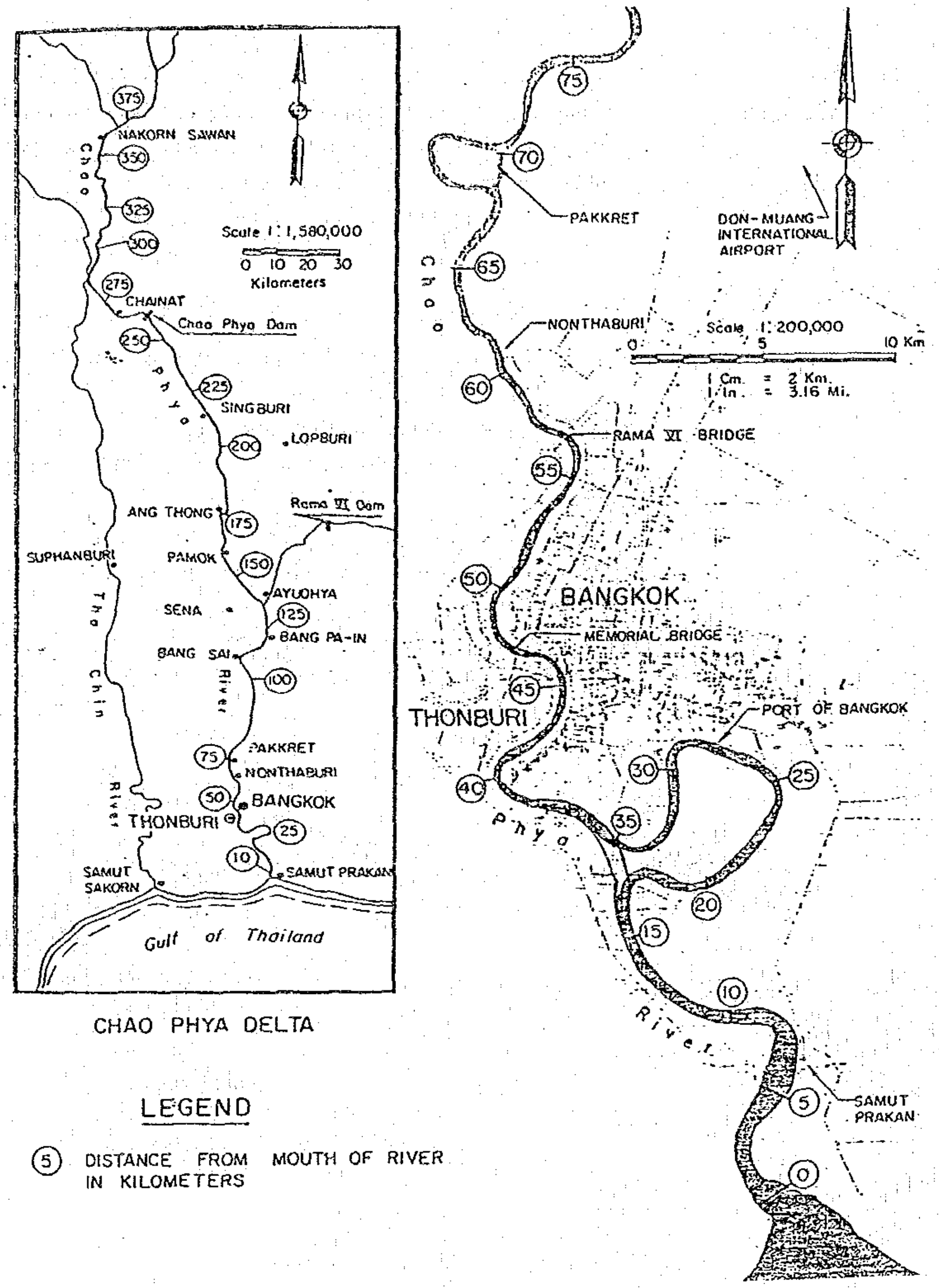


Fig. 6 Chao Phya River Stationing

alone, not considering fire requirements, cannot be met.

The klongs should continue as a source of supply for fire-fighting water in addition to serving as the most economical means of removing storm water. In addition to these practical functions the klongs are an important part of the historical culture of Bangkok.

PRESENT SITUATION

- Bangkok has a ground level which is an average of 1.0 metre above Mean Sea Level;
- During periods of very high discharges of the Chao Phya River and of high tide levels in the Gulf of Thailand extensive flooding of low lying areas in Bangkok occurs;
- High intensity rainfall and drainage problems occur during August through October;
- The Bhumipol and Sirikit Dams and the Chainat barrage provide some degree of flood control to Bangkok: according to the Acres/rid paper, these dams cannot provided greater flood control benefits in Bangkok than are presently being achieved;
- According to the Acres/rid paper, there are no opportunities for new storage projects which would result in major increases in the degree of control of flows in the lower Chao Phya Basin;
- Plans for agricultural development and improved drainage of the so-called Central (Bangkok) Plain will result in an increase in high water discharges of the Chao Phya River near Bangkok. This increase will partly offset the flood control effect of the Bhumipol and Sirikit Dams and the Chainat Barrage;
- It is not anticipated that improvement of the flooding conditions in the areas to the north of Bangkok, if feasible, would substantially reduce flood problems in the Bangkok region.

The Chao Phya River Basin
The control of water

The Bhumiphol reservoir controls the outflow from a catchment area of 26,400 km^2 and the Sirikit reservoir from 13,200 km^2. The combined area is only 39,600 km^2 or about 36 percent of the area drained by the Chao Phya River at Nakhon Sawan and 22 percent of the area of the entire basin. There are no opportunities for new storage projects which would results in major increases in the degree of control of flow below the two major dams in the Chao Phya basin.

Project Relationship with Chao Phya Basin Development Plans

The following line diagram amply indicates the complexity of the river network which drains the Chao Phya river basin.

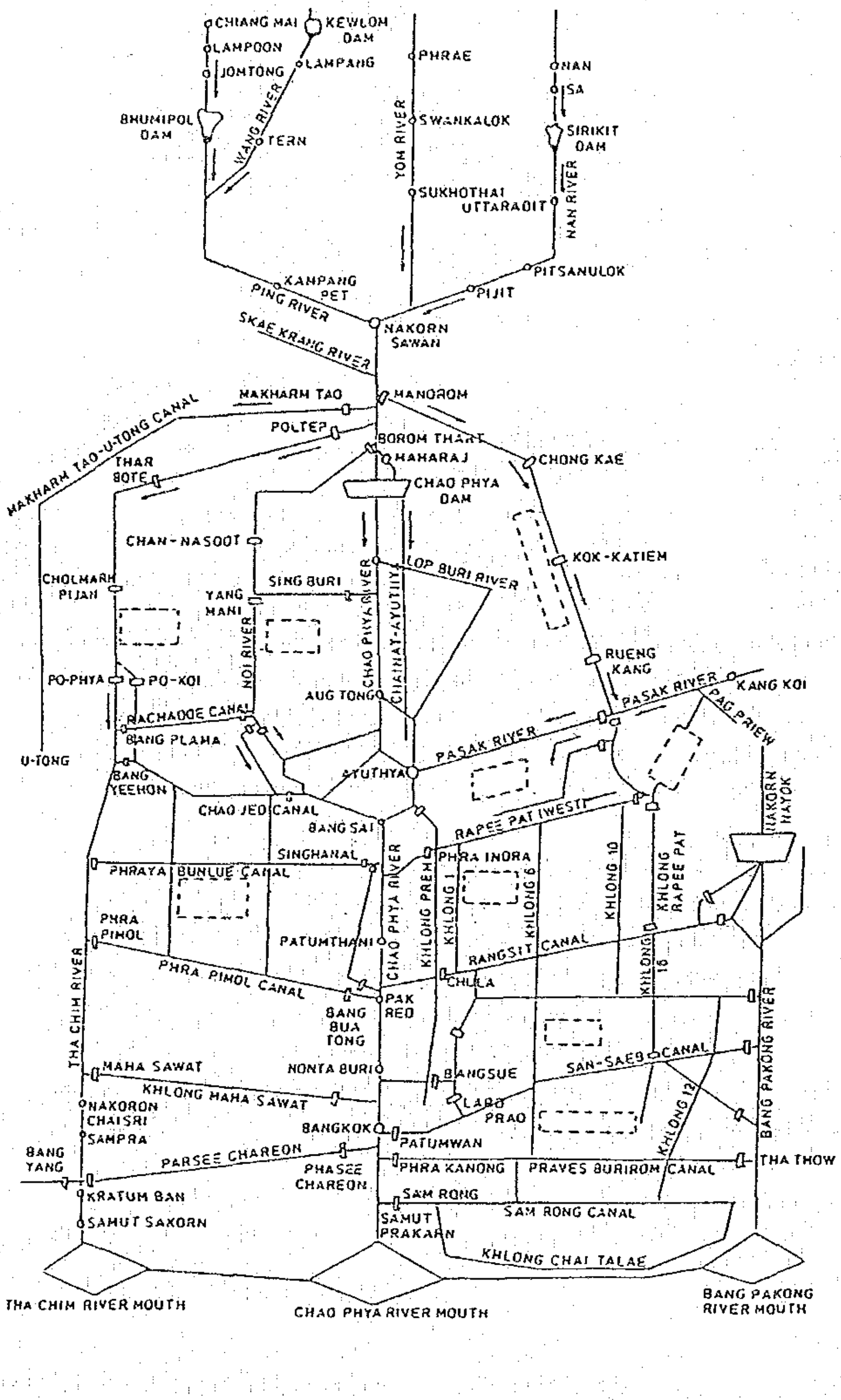
In the north the landscape is characterized by north-south trending mountain ranges and highlands. In this area the Ping, Wang, Yom and Nan rivers are well defined and their streamflow time series are well documented. In recent years the Bhumipol, Kewlom and Sirikit dams on the Ping, Wang and Nan rivers have significantly reduced the potential for flooding in the lower Chao Phya basin due to heavy rainfall in their catchment areas. Further control of these northern rivers is scheduled which will modify the storm discharge pattersn at their confluence at Nakorn Sawan, where the bankful capacity is only some 3,700 m^3/s. The Upper Ping river basin is currently under development for hydropower, irrigation and flood control, the latter being particularly important for Chiang Mai. When fully developed, this river network will significantly reduce flood potential at this northern capital. Development of the Koeng Sua Ten dam in the Yom basin is being studied, as is the Ping-Yom-Nan transbasin diversion scheme. When completed, these various projects will result in a high degree of control of these northern rivers.

Further south, the Skai-Krang river discharges into the main stem of the Chao Phya just north of the Chainat Dam. It is at this point that the Chao Phya river discharges into the central plain of Thailand. The small bankful capacity of the river at this point, 3,200 m^3/s, the flatness of the topography, and diversions into the irrigation service areas supplied from the Chainat Dam spreads the monsoon season flows over a wide area into a network of canals and natural drains. The Ta Chin river, to the west of the main stem, acts as a major branch of the Chao Phya river and carries significant excess flow past Bangkok to discharge into the Gulf at Samut Sakorn.

A further major source of flooding, further south and entering the main stem of the river at Ayuthya, is the Pasal river. In 1973 exceptionally heavy monsoon rainfall centred over this basis and contributed significantly to the flood problem in Bangkok.

South of Ayuthya the terrain is very flat and the land is a web of interconnecting canals and drains. Some of these run north-south such as Klong Prem, Klong No 6 and Klong

CHAO PHRYA RIVER BASIN RIVER NETWORK



Rapepat, while others such as Klong Rangsit and Klong San Sawp, intercept these and tend to drain back towards the main stream of the river. Klong San Saep, of course, runs right through Bangkok.

Bangkok is thus attacked not only from the main stem of the river but also from overland flow from the north, the north-east and the east.

Much can be done to reduce peak flood flows from the northern rivers. The Skai Krang river can be partially controlled and studies have already been undertaken to examine the potential for control of the Pasak River. These are long term developments and the Ping-Yom-Nan diversion scheme could reduce the beneficial effects fo these storage schemes. Clearly, in the near term, Bangkok will not benefit from these schemes.

A more immediately beneficial scheme is that developed by RID by Royal Initica-tive. The conceptual guidelines for this project are;

- Improve discharge through a system of canals to the east of Bangkok to drain this area more effectively to the Gulf. Klongs to be so improved are Klong Praya Surenth, Klong Moh Tack, Klong Song, Klong Lam Pak Chi and Klong Tong Lang.

- Establish a green belt in the Klong Praya Surenth and Klong Sam Wa or Klong Sam Wa and Klong Pet area to facilitate construction of main drains now and in the future.

- Construct flood protection systems within the Bangkok area – the BMA Project.

- Construct flood retention areas within Bangkok as a menas of strengthening the effectiveness of the flood prevention scheme. This work is reported to be in hand and will be considered under the Project studies for rural and semi-rural areas.

- Extend and open the waterways to the east of Bangkok at various highway and rail-way crossings.

- Klong cleaning in Huay Kwang, Prakanong and Bangkapi areas.

- Weed eradication in the canals east of Bangkok.

RID advise that the major work outside the Project area is to commence in 1982 –

Flood control benefits of the major reservoirs

The Acres/RID paper shows that nearly all the flood reduction benefits which can be provided by the Bhumiphol and Sirikit reservoirs automatically result from operation of the reservoirs to meet downstream water needs. The Ping and Nan River reservoirs cannot provide greater flood control benefits in Bangkok than are presently being achieved.

Flood protection system

The natural ground level in Bangkok varies from about elevation 0.5 m + MSL. On the average this represents a height of one metre above mean sea level. Normal tidal range at Bangkok is slightly over one metre.

