THE REPORT OF THE TOPEX ROVING MISSION TO THE PHILIPPINES, MALAYSIA, THE REPUBLIC OF KOREA AND THAILAND ON BOTH HYDROLOGICAL AND WARNING DISSEMINATION AND INFORMATION EXCHANGE COMPONENTS

JANUARY AND FEBRUARY 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN

Preface

This is a report of the TOPEX Roving Mission for both Hydrological and Warning Dissemination and Information Exchange (WD/IE) Components sent to the Philippines, Malaysia, the Republic of Korea and Thailand.

Typhoon Operational Experiment (TOPEX) is one of the most important activities of the United Nations, aimed at reducing losses of life and damages caused by typhoon in Southeast Asia and the Pasific Region. For promotion of TOPEX, Japan International Cooperation Agency (JICA) organized the Roving Mission to discuss and exchange ideas on hydrological and warning dissemination and information exchange problems with the experts of Members of the Typhoon Committee (TC).

The Mission consisting of three experts for hydrology and three experts for warning dissemination and information exchange visited the Philippines and Malaysia in January 1982 and the Republic of Korea and Thailand in February 1982, respectively, and successfully achieved the initially anticipated purposes of the mission through the discussion meetings and the field survey under the warm cooperation of the organizations concerned.
The mission obtained many useful informations and experiences from the counterparts of the each country.

I sincerely hope that this report will be beneficial and indispensable to the future development in Hydrological and WD/IE Components not only for the respective countries but also for all TC Members.

I would like, on behalf of JICA, to express my great appreciation to the Governments of the Philippines, Malaysia, the Republic of Korea and Thailand as well as other relevant organizations for their generous and hearty assistance extended to the mission throughout the period of their stay.

March 1982

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1. OUTLINE OF TOPEX

1.1. Objective

Typhoon Operational Experiment (TOPEX), a project of the ESCAP/WMO Typhoon Committee (TC) and also as a sub-project of the WMO Tropical Cyclone Programme is carried out under the programme of the Typhoon Committee.

The objective of TOPEX is to reduce the risk of loss of lives and damages from typhoon winds, floods and storm surges by improving the forecasting and warning capabilities of Members of the Typhoon Committee through the implementation of an operational test of the various systems used for typhoon analysis, forecasting and warning as well as for flood forecasting during all stages of typhoons in the area.

1.2. Historical background

In 1964 discussions were held between WMO and ESCAP on the feasibility of setting up a joint programme aimed at reducing the loss of human lives and the damages caused by typhoons in southeast Asia and the Pacific. Following these discussions, the Typhoon Committee was formally established in 1968.

The Typhoon Committee has held annual meetings at which planning and implementation programmes were made to improve meteorological and hydrological facilities. Efforts have also been made by the Committee to improve the facilities in the region for training personnel and to co-ordinate the research activities concerning typhoons. In addition, in consultation with UNDRO and LRCS, the Committee recommended ways and means to enhance community preparedness and disaster prevention. With the assistance of UNDP a secretariat was set up to assist countries in the region to implement the Committee's programmes.

At the eleventh session of the Typhoon Committee held in Bangkok in October 1978, China's suggestion for typhoon experiments was supported by Japan. As a result of discussion, documents containing an outline of a Typhoon Operational Experiment (TOPEX) were submitted by Members of the Typhoon Committee to the Eighth World Meteorological Congress held in 1979.

The Eighth Congress adopted Resolution 9 (Cg-VIII) by which WMO Members were urged to support the experiment to the maximum extent possible.

1.3. Time schedule of TOPEX

The whole experiment period of TOPEX covers from 1981 through 1984 as follows:

1981	Pre-Experiment
1982	First Operational Experiment
1983	Second Operational Experiment
1984	Evaluation phase

1.4. Components

TOPEX consists of three components:

(a) Meteorological Component

(b) Hydrological Component

(c) Warning dissemination and information exchange (WD/IE) Component.

The Meteorological Component of TOPEX comprises two Experiments, i.e.

(i) the Core Experiment

(ii) the Sub-Experiment

The Core Experiment is designed to obtain observational data in and around a typhoon from an intensified network. Using data obtained from this intensified observing network all participating members will follow, on a real-time basis, agreed common procedures for an integrated typhoon analysis-forecasting-warning system.

The Sub-Experiment is aimed at obtaining detailed information on the three-dimensional structure of typhoons and on the mechanism of their generation, development and decay, thereby improving the techniques for the forecasting the trajectory and intensity of typhoon.