The concept of polders has been accepted in principle for Bangkok and a construction programme has been underway for some years. Parts of the city are already protected against floods by partially completed polders. Emergency measures including sand bags, temporary cofferdams and mobile pumping units are also used when floods arise, as in the significant floods of October, 1978 and 1980.

Permanent pumping stations have already been built for polders number 1 and 2 and many sections of the peripheral embankments, usually comprising permanent roads, are already built, but flooding is still a recurring and costly problem which is worsening.

The river and flood stages

The overall slope of the Chao Phya River is about 5.5 cm per km. Below Bangkok the slope is at its minimum of about 2 cm per km.

A serious flood was in 1952 when the river level rose to about 0.7 m above the roads in Bangkok. The maximum flood level reached at Memorial Bridge (river km 47) an elevation of 2.3 m + MSL. During that flood practically the entire area of Bangkok was under water for nearly one month.

Downtown districts and residential areas have been filled to elevations between 1.5 and 2.0 m + MSL. In general the built-up ground is just below the expected 100-year frequency river flood level but the natural ground is subject to annual flooding.

It must be pointed out that the expected river flood levels are subject to change. The Royal Irrigation Department reported in 1964 that the average flood levels in the Chao Phya River tend to increase every year by about 1.1 cm. This annual rise seemed to have been checked by the constructed upstream flood control and diversion structures. However, in recent years flooding appears to be on the increase.

Economics

The Government has attempted to quantify losses from some past floods. The localized flood of June 1979, which inundated about 5 km² for about 3 days are estimated to cost Baht 100 million. The more general and extensive flood of October 1975, which inundated several large areas of the city for up to two months, was estimated by the Government to cost about Baht 580 million.

Water Transportation
Venice of the East

Two hundred years ago, Bangkok was a quiet river-side-village situated near the mouth of Chao Phya River. King Rama I, the founder of the Capital took the advantage of the low laying topography and soft clay to excavate a crescent shaped cannal linking Chao Phya River to form an oval moat surrounding the city. From then on, many canals were excavated to form a network of waterways throughout the city and the surrounding area. It reflects the Thai appreciation of the value of water and the dependency on it as a means of irrigation, flood control and transportation. An early map of the city, is evidence of this: it shows the area crisscrossed by canals. Because of this, the city was dubbed the "Venice of the East".

Being the tropical Zone and on low-lying area, seasonal flooding of Bangkok is unavoidable. The old generation of Bangkokians built their houses on stilts to avoid the flood. But as commerce flourished, Bangkok grew, stilted houses gave way to medern buuldings, canals to roads, but flooding remained. But this time, it caused great damage to the city not only in monetary terms but political as well.

Existing Main Canals

The main canals which crisscross and form networks in the proposed project area are:

1. Klong Lord, running from Chao Phya River to Sanam Luang with total length of about 1.8 km.

2. Klong Ong Ang and Klong Banglampoo, forming a crescent shaped route about 3.5 km across the area with opening at both ends to Chao Phya River.

3. Klong Pradung Krung Kasem, a crescent shaped canal of about 5.5 km in length with both ends opening to Chao Phya River.

4. Klong Mahanak running east-west about 1.3 km in length connecting Kolong Banglampoo to Klong Pradung Krung Kasem.

5. Klong Saen Saep extends from Klong Mahanak eastward for about 9.5 km in the project area. This canal has a extensive conncetion with other canal networks in the surrounding area.

6. Klong Sam Sen running east from Chao Phya River with total length of about 5 km in the project area.

7. Klong Prem Prachakorn running north-south for about 5.6 km connecting Klong Pradung Krung Kasem to Klong Sam Sen and Klong Bangsue.

8. Klong Bangsue forming a north boundary of the area. This Klong starts from Chao Phya River and runs due west for about 1.8 km to join Klong Prem Prachakorn.

Waterborne Transport and Navigation

Canals in Bangkok have served at transportation channels for a long time. They allow the populace to be mobile, provide cheap transportation for minimum investment and without importing equipment.

In view of the face that there are many canals in Bangkok, it is an advantage to utilize and incorporate them into the flood control programme. A series of dikes and gates can be built across the canals and flood water is removed by pumping during the flood season. However, it should be emphasise that several canals are being used for transportation as well. Therefor, it is important that particular attention should be paid to them.

6-4 COUNTRY REPORT

Name: IR. Chia Chong Wing
Country: Malaysia
Oranization: Drainage and Irrigation Department
Position: Deputy Director D.I.D Terengganu

1. Malaysia (In-Brief) (See Fig. 1)

1.1 General

Malaysia Consists of West Malaysia (Malay Peninsula) which is bounded by Thailand in the North and Singapore Island in the South, and East Malaysia (States of Sabah and Sarawak) which is situated at the North-Western Borneo Island. The two regions are separated by about 640 km of the South China Sea.

The total area of Malaysia is about 336,600 km^2 – West Malaysia 134,600 km^2 and East Malaysia 202,000 km^2.

The Federation of Malaysia consists of 13 states in all, namely Perlis, Kedah, Penang, Perak, Selangor, Negeri Sembilan, Malacca, Johore, Pahang, Terengganu, Kelantan, Sabah and Sarawak.

1.2 Topography

The central part of west Malaysia is mountainous with a series of mountain ranges running from North to South. More than half of the area is above 150 m above sea level while a quarter above 300 m. The highest mountain peak is named Gunong Tahan which is about 2,190 m. The mountains slope drawn and end in wide alluvial coastal plains. East Malaysia (Sabah and Sarawak) too can be said to be mountainous with Mount Kinabalu 4,101 m to be the highest for state of Sahab and also for Malaysia. The low alluvial plains are found mainly along the coast.

1.3 Climate

Situated in the equatorial zone, the climate is characterised by a small seasonal variation of temperature and high relative humidity. The average daily temperature varies from 18°C in the highlands to 35°C in the coastal plains. The annual average rainfall is around 2,500 mm. Relative humidity is in the region 80 – 90%.

1.4 People

In the 1980 census, the population of Malaysia is estimated to be around 13,750,000 or which 11,500,000 are found in West Malaysia and 2,250,000 in East Malaysia. Malaysia has a diversity of races and cultures. The major races are Malay, Chinese, Indians, Ibans and Kadazans. The National language is Bahasa Malaysia, however English is also widely used especially in the non Government sector.

1.5 Land-Use

A large part of Malaysia is covered by forests and swamps. Forests are found in the upper mountainous reaches while swamps are found at the lower reaches of the rivers. A large portion of the area in between the foothills and the coast consists of mainly rubber and oil palm estates. Padi cultivation is found throughout Malaysia, being more widespread in the states of Kedah, Perlis and Kelantan. Tin mining activities are found to be comman features in the states of Perak and Selangor while logging activities in Kelantan, Pahang, Terengganu and East Malaysia.

1.6 Rivers

In Malaysia there are numerous river basins, amongst the larger ones are Perak River, Pahang River, Kelantan River in West Malaysia and the Rejang River and Kinabatangan River in East Malaysia. The heavy monsoonal rains in Malaysia generally cause the rivers to overspill and flood the lower coastal plain. Periodically people living in riverine and low areas have to be evacuated to safer higher grounds.

1.7 Priority Policy of Malaysia

The priority policy of the government is spelt out clearly in the New Economic Policy. The main aim would be to eradicate powerly in all sectors of the people irrespective of race and to raise the income and standard of the lower income Group especially the rural poor. Development is being carried out in all sectors. To uplift the living standard of the rural poor, the government invest heavily in agriculture development.

2. Main Organizations Dealing with Water Administration

The main organizations dealing with water administration are:

2.1 Drainage and Irrigation Department

This Department under the Ministry of Agriculture is the greatest 'consumer' of water in the country. Its main functions are as follows:

a) Planning and Implementation of all Drainage and Irrigation Schemes.
b) River Conservancy and Flood Mitigation works.
c) Flood forecasting and warning.
d) Hydrology.
e) Groundwater Investigations for Agricultural Purposes.

2.2 Public Works Department

This Department is responsible to provide water supply for both domestic and industrial use. The main sources of supply are from rivers or on a smaller extent from groundwater.

2.3 National Electricity Board

This organization is interested in tapping off hydro electric power by the construction of large dams in the rivers. Lately the department also implemented mini hydro dams to provide electricity for the people in poorly accessible rural areas.

3. Pilot River Basins in Malaysia

Two river basins out of a number of river basins in Malaysia which are frequently subjected to flooding are selected as pilot river basins by the Typhoon Committee Team. They are the Kelantan River Basin and the Klang River Basin.

In this report I intend to give an outline of only the Kelantan River Basin.

3.1 The Kelantan River Basin (See Fig. 2)

3.1.1 Location

The State of Kelantan lies in the north-east of West Malaysia and in bounded on the west by the State of Perak and by Thailand, on the south by the State of Pahang and on the north-east by the South China Sea and the State of Terengganu. The Kelantan river and its principal tributaries drain approximately 85 percent of the State's total area of 15,042 sq.-kilometres. The Golok river, a separate river system, forms the international boundary between Malaysia and Thailand. The Coastal region east of the Kelantan river is drained by a number of small rivers and creeks, the principal ones being the Kemasin and the Semerak rivers.

3.1.2 Physical Features

The hinterland of Kelantan is bounded by mountain ranges which form the water-shed of the Kelantan River Basin. These mountains which rise to over 2,000 metres above sealevel almost totally ring the basin.

The general aspect of this basin beyond the coastal plains is of endless hills and valleys, densely covered by tropical rain forest. Ground slope is generally steeper than 15 degrees.

The coastal region comprises approximately 135,000 hectares of alluvial plain protruding into the South China Sea. The total relief of the coastal plain elsewhere is seldom more than 15 metres above sea level. Consequently land drainage generally is inefficient and streams tend to be sluggish and meandering. These combine to promote widespread flooding whenever heavy rain falls and this has been an important constraint on the agriculture development of the region.

3.1.3 Climate (See Fig. 3)

From November to January the climate is dominated by the North-East monosoon blowing across the South China Sea. This brings heavy rain, especially to the coast which receives about half its average annual rainfall in this season. During the monsoon, sunshine hours are low and humidities high. Peak rainfall usually occurs in the inter-monsoonal months of April and May and October and November.

The extreme temperature range is about 20° – 35°C at Sea level and 10° – 25°C at 1,500 metres altitude. Annual rainfall in the basin averages about 2,700 millimetres (ranging from 2,200 to 3,200 mm).

The storm rainfalls in the coastal region are notable. The maximum daily rainfall recorded is over 600 millimetres and a three day storm can produce over 1,200 millimetres.

3.1.4 Problems in the Basin

The main problem in the basin is periodic flooding. Flood is caused either by torrential local rainfall or river overspill or the worse by a combination of both. Very big floods such as in 1926 and 1967 are disastrous. Records of past floods can be seen in Fig. 4. The most severe floods usually ocurred in the the monsoon season between November and February.

The January 1967 flood is well remembered in Kelantan (See Fig. 5). More than 150,000 hectars of land in the coastal region were inundated to depths of up to 6 metres. At least half of the state population (300,000) was seriously affected. Four floods of the 1967 magnitude or larger have occurred in the basin since 1900.

The Kelantan river overspills its banks below Kota Bahru almost every years. Further upstream, the frequency of overspill averages once in four years. Every year there is flooding in the coastal region due to torrential rainstorms that occur mainly in the monsoon season. These floods do much damage, particularly to the lowlands.

The direct cost of damage that would occur to crops and property in Kelantan today ranges from at least $1 million for most years to an estimate of almost $125 million for a repetition of the 1926 type flood. The floods of the last 50 years indicate further average costs of $20,000 million a year. (See Fig. 6).

This recurrent economic loss will worsen as population and development increase. Not only are such losses an intolerable burden on a poor economy but their possible recurrence in any year acts as a depressant to the farming community. They also inhibit progress in the industrial sector as few investors dare to invest in Kelantan while flooding remains uncontrolled.

3.1.5 Proposed Projects in the Basin

An extensive study was carried out on the Kelantan river basin from 1974 to 1977. From the comprehensive study the following projects were identified and recommended.

a) Bulk Drainage Projects

Examination of the drainage problems in the coastal region indicates that the local rainstorm flooding problems can best be solved by intercepting flood waters before they reach low-lying areas and divert them either by bunded and improved existing river system or by new high-level flood ways. Following extensive investigations five bulk drainage projects are recommended (See Fig. 7). These projects are designed to provide substantially improved drainage to some 110,000 hectares of land and to enable the subsequent reclamation of 19,650 hectares of existing swampland.