Under the Hydrological Component, the Experiment is to concentrate on the following three activities:

(i) the evaluation of the established systems for the forecasting and warning of the hydrological effects of flood and/or storm surges by comparing their outputs with actual observed data in the field;

(ii) the identification of simple deterministic forecasting models used by, or available to services in the typhoon area, the selection of specific models for application to each designated area, and the comparison of the models' results in real-time forecasting operations;

(iii) the evaluation of the separate and/or combined hydrological effects of typhoons, particularly river and storm surge flooding, and thus the determination of associated flood risk.

The main activity under the Hydrological Component is the evaluation of existing flood forecasting systems in designated basins. The Pampanga River in the Philippines, the Kelantan River in Malaysia, the Han River in the Republic of Korea, and the Pasak River in Thailand are designated.

The Warning Dissemination and Information Exchange (WD/IE) Component could be identified as primarily national. The WD/IE experiment should be carried out in the framework of the disaster preparedness sturcture in each Member in co-ordination with the other two components, because the effectiveness of the warnings issued by the other two components can only be measured by the impact such warnings have on the organization and popularization of the required action by the responsible agencies toghther with the people in the affected areas. To this end, it is imperative that the dissemination of warnings and exchange of information between all three components, the agencies involved and the general public, be carried out during all crucial phases.

The TC Members are invited to review and evaluate the present warning system in each Member in the light of the following three aspects:

(a) institutional aspect
(b) technical aspect and
(c) social aspect

The plan of WD/IE Component consists of three stages:

Stage 1	Pre-experimental Stage	(year 1981)
Stage 2	Experiment Stage	(year 1982/83)
Stage 3	Evaluation Stage	(year 1983/84)

2. Roving Mission for TOPEX

Although TOPEX meetings such as the Management Board and the Planning Meeting have been held frequently, some disadvantages were still found, especially in Hydrological and WD/IE Components. In this connection the Government of Japan organized the TOPEX seminar related to Hydrological and WD/IE Components from 22 July to 21 August 1981, simultaneously with the Pre-Experiment period and the activation of the International Experimental Center (IEC) of TOPEX. It was regretful to invite only five participants from TC Members for both components. In addition to the seminar, the Roving Mission, which can promote further implementation by discussing about the two components of TOPEX with many staffs of all the relevant organizations in each Member, was proposed. Because these Components cover so wide fields in the institutional systems that understanding of the general public about TOPEX should be essentially required in each Member. The Government of Japan sent the Roving Mission to four of the TC Members under the request by ESCAP and WMO, referring to the letter 48,075/W/CY/TC.8 dated 20 October 1981 by the Secretary-General of WMO. A joint mission on the Hydrological and WD/IE Components was suggested in his letter to serve as a follow-up to the seminar meeting held in Tokyo. Two teams of the Mission, supported by Japan International Co-operation Agency, were organized; one for the Philippines and Malaysia and the other for the Republic of Korea and Thailand. Each team consisted of three experts for Hydrological Component and three experts for WD/IE Component. Therefore twelve Japanese experts contributed to promote the TOPEX activity, especially Hydrological and WD/IE Components.

Two more teams of the TOPEX Roving Mission consisting of staffs of Japan Meteorological Agency were sent to TC Members for promotion of the Meteorological Component of TOPEX. One of them arrived in the Philippines together with the Philippines-Malaysia team of Hydrological and WD/IE Components of TOPEX, and left Malaysia for Japan also together with the same team of Hydrological and WD/IE Components. This report is compiled only for Hydrological and WD/IE Components of TOPEX, not including Meteorological Component.

It is highly appreciated that Dr. Kingsley J. Seevaratnam, League of Red Cross Societies, successfully finished his works as a consultancy mission of WMO/UNDRO for disaster preparedness for six months in 1981. His report already published is useful for better management of warning dissemination and information exchange in all TC Members.

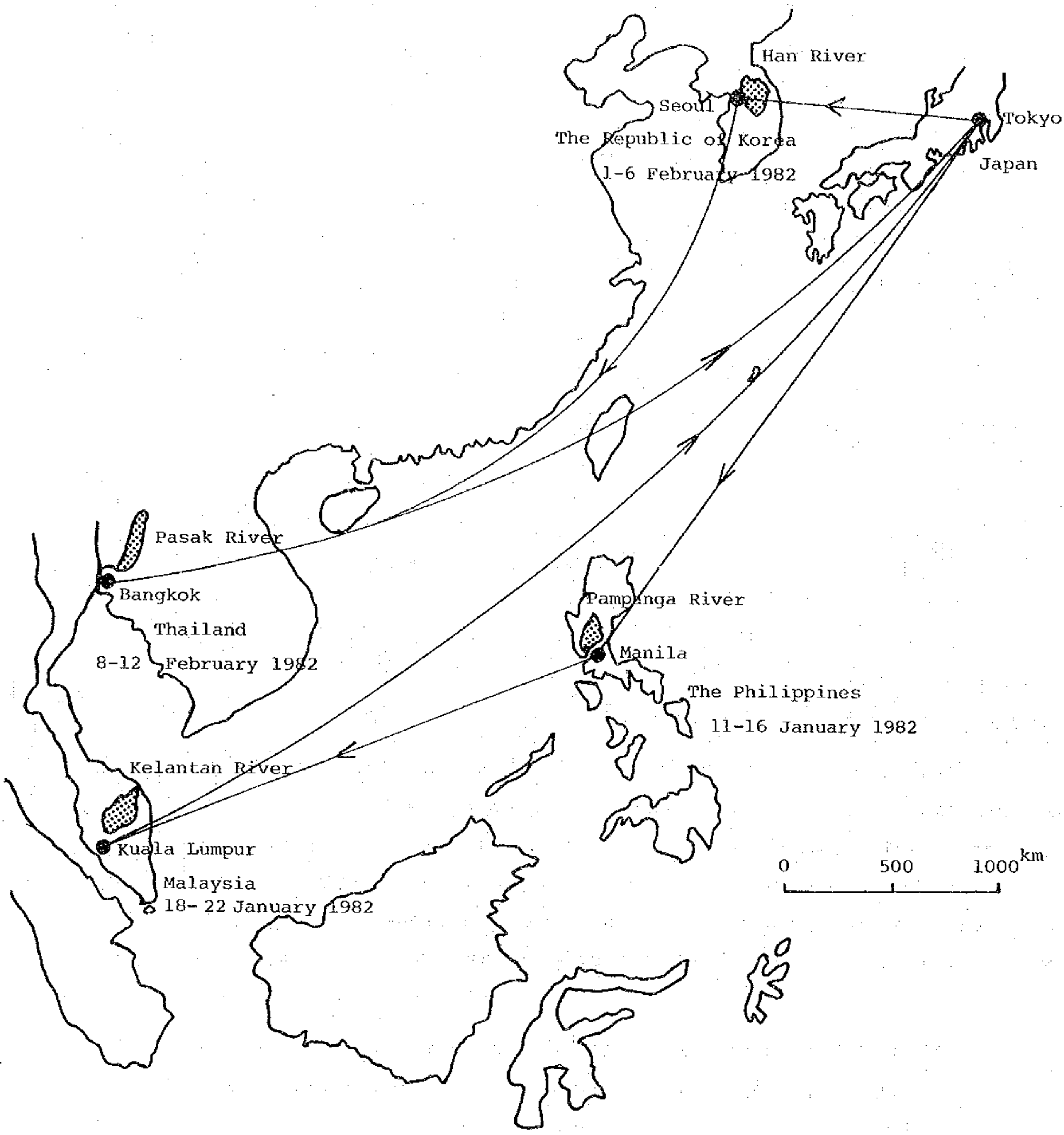

Fig. 1 Visits of the Roving Mission

The mission held the lecture session, including statistics on disaster, the field survey and the discussion with the helpful co-operation of all organizations concerned.

2.1. Period of the mission

The mission visited to four of the TC Members in January and February 1982. A week was alloted to a country for service of the mission. The schedule was listed below.

11 - 16 January 1982 for the Philippines

18 - 22 January 1982 for Malaysia

1 - 6 February 1982 for the Republic of Korea

8 - 12 February 1982 for Thailand

The members and the detailed itinerary of the mission, and some comments on TOPEX discussed in each country were described in the later chapters.

2.2. Importance of Statistics on Disasters

The importance of statistics on disasters was presented at the lecture session and hot discussions arose from the participants. A short history of the preparation of statistics on disasters was summarized as follows.

"Improvement of technique for assessment and reporting of damage" was stressed as one of the important activities under the disaster prevention and preparedness (DPP) component of the Tyhoon Committee. The following proposals from Japan were adopted as a programme for 1982 in accordance with the short-term and long-term programmes of the DPP component in the fourteenth session of the Committee in Manila in November 1981.