The proposed projects incorporate 12 pumping stations with a combined capacity of 358 cubic metres per second, 40 kilometres of flood channels and 59 kilometres of flood protection bunds. Before these projects can operate effectively, the existing network of internal drains on the plain will require major upgrading to channel flood waters to the bulk drainage systems. Most of these proposed projects are still under planning and investigation.

b) Irrigation Projects

The strategy of agriculture intensification in the coastal region can be achieved only through all-year-round irrigation. A total of 13 new irrigation projects are proposed which when implemented will add about 92,000 hectares to the 42,000 hectares of land currently served by existing schemes (See Fig. 7). More than 70% of the proposed schemes have been completed while the remainning schemes are either under investigations or design.

c) Flood Mitigation Projects (For details see Fig. 8, 9 and 10)

Flood mitigation Projects are found to be necessary in order to improve the overall confidence level of the farmers and the investment climate of the economy. River regulation is particularly essential for the success of the irrigation projects, otherwise intolerable high and frequent water deficits will occur. Flood mitigation projects can be classified under two components in multipurpose Dams and River Bunding.

i) Multipurpose Dams

Two multipurpose dams which will reduce the major flooding problems caused by overspill onto the plain from Kelantan river are recommended. In addition, the dams will generate electricity and regulate the river flow to meet irrigation demand of the plain. The most important development priority is the Debong dam on the Galas river, to be followed by the Jeram Panjang dam on the Lebir river. These two dams when implemented will not only greatly reduce flooding in the coastal plain especially from river overspill but also to ensure adequite water supplies for consumption in the state. Electric supply can also be tapped to help the state and improve the economic viability of the projects. The Jeram Panjang dam is at the moment under detailed feasibility study while nothing much is done on the Dabong dam because socially and politically the proposal is not acceptable as it involves the resettlement of some 2,000 families affected by the dam.

ii) River Bunding

The final contribution to the overall flood protection scheme is the construction of bunds along the lower reaches of the Kelantan river to prevent overspilling of flood water onto the coastal plain. The proposed bunds, extending along both bands of the Kelantan river from Guillemard bridge to the river mouth, a distance of 64 kilometres, can substantially increase the capacity of the main channel to convey floods and should also improve outlet conditions at the river mouth. Certain streches of the bunds have been constructed while the rest are under planning.

3.1.6 Existing Flood Loss Prevention Measures in the Basin

Floods in the river basin occur almost annually during the North East Monsoon Season between months of November to March resulting in serious damage to crops, properties and possibly loss lives.

While engineering measures can slove the flooding problem, it is often very costly and takes many years to be realised. Hence the Government has resorted to take flood loss prevention measures like flood forecasting and warning as a temporary step.

i) Flood Forecasting and Warning System (See Fig. 11)

In Kelantan a good telemetric flood forecasting system was established in 1972. This system comprises of 5 rainfall and 4 water level stations which are located in the upper hinterland region with a repeater station at Bukit Bakar and a terminal station at Kota Bharu (See Fig. 12). The system is operated automatically by a wireless network of telemetering equipment, which transmit instantaneous rainfall and water level from the above monitoring stations to the terminal station in Kota Bharu. These data are processed by the Hydrological section of the Drainage and Irrigation Department

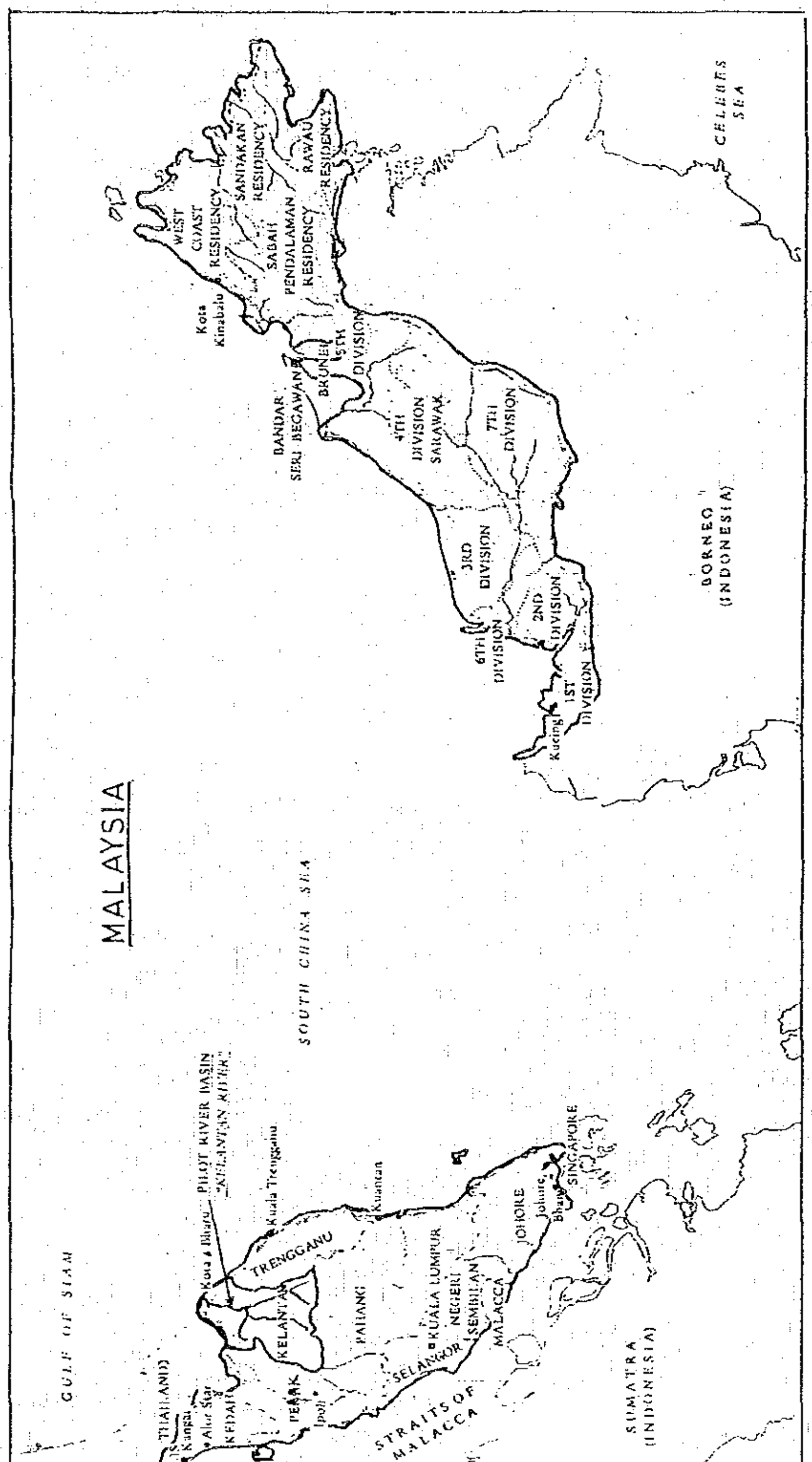
Kelantan and transmitted to the Flood Forecasting Centre situated at the D.I.D Headquarters in Kuala Lumpur via a telex system where these are fed into a computer which has an inbuilt flood forecasting programme based on the Sacramento Model for forecasting the flood for the basin.

Beginning from October to January each year of the monsoon season the Flood Forecasting Centres of the D.I.D both in Kelantan and Headquarters in Kuala Lumpur are put on alert when routine flood frecasting works are carried out once a day to keep track of the rainfalls and river flows within the catchment irrespective of weekends on holidays. This also ensures that the forecasting model is updated with the soil moisture conditions to give accurate forecasts of any impending flood. The moment heavy rainfalls in the catchment are reported, the frequency of forecasting is increased to twice daily and in the event of floods, every 6 hourly.

With this system it is now possible to forecast the water level at Kuala Krai Station 10 – 20 hours ahead of any impending flood. For areas downstream of Kuala Krai the levels of the impending flood can be forecasted using the water level correlation chart derived from past floods (See Fig. 13).

The detailed mechanism of the flood forecasting and warning system of the Kelantan river basin can be seen in Fig. 11.

In 1981 to make the warning system more effective flood warning boards had been erected all over flood proned areas and information phamplets on flood warning bards were distributed to educate the people (a sample of the information phamplet is attached at the back of the report).



MALAYSIA
GULF OF SIAM
SOUTH CHINA SEA
CELEBES SEA
STRAITS OF MALACCA
SUMATRA (INDONESIA)
BORNEO (INDONESIA)
THAILAND
PERLIS
KEDAH
Alor Star
George Town
PENANG & PROVINCE WELLESLEY
PERAK
Ipoh
KELANTAN
Kota Bharu
PILOT RIVER BASIN "KELANTAN RIVER"
TRENGGANU
Kuala Trengganu
Kuantan
PAHANG
SELANGOR
KUALA LUMPUR
NEGERI SEMBILAN
MALACCA
JOHORE
Johore Bharu
SINGAPORE
Kuching
1ST DIVISION
2ND DIVISION
3RD DIVISION
4TH DIVISION
5TH DIVISION
6TH DIVISION
7TH DIVISION
SARAWAK
BRUNEI
BANDAR SERI BEGAWAN
Kota Kinabalu
WEST COAST RESIDENCY
SANDAKAN RESIDENCY
SABAH
PENDALAMAN RESIDENCY
RAWAU RESIDENCY

Fig. 1

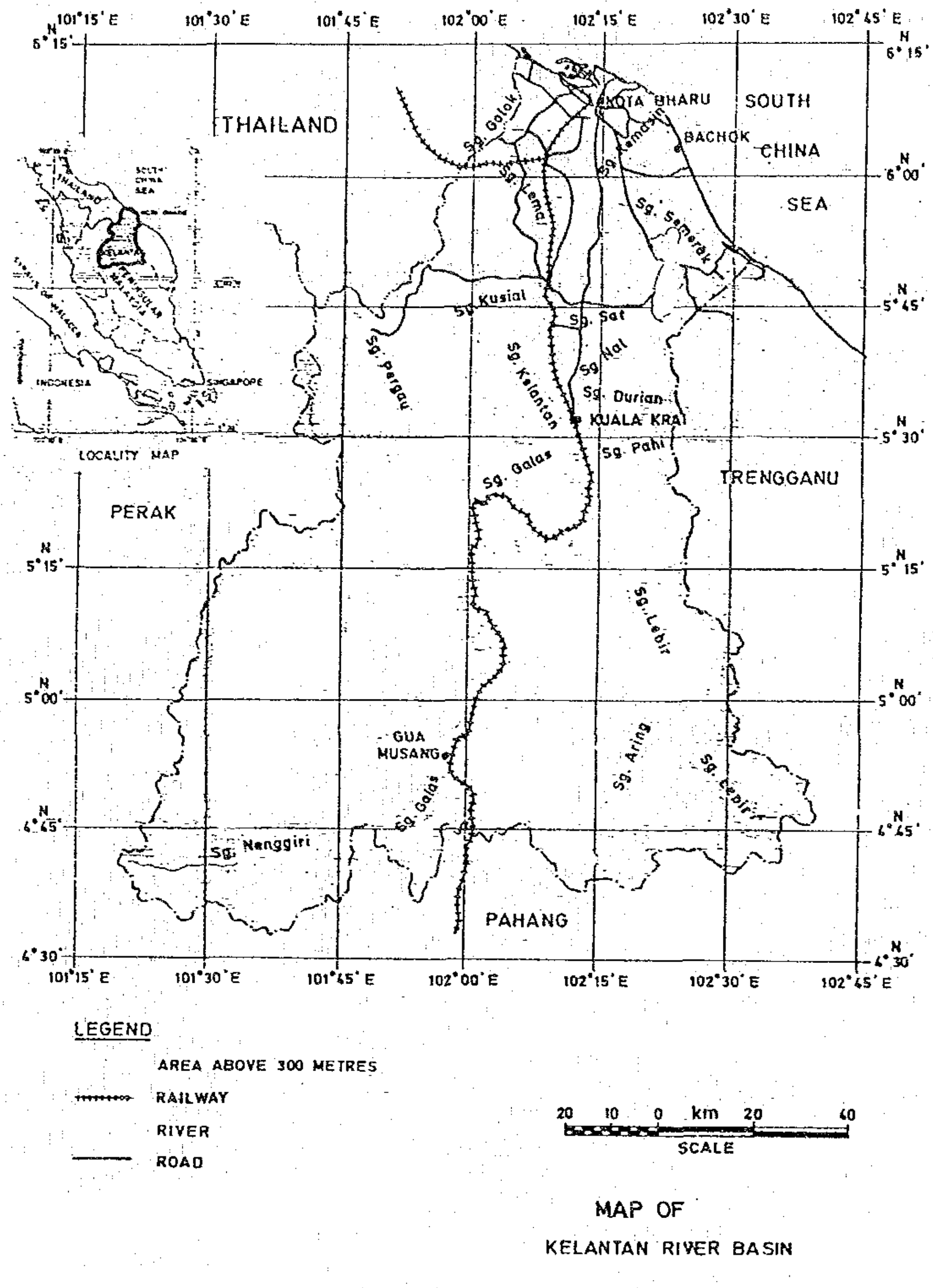
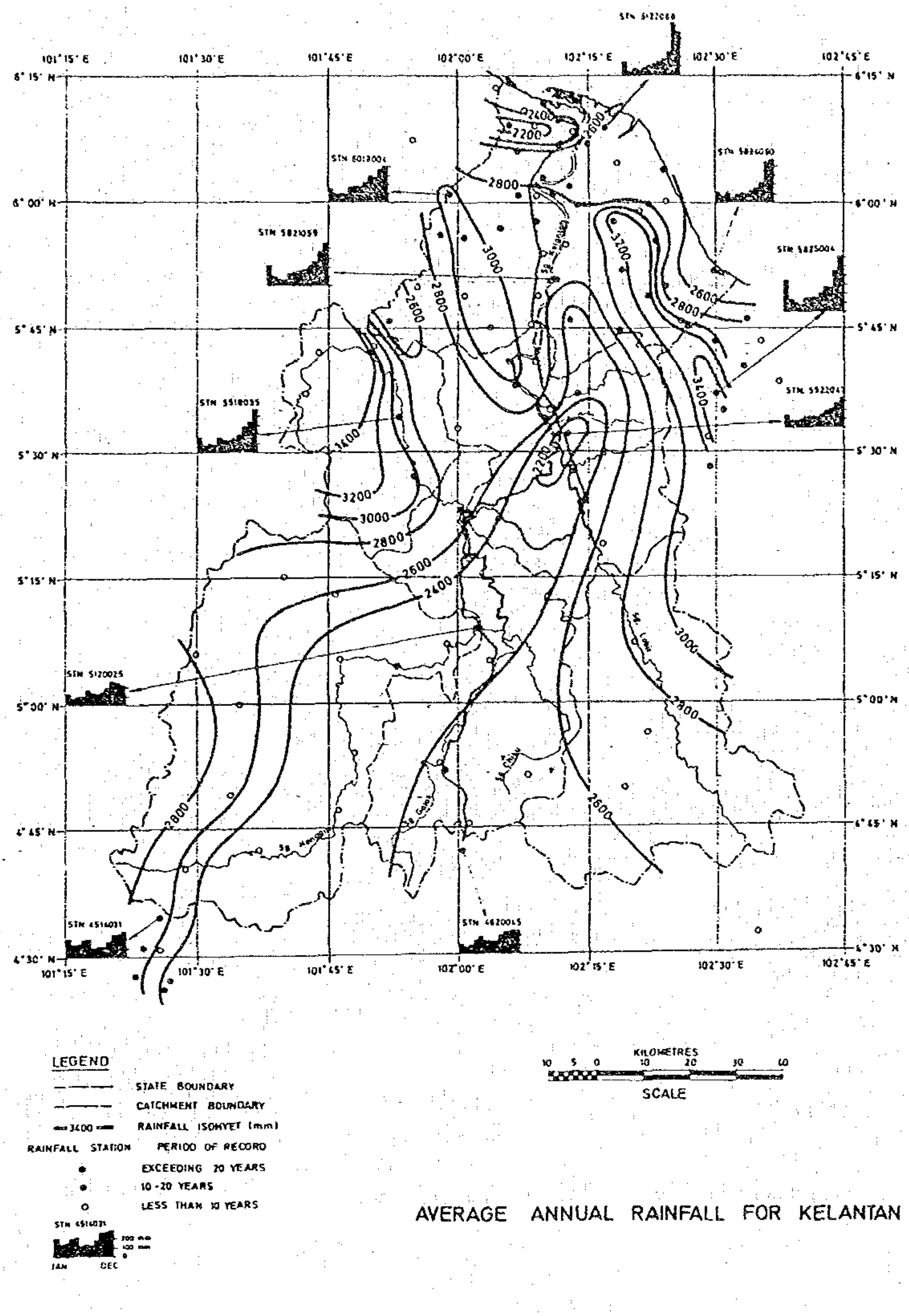

101°15' E
101°30' E
101°45' E
102°00' E
102°15' E
102°30' E
102°45' E
6°15'
6°00'
5°45'
5°30'
5°15'
5°00'
4°45'
4°30'
THAILAND
SOUTH
CHINA
SEA
KOTA BHARU
BACHOK
Sg. Golok
Sg. Lemal
Sg. Kemasin
Sg. Semerak
Sg. Kusial
Sg. Sat
Sg. Nal
Sg. Pergau
Sg. Kelantan
Sg. Durian
KUALA KRAI
Sg. Pahi
Sg. Galas
LOCALITY MAP
PERAK
TRENGGANU
Sg. Lebir
GUA
MUSANG
Sg. Aring
Sg. Galas
Sg. Lebir
Sg. Nenggiri
PAHANG
LEGEND
AREA ABOVE 300 METRES
RAILWAY
RIVER
ROAD
20 10 0 km 20 40
SCALE
MAP OF
KELANTAN RIVER BASIN

Fig. 2



AVERAGE ANNUAL RAINFALL FOR KELANTAN

Fig. 3

FLOOD LEVELS OF SG. KELANTAN & ITS TRIBUTARIES (IN FEET R.L.) 1926 – 1979

River & Location	1926	1931	1933	1939	1947	1957	1959	1961	1962	1963	1964	1965	1966	1967 (JAN.)	1967 (NOV.)	1968
SUNGAI GALAS Dabong	164.0	145.0												145.99		
SUNGAI LEBIR Kg. Tualang	147.6		–											126.3		
SUNGAI NENGGIRI Bertam	227.36	208.99						170.1				168.25 (1/12)	–	200.13		
SUNGAI KELANTAN Batu Lembu														168.50	–	–
SUNGAI KELANTAN Kuala Krai	116.14	102.7		91.4	97.7	82.15	75.0	701 (27/12)	–	–	63.3 (23/12)	81.9 (3/12)	75.0 (29/12)	104.0 (6/1)	89.9 (27/11)	62.2 (28/12)
Guillemard Bridge	75.13	73.16				56.0	–	–			39.5 (23/12)	56.4 (3&12)	–	73.3 (5/1)	60.8 (27/11)	40.1 (28/12)
Kemubu Pump House	–	–	–	–	–	–	–	–	–	33.5	28.1 (23/12)	43.0 (3/12)	39.6 (30/12)	52.2 (6/1)	49.7 (27/11)	–
Lemal Pump House	–	–	–	–	–	–	–			–	–	–	–	40.0 (6/1)	–	–
Pasir Mas Pump House	32.0	27.0	–	36.0	38.0	30.0	23.0 (19/12)	21.9 (28/12)	22.6 (19/12)	20.3 (28/12)	15.45 (23/12)	27.8 (3/12)	25.0 (30/12)	33.3 (6/1)	30.1 (27/11)	17.0 (28/12)
Kota Bharu	21.0		13.0	18.0	19.0	16.0	14.5 (19/12)		14.5 (19/12)		8.8 (24/12)	17.3 (3/12)		20.4 (6/1)	18.4 (27/11)	9.8 (28/12)
Kuala Besar														7.6 (6/1)		

Fig. 4

River & Location	1969	1970	1971 (JAN.)	1971 (DEC.)	1972	1973	1974	1975 (JAN.)	1975 (DEC.)	1976	1977	1978	1979	1981	1982
SUNGAI GALAS Dabong					122.8 (17/12)	130.4 (9/12)	108.35 (25/12)		122.67 (21/12)	100.7 (23/12)	101.87 (20/11)	106.23 (7/12)	137.96 (27/11)	100.20 (2/12)	117.60 (15/12)
SUNGAI LEBIR Kg. Tualang					124.56	122.76	89.16	95.96	90.75	91.46 (24/12)	90.62 (20/11)	96.36 (7/12)	127.95 (27/11)	87.90 (2/12)	117.90 (16/12)
SUNGAI NENGGIRI Bertam	213.24 (29/11)		210.78 (5/1)	–	212.10 (17/12)	189.30	186.18 (24/11)	183.71	190.37 (21/12)	176.16 (27/12)	176.99 (6/11)	177.09 (3/12)	196.19 (27/11)	161.30 (3/12)	117.30 (15/12)
SUNGAI PERGAU Batu Lembu	–	–	–	–	–	–	–				137.43 (19/11)	148.75 (7/12)	150.92 (27/12)	–	–
SUNGAI KELANTAN Kuala Krai	84.3 (30/11)	82.3 (29/12)	89.9 (5/1)	81.6 (16/12)	92.0 (18/12)	95.25 (9/12)	71.5 (28/12)	72.4 (5/1)	80.4 (22/12)	67.80 (24/12)	68.0 (20/11)	72.6 (7/12)	98.8 (28/11)	67.80 (2/12)	86.60 (16/12)
Guillemard Bridge	547.4 (30/11)	54.7 (29/12)	61.9 (5/1)	54.8 (16/12)	64.1 (18/12)	65.7 (10/12)	49.5 (28/12)	52.0 (5/1)	53.4 (22/12)	44.19 (24/12)	43.44 (20/11)	48.75 (7/12)	67.5 (28/11)	42.25 (2/12)	86.60 (16/12)
Kemubu Pump House	42.7 (30/11)	41.7 (29/12)	47.3 (5/1)	–	49.4 (18/12)	50.8 (10/12)	38.4 (29/12)	40.65	–	32.0 (24/12)	30.8 (20/11)	36.0 (7/12)	51.5 (28/11)	30.80 (3/12)	46.10 (16/12)
Lemal Pump House	33.10 (30/11)	31.7 (29/12)	36.0 (5/1)	31.6 (16/12)	37.45 (18/12)	38.2 (10/12)	28.50 (29/12)	31.0	31.5	22.65 (24/12)	22.0 (20/11)	26.70 (7/12)	38.35 (28/11)	22.30 (3/12)	35.30 (16/12)
Pasir Mas Pump House	28.65 (20/11)	27.3 (29/11)	30.9 (5/1)	27.35 (16/12)	32.25 (18/12)	33.0 (10/12)	24.60 (29/12)	26.7	27.3	20.75	21.4 (20/11)	24.35 (7/12)	37.35 (29/11)	19.60 (3/12)	32.00 (16/12)
Kota Bharu	17.8 (30/11)	17.0 (29/12)	18.8 (5/1)	17.0 (17/12)	19.5 (18/12)	19.8 (10/12)	16.4 (20/12)	17.3	–	12.5	12.04 (20/11)	15.32 (8/12)	20.50 (29/11)	12.73 (3/12)	19.00 (16/12)
Kuala Besar													8.64 (29/11)	–	–

NOTE:

Change of D.I.D. to Survey Datum

i) Guillemard Bridge +0.68' from 23/2/76

ii) Kota Bharu +0.73' from 18/2/74

Fig. 4 - Continued

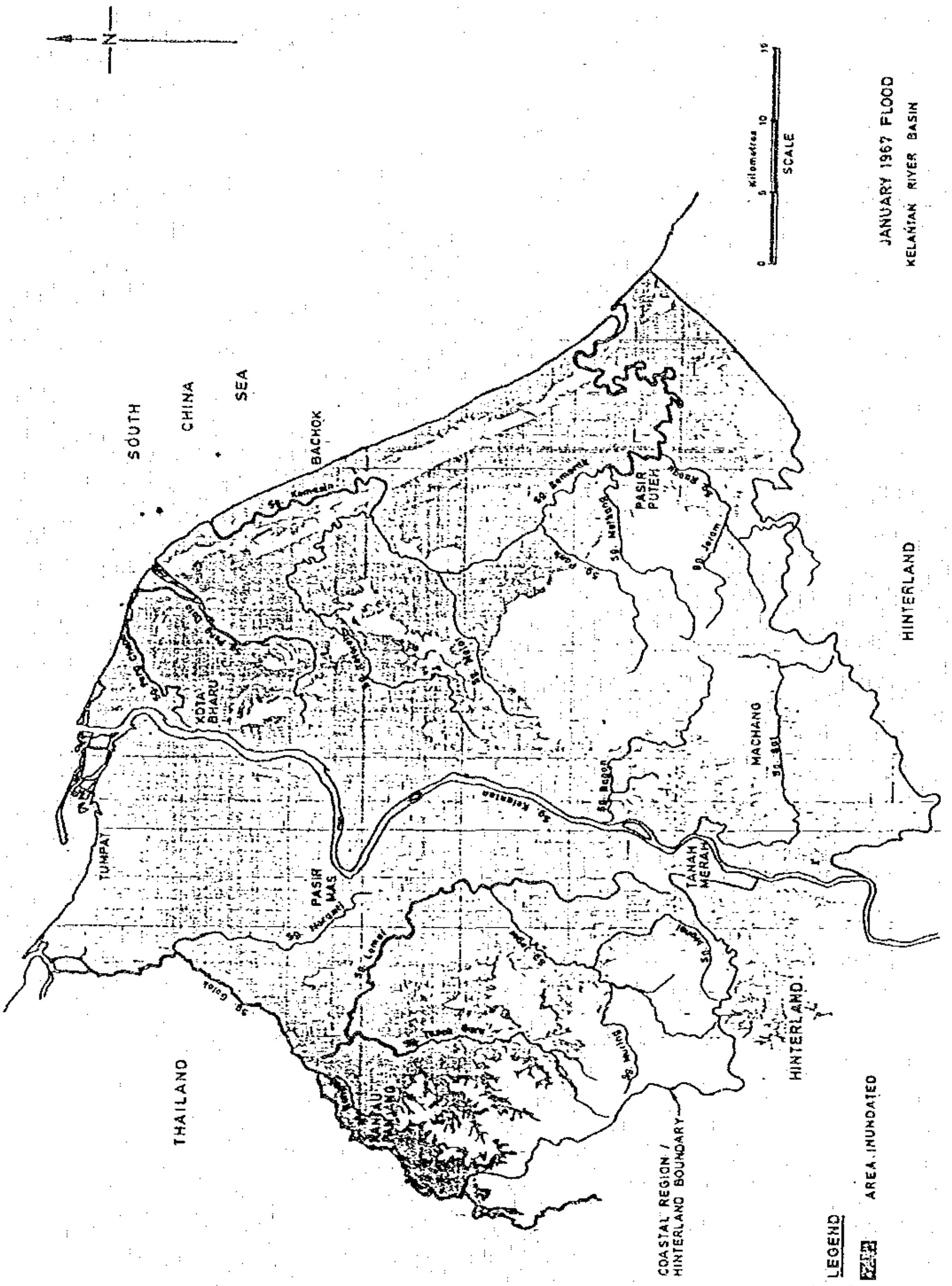
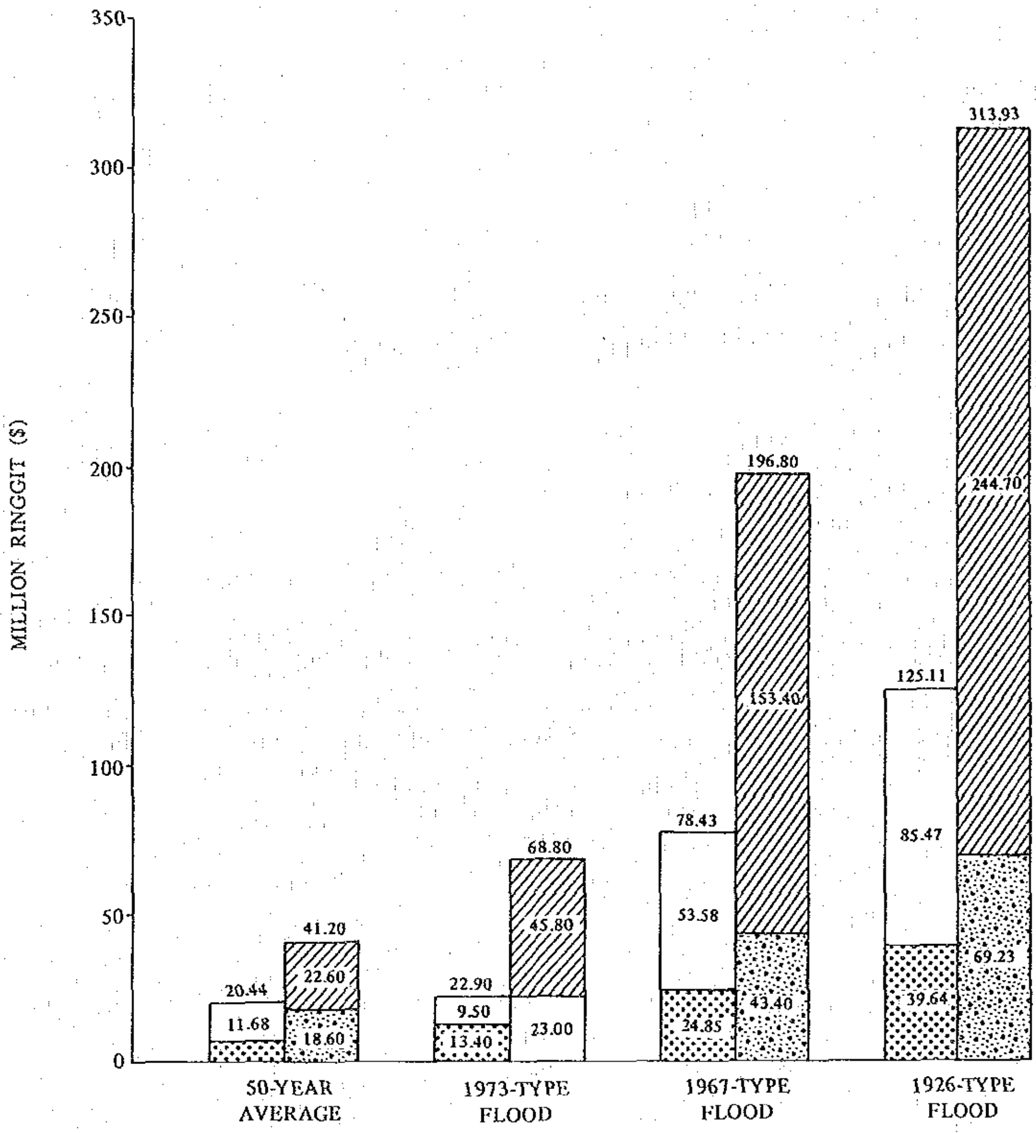
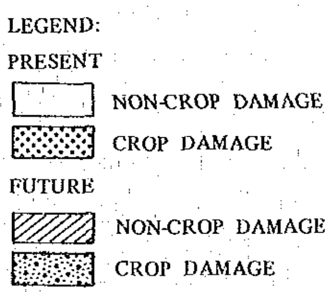