(1) Each Member should collect the information on damage caused by typhoons and/or floods, and send it to the Typhoon Committee Secretariat before the annual session.

(2) The information must include disaster situation such as loss of human lives, damages to houses, public facilities, agricultural products and so on.

(3) The Government of Japan also had the capability to discuss and give a lecture on the way of collecting the information during the period of the stay of the TOPEX Roving Mission.

3. Country Report

Every country has its own regime for flood forecasting, flood risk evaluation, typhoon warning, information exchange and other activities for disaster preparedness which have developed for many years in communities. It is generally difficult for foreigners to understand the domestic regime related to disaster preparedness. It is very happy for the mission to receive a lot of useful informations about Hydrological and WD/IE Components under the warm co-operation of the host countries. Some of the information obtained during the periods of the services of the mission were summarized in the interim reports which were submitted to the host countries. The time to prepare the interim report in each country was too limited to present adequate expressions. The country report in this chapter is mainly re-arranged by the interim reports, including some additional comments. In the country report the existing system of Hydrological and WD/IE Components in each country as well as several suggestions are described for successful implementation of TOPEX. It is effective for promotion of TOPEX to know the existing systems in friend countries, because there is something common in the Typhoon Committee area. The country report is a fruitful memory of the Roving Mission for TOPEX.

3.1. The Philippines

The Government of the Philippines kindly acted as a host to the Roving Mission. All participants of the Philippines are listed in Annex I.

3.1.1. Members

The members of this mission were as follows:

(Hydrological Component)

Sadao Kishimoto	Water Management Officer, River Bureau, Ministry of Construction
Kunio Ichimiya	Chief Telecommunication Engineer, Kinki Regional Construction Bureau, Ministry of Construction
Minoru Kuriki	Chief of River Planning Section, River Planning Division, River Bureau, Ministry of Construction

(WD/IE Component)

Takeo Kinosita (Co-ordinator)	Director, First Research Division, National Research Center for Disaster Prevention, Science and Technology Agency
Nobuyuki Kato (Focal Point for WD/IE Component)	Senior Staff, International Affairs Division, Promotion Bureau, Science and Technology Agency
Tsuneo Sato	Chief of Service Section, Disaster Prevention Policy Planning Division, National Land Agency

3.1.2. Itinerary

The activities of this mission in the Philippines were as follows:

Jan. 10 (Sun)	Arrival in Manila
Jan. 11 (Mon)	Group meeting to finalize the mission's shedule in the Philippines
Jan. 12 (Tue)	Report and lectures on the activity of TOPEX in Japan in 1981 and discussions at OCD Office (The program is in Annex II.) See Photo 2.

Jan. 13-14 (Wed.-Thu)	Field survey of Pampanga River Basin and visit to the Pantabangan Dam, the local office of OCD at Cabanatuan, the local office of MPWH at Apalit, some gauging stations at San Isidro, Arayat, and Sulipan.
Jan. 15 (Fri.)	Final discussions, preparation and presentation of the interim report at PAGASA Office
Jan. 16 (Sat.)	Leaving

3.1.3. Outline of Hydrological Component in the Philippines

Activities of the Hydrological Component of TOPEX are the evaluation of the existing systems for forecasting and warning of the hydrological effects of flood, the identification of simple deterministic forecasting models and the evaluation of flood risk.

In order to evaluate the existing system for flood forecasting, the TC Members are requested to monitor all significant flood events and to record them in a standard format.

In regard to the evaluation of flood risk, Japan offered to make a report on flood risk analysis on the basis of reports submitted by TC Members.

As for the activities in the Philippines, the Pampanga River Basin has been selected as the designated river basin of TOPEX, and a detailed description of the river basin has been submitted. The whole system of the Flood Forecasting Network, which is 8 years old and has deteriorated considerably, is expected to be rehabilitated completely by the time the First Operational Experiment is carried out.

During the period of the approach of the typhoon ANDING (1981 Nov.) Flood Advisory was issued based not on data of the existing Pampanga River Flood Forecasting System but on meteorological data.

Standard format for evaluation of existing model (Refer to Appendix L of PM-1) were being prepared for the case of Typhoon Anding.

3.1.4. Pampanga River Basin

The designated river basin, the Pampanga river basin, is located in the central part of Luzon and the basin area is 8,540 Km^2. Two thirds of the basin is flat lands of alluvial deposits which includes the swamp lands, namely San Antonio Swamp and Candaba Swamp.

The climate of the basin is characterized with two seasons, wet (June to October) and dry (December to April). Tropical disturbances like a typhoon and southwest monsoon during the wet season are main causes of floods.