N
SOUTH CHINA SEA
BACHOK
KOTA BHARU
TUMPAT
PASIR MAS
PASIR PUTEH
MACHANG
TANAH MERAH
HINTERLAND
HINTERLAND
THAILAND
RANTAU PANJANG
Sg. Kelantan
Sg. Golok
JANUARY 1967 FLOOD
KELANTAN RIVER BASIN
0 5 10 15
Kilometres
SCALE
LEGEND
AREA INUNDATED
COASTAL REGION / HINTERLAND BOUNDARY

Fig. 5





ESTIMATED VALUE OF FLOOD DAMAGE: ORDER OF MAGNITUDE

KELANTAN RIVER BASIN

Fig. 6

BULK DRAINAGE PROJECTS

Name of Scheme	No. of Pumping Stations	Flood Channels (kilometres)	Bunds (kilometres)	Areas Affected (hectares)		Estimated Costs ($ million)	
				Swamp	Agricultural	Capital	O and M
Golok	2	22	32	9,350	44,000	32	0.64
Upper Kemasin	–	2	–	450	8,000	1	0.01
Lower Kemasin	3	6	–	1,960	18,500	11	0.20
Upper Semerak	1	10	–	2,160	13,000	26	0.19
Lower Semerak	6		27	5,730	26,500	20	0.31
TOTAL	12	40	59	19,650	110,000	90	1.35

PROPOSED IRRIGATION PROJECTS – BASIC SPECIFICATION

PROJECT		Gross Area (hectares)	Area Irrigated (hectares)	WATER DEMAND		Pumping Station Capacity (kilowatts)	COST	
No.	Name			Peak (cubic metres per second)	Anual (million cubic metres)		Capital	O & M
							($ million)	
1	Lemal, Pasir Mas & Alor Pasir Extension	22,668	15,463	15.4	123	301	23.50	1.52
2	North Lemal	12,038	9,265	10.9	91	960	50.96	1.34
3	Rantau Panjan	5,682	2,961	2.2	16	147	19.39	0.76
4	Tasek Garu	43,316	18.650	15.9	87	2,730	166.52	8.30
5	Ulu Lemal	8,450	7.371	4.6	26	681	29.05	1.03
6	Upper Ulu Lemal	2,118	758	0.4	3	74	5.36	0.22
7	Kemubu & Salor Extension	48,779	32,676	28.6	211	3,719	75.99	4.19
8	Bachok	9.857	5,287	5.1	50	666	41.29	1.26
9	Pasir Puteh – Stage I	20,328	13,528	9.24	93	680	90.49	3.25
10	Pasir Puteh – Stage II	18,317	16,586	15.1	192	1,965	106.54	3.73
11	Sg. Bagan	12,474	4,281	2.5	21	108	33.12	1.25
12	Sq. Sat	14,974	6,652	3.5	27	400	42.90	1.79
13	Putat and Pertok Extension	4,264	1,491	1.1	9	147	13.04	0.70
	TOTAL	113,265	134,969	114.5	949	12,578	698.15	29.34

Fig. 7

MULTIPURPOSE DAMS – BASIC SPECIFICATIONS AND COSTS

Specifications	Dabong Dam	Jetram Panjang
Top Elevation of Structure, metres M.S.L.	69	75
Spilling Crest Level, metres M.S.L.	57	65
Maximum drawdown, metres	7	6
Length of Crest, metres	230	430
Maximum height of dam, metres	53	50
Hydro-electric generating capacity, MW	95	42
Average annual output, GWH	525	230
Capital Cost, $ million	289[1]	200
Annual Operating Cost, $ million	3	2

*[1] Including associated capital cost of $69 million attributed to the Pergau-Galas development.

KELANTAN RIVER BUNDS – BASIC SPECIFICATIONS

Nominal bunded channel capacity	10,000 m^3/s
Length of bunded channel	64 km
Total crest length of bunds (both banks)	76 km
Average height of bunds:	
Upstream Kota Bharu	1.75 m
Downstream Kota Bharu	4.0 m
Land required	215 ha
Capital cost	$ 46 million
Annual maintenance etc.	$ 1 million

Fig. 8

PREFRRED IRRIGATION & DRAINAGE SCHEDULE WITH FLOOD MITIGATION PACKAGE

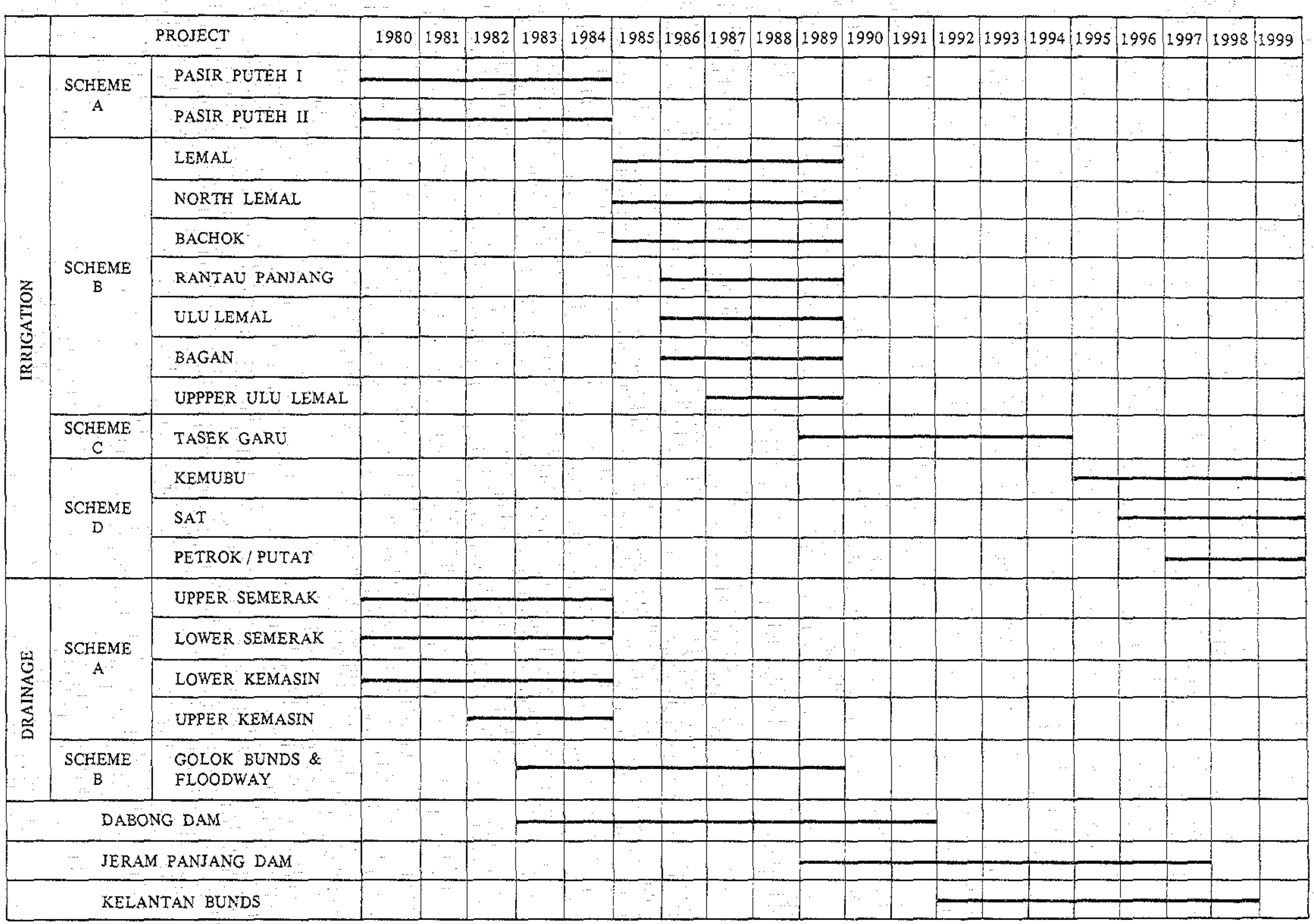


Fig. 9

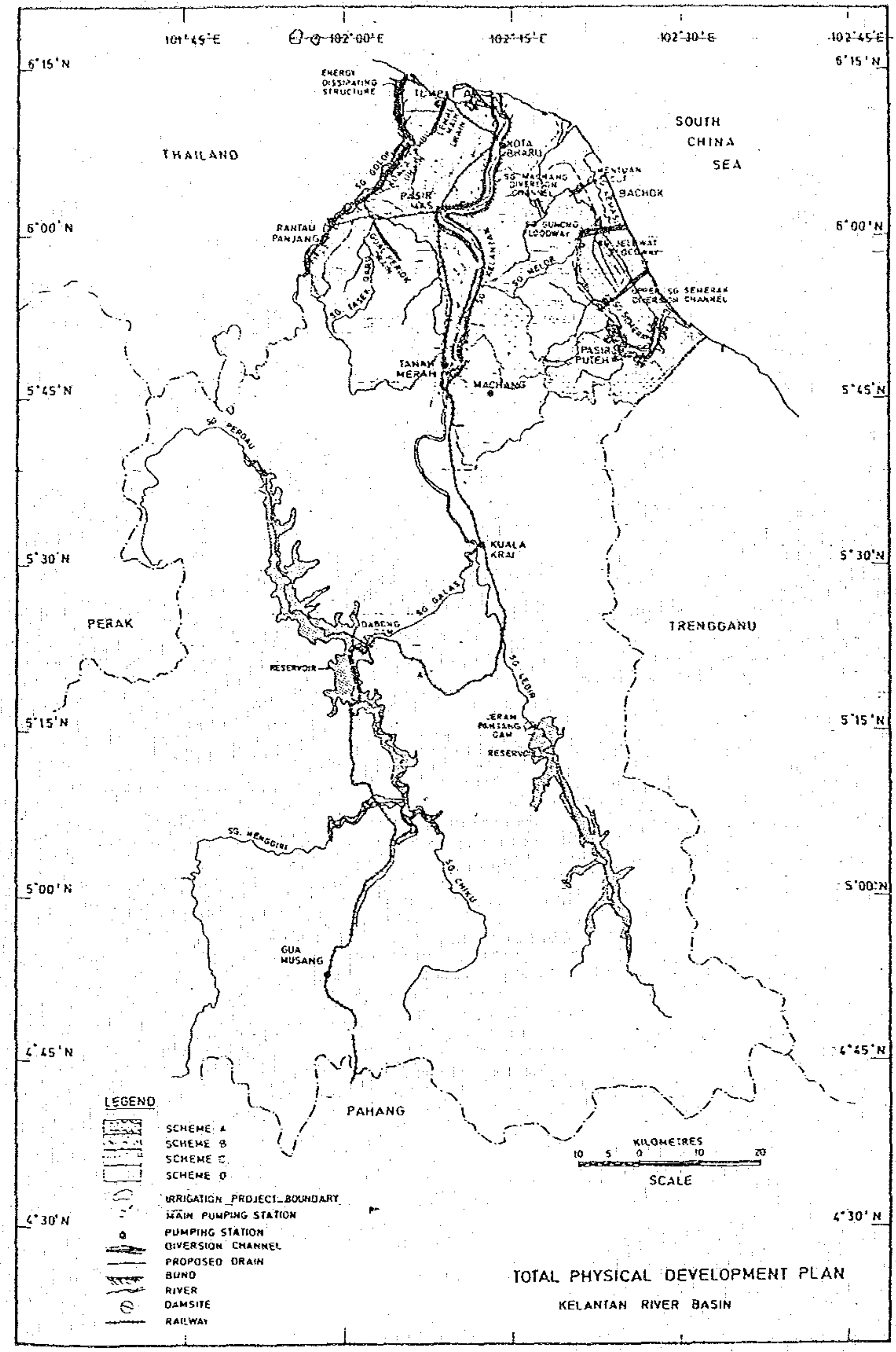

THAILAND
SOUTH CHINA SEA
KOTA BHARU
PASIR MAS
BACHOK
RANTAU PANJANG
TANAH MERAH
MACHANG
PASIR PUTEH
KUALA KRAI
DABONG
RESERVOIR
PERAK
TRENGGANU
PAHANG
GUA MUSANG
SG. PERGAU
SG. GALAS
SG. LEBIR
SG. CHIKU
SG. NENGGIRI
SG. KELANTAN
SG. GOLOK
LEGEND
SCHEME A
SCHEME B
SCHEME C
SCHEME D
IRRIGATION PROJECT BOUNDARY
MAIN PUMPING STATION
PUMPING STATION
DIVERSION CHANNEL
PROPOSED DRAIN
BUND
RIVER
DAMSITE
RAILWAY
KILOMETRES
SCALE
TOTAL PHYSICAL DEVELOPMENT PLAN
KELANTAN RIVER BASIN

Fig. 10

Fig. 11 Organisational Operation of Flood Warning System for the Kelantan River

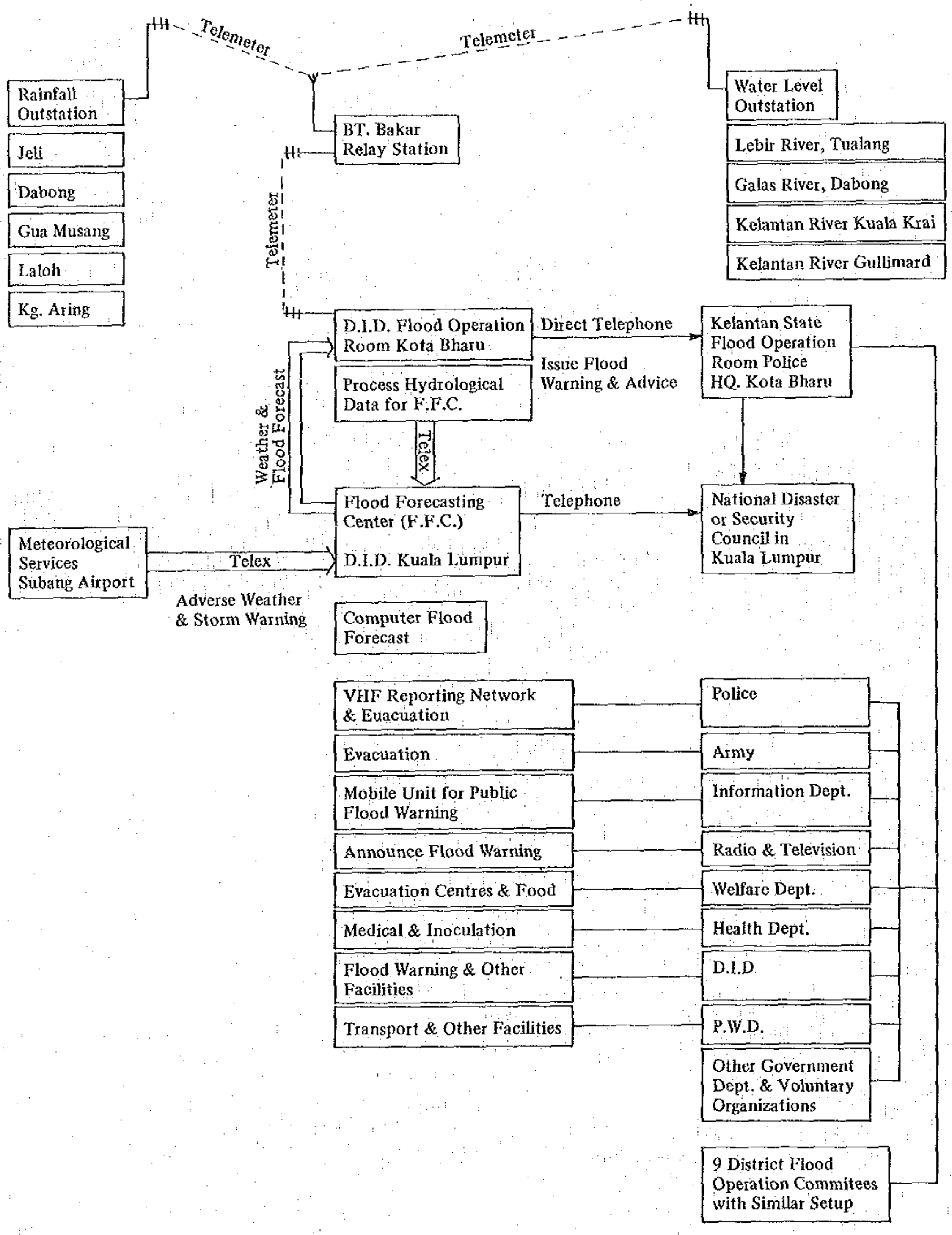
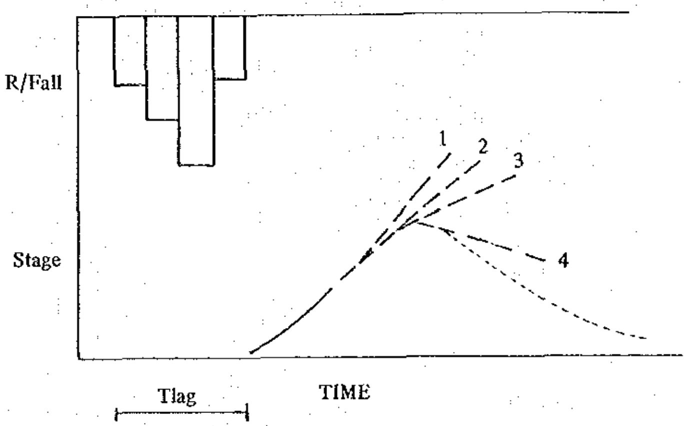
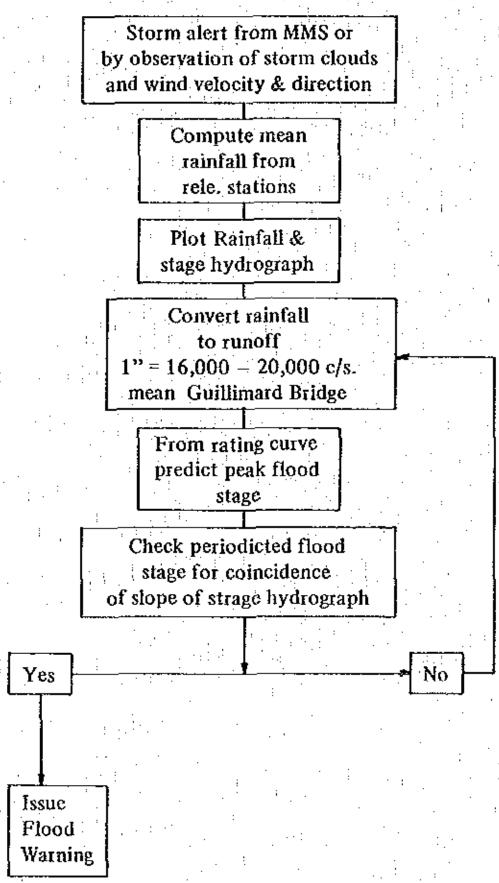


Fig. 11 A Kelantan Flood Forecasting (Back up Model)

1, 2, 3, 4 Slope of Stage Hydrograph at Different Time





Note:

1. Mean rainfall in upper catchment – by arithmetic or thiessen method.
2. Rainfall – Run off conversion depends on wetness of catchment.
3. Storm duration longer than 36 hours are more difficult to predict: High reliance on stage hydrograph slopes is used.
4. Time lag is about 24 – 36 hours depending on storm centres.

KELANTAN

SISTEM AMARAN BANJIR TALIMETRIK

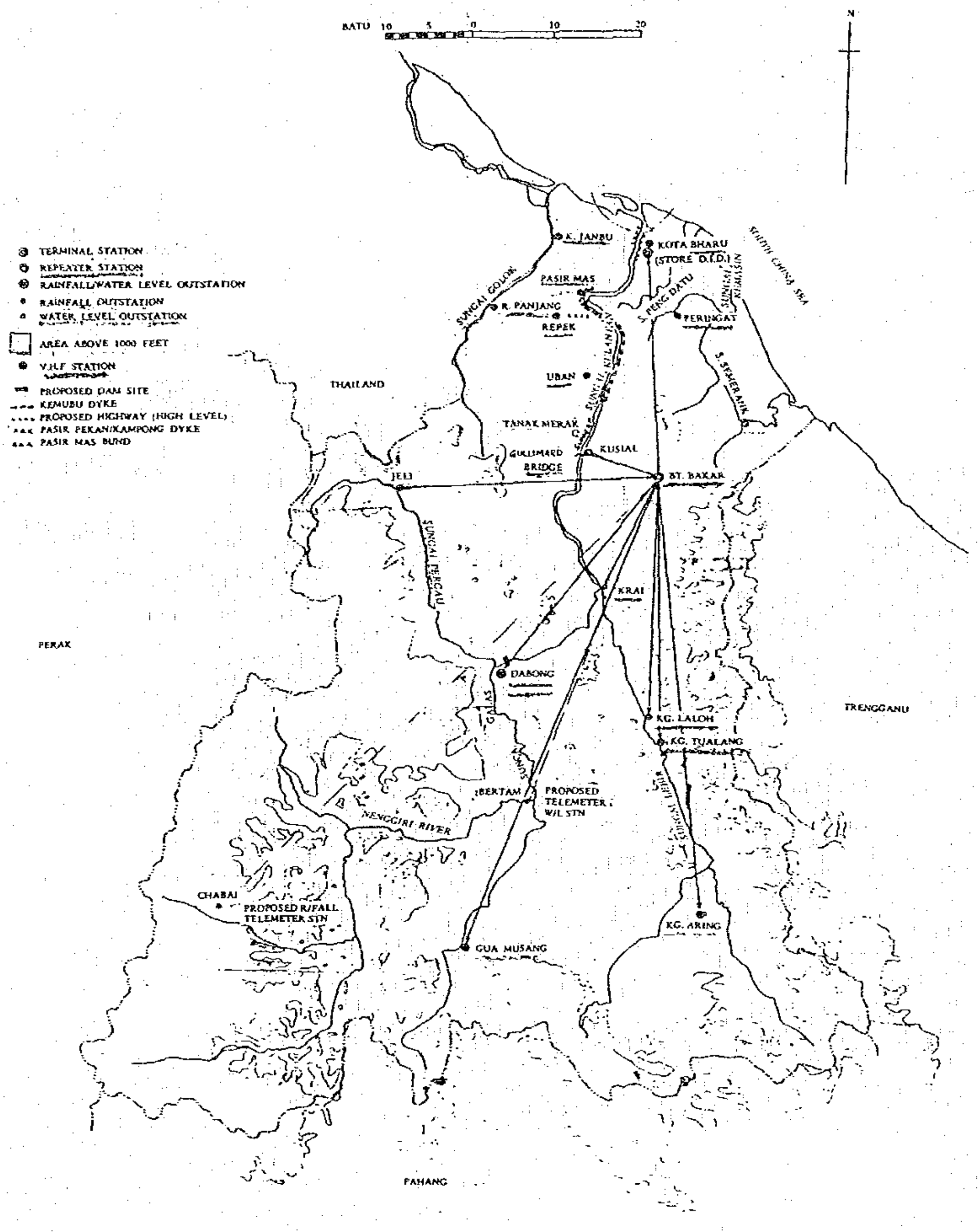


Fig. 12

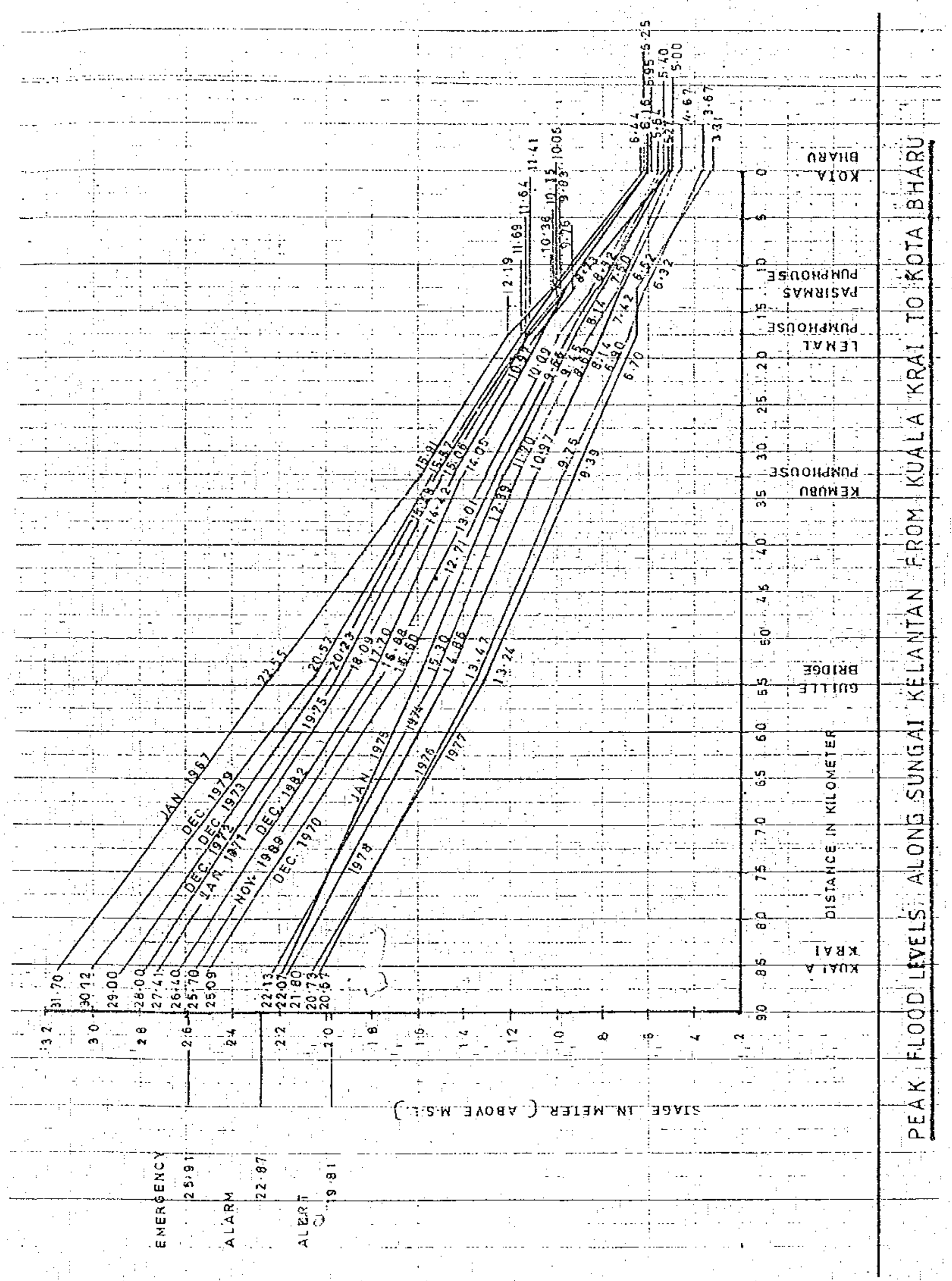

PEAK FLOOD LEVELS ALONG SUNGAI KELANTAN FROM KUALA KRAI TO KOTA BHARU
STAGE IN METER (ABOVE M.S.L.)
DISTANCE IN KILOMETER
KUALA KRAI
GUILLE BRIDGE
KEMUBU PUMPHOUSE
LEMAL PUMPHOUSE
PASIRMAS PUMPHOUSE
KOTA BHARU
EMERGENCY
25.91
ALARM
22.87
ALERT
19.81
JAN. 1967
DEC. 1979
DEC. 1973
DEC. 1972
JAN. 1971
NOV. 1969
DEC. 1970
DEC. 1982
JAN. 1975
1976
1977
1978
1974
1975

Fig. 13

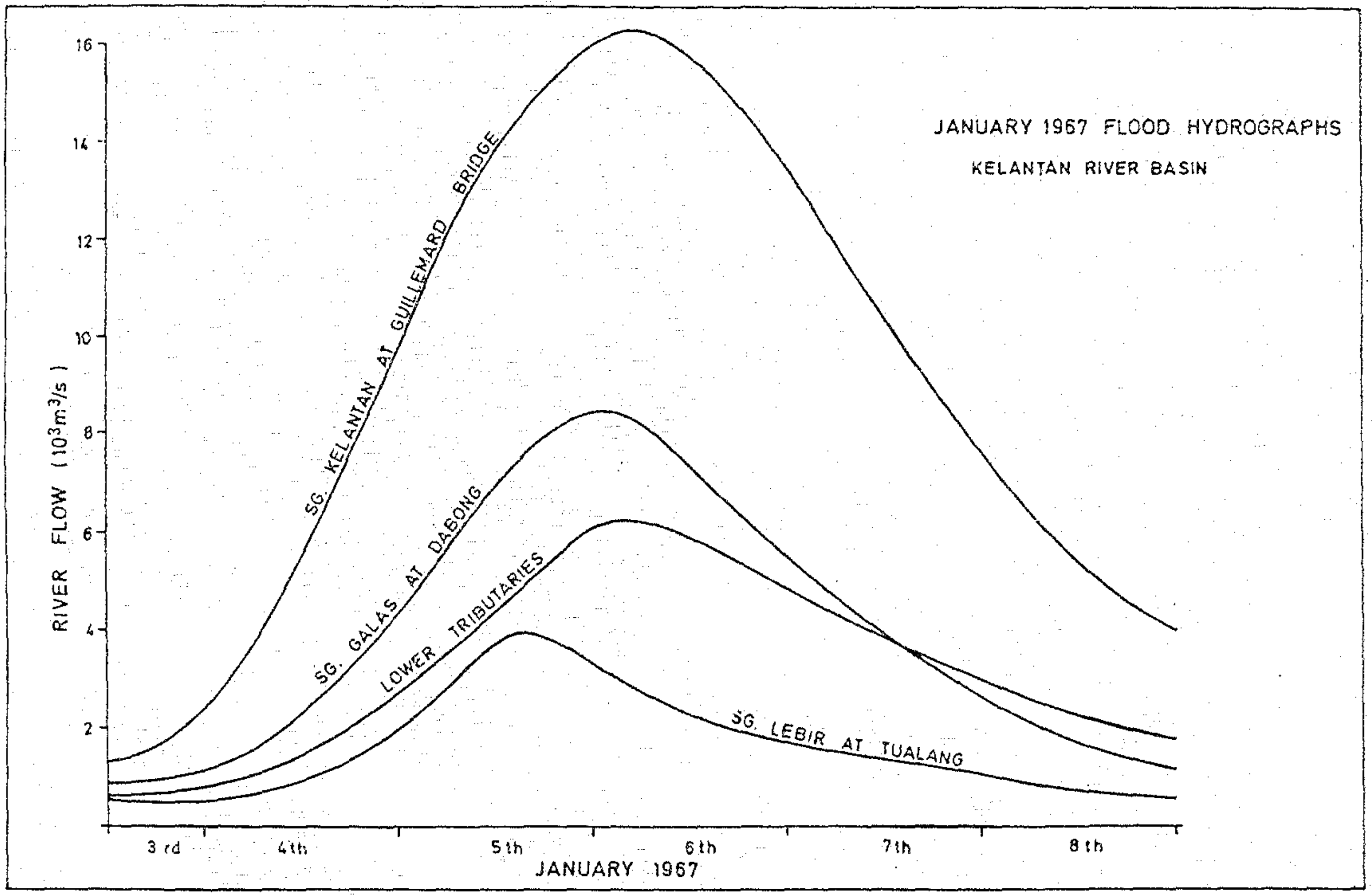

JANUARY 1967 FLOOD HYDROGRAPHS
KELANTAN RIVER BASIN
SG. KELANTAN AT GUILLEMARD BRIDGE
SG. GALAS AT DABONG
LOWER TRIBUTARIES
SG. LEBIR AT TUALANG
RIVER FLOW ($10^3 m^3/s$)
16
14
12
10
8
6
4
2
3 rd
4th
5th
6th
7th
8 th
JANUARY 1967

Fig. 14

DISTRIBUTION OF LAND USE CATEGORIES IN THE COASTAL REGION AND HINTERLAND OF KELANTAN

Land Use Category	Coastal Region Area		Hinterland Area		Total Area
	(ha)	(%)	(ha)	(%)	(ha)
Agricultural Land Use					
Mixed Horticulture	27,534,0	80.2	6,816.9	19.8	34,350.9
Rubber	53,221.6	41.1	76,381.8	58.9	129.603.4
Coconut	7,544.9	98.5	118.0	1.5	7,662.9
*Oil Palm	2,150.5	40.9	3,108.1	59.1	5,258.6
Orchards	1,012.1	97.3	28.0	2.7	1,040.1
Padi	71,356.6	94.9	3,869.6	5.1	75,226.2
Diversified Crops	1,401.9	61.8	867.2	38.2	2,269.1
Shifting Cultivation	0	0	1,157.9	100.0	1,157.9
Sub-total	164,221.6	64.0	92,347.5	36.0	256.569.1
Other Land Use					
Urban	2,497.6	81.5	568.3	18.5	3,065.9
Grassland	12,065.9	67.1	5,920.7	32.9	17,986.6
Forest	15,313.6	1.4	1,089,026.3	98.6	1,104,339.9
Scrub Forest	13,305.4	23.9	42,385.0	76.1	55,690.4
Swamp	22,892.4	88.2	4,059.0	11.8	25,951.4
Unclassified	5,090.9	12.5	35,498.4	87.5	40,589.3
Sub-total	71,165.8	5.7	1,176,457.7	94.3	1,247,623.5
State Total	235.387.4	15.6	1,268,805.2	84.4	1,504,192.6

Fig. 15

TUJUAN:

Papan amaran banjir ini membolehkan anda mengaitkan paras air di Kuala Krai dengan paras air banjir ditempat anda.

- o Amaran ini membantu anda membuat persediaan awal bagi menyelamatkan harta benda dan nyawa keluarga anda.
- o Siap sedia untuk pindah ke pusat permindahan.

CARA MENGGUNAKAN PAPAN AMARAN BANJIR:

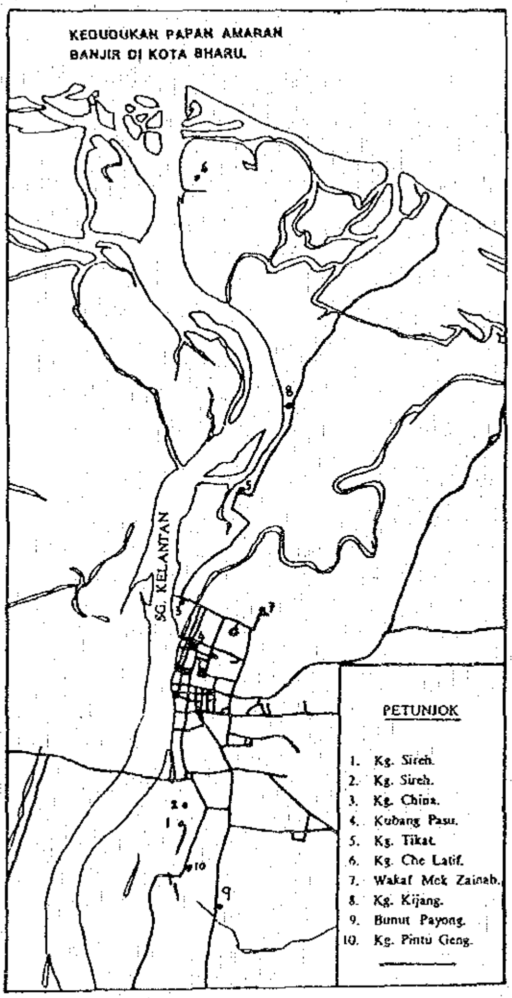
Apabila paras air di Kuala Krai meningkat ke 75 kaki tempat anda akan dinaiki air hingga keparas kuning.

Apabila paras air di Kuala Krai meningkat ke 85 kaki tempat anda akan dinaiki air hingga keparas merah.

Apabila paras air di Kuala Krai meningkat ke 95 kaki tempat anda akan dinaiki air hingga keparas coklat.

Apabila paras air di Kuala Krai meningkat ke 105 kaki tempat anda akan dinaiki air hingga keparas hitam.

Sila lihat contoh papan amaran banjir.



DI KUALA KRAI		DI TEMPAT ANDA
75 kaki (23 m.)	→	
85 kaki (26 m.)	→	
95 kaki (29 m.)	→	
105 kaki (32 m.)	→	

PERHATIAN:

- o Sila dengar pengumuman-pengumuman di radio mengenai paras air di Kuala Krai.
- o Tempat anda akan dinaiki air ke paras yang disebutkan dalam jangka masa berikut:-

Kota Bharu:	12–15 jam	dari waktu bacaan paras air di Kuala Krai
Pasir Mas:	10–13 jam	
Kusial & Tanah Merah:	4–7 jam	
Kuala Krai & Guchil:	0 jam	

７．研修に参加した感想

7－1 「研修に参加した感想」― 研修参加者への課題の指示内容

Please submit and present your revised country report and others on 12th, Sept., which contain following materials.

1. Revised country report （前段に記載済）

2. The impression of field inspection in the Tone, Ara basin, The yodo, Neya basin and the Tsurumi basin.

   The problem which rivers in Japan hold from these inspections and present your ideas to solve them.

3. Problems when non-structural measures to reduce flood damages may be introduced in your country and ways of improving these problems.

   Items

   (1) System of flood forecasting and dissemination of warning.
   (2) Evacuation of endangered inhabitants.
   (3) Flood proofing for building, installation or structure and building codes.
   (4) Improvement of flood fighting Organization.
   (5) Flood detention structures in urban areas.
   (6) Watershed management.
   (7) Zoning regulation, land use regulation and comprehensive basin development plan.
   (8) Utilization of flood risk map for flood prevention plan and basin development plan.
   (9) Flood insurance.
   (10) Others

4. The difference of river utilization and flood prevention measures between rivers in Japan and in your country, and the reason of the difference. Your ideas and reasons whether the treatment of rivers in your country in future might follow the Japanese one or not in detail.

5. Presentation of non-structural measures conducted in your country which may be useful in Japan.

6. Others

7-2 Ignacia M. Ramos

1. IMPRESSION ON FIELD INSPECTION:

TONEGAWA and ARA RIVER with their tributaties has the important role to meet the increase of human water demand as well as municipal, industrial and agricultural needs in Tokyo Metropolitan area and Saitama Prefecture.

So as the structural measures done by the Ministry of Construction are so important. Weirs, levees, retarding pont, diversion channel, water gates and drainage pump where each of operation of the structures are verified in an office control system.

Field trip in Yodo & Neya Basin is so impressive for their Control Facilities of hydrological gathering and hydrological observation by telemeter system; also the radar raingage system which monitors the movement of rainfall area in and outside the river basin and measure the rainfall distribution and area precipitation.

Study/Tour in TSURUMI River Basin gave me an idea about pump dredging activities using the system of pump vessel and sludge discharge thru pipeline.

2. NON-STRUCTURAL MEASURES that may introudce to reduce Flood Damages in my Country and ways of improving some problems:

(1) System of Flood Forcasting and Dissemination of warning.

In the Philippines we have three (3) classification of flood forcasting and warning:

a. Flood Caution – residents are called their attention to make necessary preparation for the flood.

b. Flood Warning – people must take measures against the flood.

c. Flood Imformation – showing the present condition of flood and its estimated change so that measures can be taken against the flood.

Public storm signal issued by PAGASA were relayed to all office of Civil Defense Regional Centers which in turn disseminated the warning information continously thru the Regional Emergency Broadcasting System consisting of radio stations and

TV network.

Continuous warning and issuance of precautionary measures were aired to reach out to all communities in the path of typhoon especially the remotest and coastal town of Central Luzon.

The Civil Defense Operation Center (CDOC) coordinated by Philippine Air Force (PAF) use helicopters to conduct areal survey to give relief goods to calamity areas. PNRC and MSSD use truck for transporting emergency assistance.

JAPAN has a good telemeter of forecasting such as water level, discharge, and rainfall telemeter associated with measuring facilities which are received by hydrological gathering control office from hydrological observation station.

Warnings are disseminated by the people thru microwave transmission, telephone, wireless telephone, exclusive public telephone implemented by the Ministry of Construction.

(2) Evacuation of Endangered Inhabitants.

After the flood warning with a flood information stating the danagerous situation the people in flood prone areas have to evacuate their place and go to higher areas to seek their safety mostly in schools and big buildings.

(3) Flood Proofing for Building, Installation of Structures and Building Codes.

Flood proofing for buildings is one of "soft" techniques counter measures for reducing flood damages.

Using Pilotis type for houses and factory and some offices, steel water proofing plate and check valve for apartment, wooden or steel water proofing boards are also done in our country to prevent inundation.

Installation of structure must be in accordance with building code.

Building Codes are established to ensure that buildings and structures achieve the least minimum Safety Standards. No building should be built in a high rise zone. Bridges, pipelines, and crossings should built to conform the condition that they do not impede or cause an increase in flood damages at a certain point.

(4) Improvement of Flood Fighting Organization

For counteracting damage to embankment like overflowing, seepage, and scouring I have learned many practical things for levee protection work.

Bamboo drifting (kinagashi), straw-mat spreading (omote – mushiro – bari)

(5) Flood Detntion Structures in Urban Areas.

Urbanization causes an increase in the volume of surface runoff and the drainage efficiency of the new landscape. To reduce the flood peak problem a certain amount of detention storage were possible.

Roof top storage – storm rainfall can be stored on the roof of flat – topped buildings. Temporary rainfall storage on the top of the roof can be attained by placing some device at the outlet drain of the roof which will delay the flow of water through the outlet.

Parking lot detention pond – asphalt or concrete paved parking lots can create detention ponds for storage of run-off for short period of 30 to 60 minutes following. The drainage is provided by pipes thru the base of asphalt dam. The stored storm water slowly drains thru these outlet pipes.

Playground and school yards can also be used as detention pond short time after the storm.

Detention pond can be recreational purposes for fishing and boating.

(6) Watershed Management

Commonly used in the Philippines as reforestration of denuded watershed, careful road construction and planting of cover crop to eroded and exhausted land.

These measures are usually done by agricultural engineers and other related concern people.

(7) Zoning Regulations

Flood-prone areas must be under zone regulations. Zone A as dangerous one about 40% probability of being flooded every year. Zone B, C and D are those lands having a small probability of flooding. No hospitals, schools, police stations and telecommunication exchange or electrical distribution centers should be located in any flood prone areas. No building construction is allowed in high risk zone.

(8) Utilization of Flood Risk Map for Flood Prevention and Basin Development.

Flood risk mapping helps to identify highly vulnerable locations for flood damages. Flood hazard area can be identified. The size of flood is usually expressed in discharge rate, flood height or rainfall intensity.

4. RIVER UTILIZATION in the PHILIPPINES are agricultural, industrial and common human water needs. Flood prevention structural measures are levees, dams, diversion channels. Non-structural countermeasures are flood forcasting, and flood proofing structures.

In my opinion Japan ways of river improvement is a very pattern for my country depending upon the government budget and to the concern officials.

7-3 Rungsan Sirayagon

1. Tone Ara basin, Yodo, Neya and Tsurumi basin are very good control facilities. For the example warning system, flood control structural measure and flood detention process.

Characteristic of Rivers of JAPAN and short stream length and steeper gradient so that the government of JAPAN pays much money and patient to develop and control water flow of the rivers. Out came of this investment is very good system for control facilities.

2. Problems when non-structural mesures to reduce flood damages may be introduced in my country and ways of improving those problems.

In Thailand, the flood damage is not serious as in Japan, because the difference of location and tropography. For the flood forecast system we selected the Pasak River to study.

A great extent of flooding in the low lying are along the Pasak River from Saraburi to Ayuthaya has been recognized which caused especially severe damages during the flood in 1978. The flow which overtopped the banks in the upsteam reaches from Saraburi – inundated the flat plain near the city. The cannals and embankments are assume to have some role to change the inundated flow direction and flood prone pattern on the plain.

Because of the water stage on the flood plain is usually rise slowly to its maximum level over several days, which provides enough time to evacuate inhibitants and demostic animals. From these problems, the following detail are to be proposed for improve.

Flood forecast is issued by the Weather Forecasting Centre of Meteological Department usually 24 hours in advance base on field data from rainfall/water stage stations in the middle and upper reaches of the basin. Generally a simple stage correlation method is currently employed for the flood forecasting of river basin. Flood information is communicated to the community level by commercial telephone via provincial or district offices in addition to radio broadcasting.

To improve forecasting procedure should study the characteristic of rainfall in relation to the track of stroms. And improve stage correlation method by introducing rainfall data into the model as a new parameter in addition to the water stage data upsteam. The observation equipments and transmission data in the river basin should be modernized in oder to get a reliable informations. If it is necessary should be develop flood simulation model equipped with the telemetric for the not work.

For the large river basin should be divided into sub-basin and each basin have to select a specific model for forecasting.

Evacuation of endangered inhabitants should prepare when the warning level is reached by the flood, evacuate the people and domestic animal to the higher place.

Utilization of flood risk map for flood prevention plan and basin development is useful to determine good location for the people, because flood risk map helps to identify highly vulnerable locations for flood damage?

3. – The river utilization of JAPAN and THAILAND is not different. For the example rivers in JAPAN are useful to agricultural activities, domestic and industrial, for generate Hydroelectric Power. In Thailand the utilization of river due to supply irrigation and water supply. Electric hydro power and navigation is the second priority.

– The difference of location and tropography, so that the flood prevention measure in Thailand is not modernized as in JAPAN. Usually the water flow in the river basin is not so much, but only when there are heavy rainfall due to depression which occasionally passed through or active southwest monosoon the flood will occur.

– Thailand may follows JAPAN for the treatment of river in future whether the water demand or population density are increase and respond to support demand energy which will increase in the future.

4. In Thailand there is no other non-structral measure in flood prevention other than by construction the hourses on height poles in flood proned area. This is because the flood plain is very large and flood depth is nromally shallow since flood damages is minimum the government pays little attention in other non-structual measures.

7-4 Kangvan Deesuvan

1. Impression on Field Inspection

Tone gawa & Are river with their tributaries has the importance to meet the increase of human water demand as well as municipal, industrial and agricultural needs in Tokyo metropolitan area. Weires, levees, retarding pond, diversion channel water gate drinage pump where each of operation of the structure are verified in office control system.

Field trip in Yodo & Neya Basin is as impressive for their control facilities of hydrological gathering and observation by telemeter system; also the radio raingage system system which monitors the movement of rainfall area and out side the river basin.

Each basin has a master plan which must be well though of. Multiple high dams are constructed at the upper reaches, some to generate hydro-electric power and others to reduce flood peak which along the rivers numerous intakes are constructed for irrigation and water supply to optimise the use of land along the river are utilized for recreation facilities and other social amenities like golf course, car parks and other game.

In Tsurumi river basin gave me an idea about pump dreding activities using the system of pump vessel and sludge discharge by these pipeline.

2-1 Flood Forecasting System

The Thailand most river basin have some form of flood forecasting and warning. Warning are normally dissemination through radio and television broadcasts. Also on site, loud speakers on mobile vehicles are employed.

2-2 Evacuation of Endangered Inhabitants

In Thailand in flood areas. Water level about 20 – 40 centimetre. The people can stay the second floor.

2-3 Flood Proofing for Building

In Thailand in Flood area, the people normally built thier houses on elevation higher than the flood level either by constructing houses on poles, still or by raising the ground with earth fill, some house by raising existing or constructing new surrounding high walls around their houses to prevent flood water from entering and damaging their properties.

2-4 Formation of Flood Fighting Organization

In Thailand formation of flood organization fighting organization will not be of much use or effective due to the following reasons;

a. There are usually vast areas of rice field and low agricultureal land on one or both sides along the rivers which can retain flood water in the event of dike breaks.

b. Unlike in Japan not many people stay along dikes and since very few people lives and properties will be endangered in the event of dike breaks. The formation of flood fighting orgainization will not be well riceived and effective.

2-5 Flood Detention Structures in Urban Areas

a. Parking lot Detention Pond, there should be no problem in implementary this measure of detention storage. The only problem can see is the cleaning up of the mud and debris after the release of the detained water.

b. Detention Ponds. This measure has already been employed in Thailand.

2-6 Watershed Management

In Thailand most watershed for important reservoir dams have been gazetted as special watershed area. In another watershed especially near urban areas the government impose conditions like construction of silt traps, planting of cover crops on exposed land as necessary compulsory requirements before any project is approved for implementation.

2-7. Zoning Regulation, Land Use Regulation and Comprehensive Developement Plan

In Thailand flood loss is not so high and flood depth is often less than 50 centimetre in most place. It is already a practice that before any housing development or important public building is to be constructed the plan must first and processed by a group of relevant government agencies who will then assess it suitability as prerequisites if necessary. Proposals to develop in highly flood risk areas are normally rejected or if not very stiff condition will be imposed. With such government procedure in practice it is felt zoning and land use regulation may not be necessary.

3-8 Utilization of Flood Risk Map for Flood Prevention Plan and Comprehensive Basin Development Plan

The drainage and irrigation Department in Thailand prepare flood maps for the country almost every year. Flood risk maps should be prepared and be use for flood prevention and basin development plan.

4. Difference of River Utilization and Flood Prevention Measures between Japan and Thailand

Generally is no difference between river Utilization in Japan and Thailand. In Japan Flood plain are densely populated right up to the river banks hence rivers deprived of their natural flood plains are forced to rise resulting in the construction of high embankments as a means to prevent flooding. In Thailand houses are normally constructed on high ground or natural levees. Soldom are high embankments constructed a flood prevention measure to protect by high enbankments unlike in Japan.

5. Non-Structural Measures

In Thailand the river normally long and it take a long time for flood water to come down to the flood plain. From experience the people will know of any imminent flood and it's magnitude. Also the flood plain are large and consist mainly of rice fields. Hence flood usually occur at shallow depth and food loss is minimum.

There is no other non-structural measure in flood loss prevention other than the inhabitant build their houses on poles well above the flood water.