Ten rainfall stations and seven water level stations are telemeterized, though the system is out of order in January 1982. There is no rating curve lately available as of January 1982. Photo 1 shows one of the stations.

The existing flood forecasting and warning system is operated by the Pampanga River Flood Forecasting Center under PAGASA. The runoff model being used for the flood forecasting in the basin, a two-series Tank Model Runoff calculation using the tank model, could be executed with the aid of a computer to obtain the 1-day and 2-day runoff forecast. According to the forecast, two types of warnings - Flood Outlook and Flood Advisory-are to be issued.

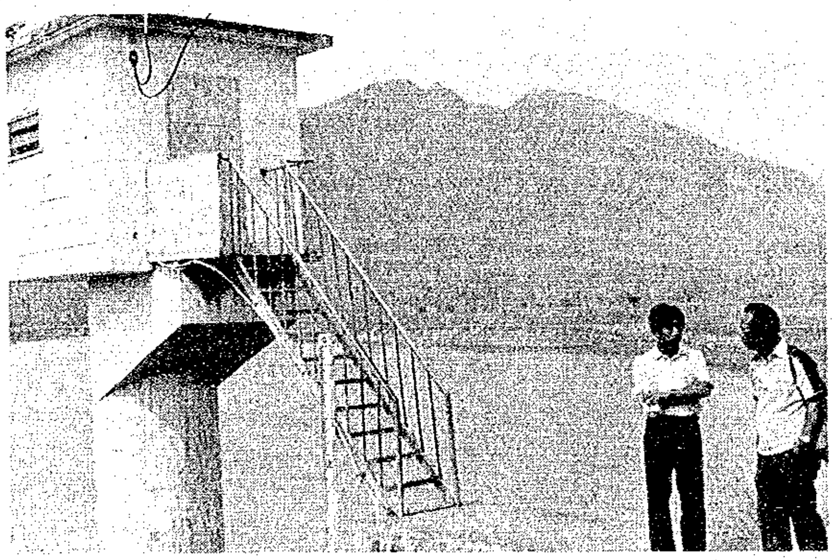

Photo 1. Arayat Water Gauging Station at Pampanga River.

3.1.5. Proposals for Success of the Hydrological Component in the Philippines

The Roving Mission had a field survey of the designated river basin, the Pampanga river basin, on January 13 and 14. It visited the Pantabangan Dam, the local office of MPWH and some gauging stations.

The Pantabangan Dam is a multi-purpose dam benefitting irrigation, domestic and industrial water supply, hydroelectric power, fish conservation and flood control. The dam was designed to reduce the flood level by about 20 cm in the Candaba Swamp. It will reduce annual flood damages on farmlands, houses, buildings, public structures, agricultural products and livestocks in the provinces of Nueva Ecija, Tarlac, Pampanga and Bulacan.

It provides flood storage of $305x10^6$ m^3 during the period of June 1 through October 15. The principle of controlling flood is that flood is stored as much as possible until after the storm passes. The operation of the crest gates is decided at National Irrigation Administration head office, consulting Office of Civil Defence and PAGASA.

The Roving Mission gave attention to the maintenance of the gates. The wires of the gates should be well greased. The gates should be got moved periodically as a test.

The mission visited some gauging stations. Discussions which arose at the field survey were summerized as follows.

a) San Ishidro water-level station

Digital water-level gauge, consisting of 3 sensing poles, is set at the left river side. The lowest one tilted, because of drag force of water. The middle one had been broken. PAGASA was planning to move the water-level gauge to the pier of the bridge, about 200 m upstream of the existing station. It was noticed that the proposed site was adequate for discharge observation, which would be easily carried out by drift rods during the high water periods.

b) Arayat water-level station

The gauge house must be set higher. It was lower than the girder of the Arayat bridge. The intake pipe seemed to be blocked by siltation. The approaches to the bridge sticked out into the river channel by about 100 m. The approach would dam up the flood water around the gauging site at the time of the flood.

c) Apalit rainfall station

It was unfortunately out of order, because the battery was removed after the big flood which had damaged the whole flood forecasting system. It was discussed that the data should be sent by the alternative system if any device was out of order.

d) Sulipan water-level station

It was not in operation. The intake pipe was perhaps blocked. It was regretful that there was no staff gauge at Sulipan. A staff gauge was strictly necessary to check the recording gauge and to read the water level in case of the failure of the recording gauge at any gauging station.

The mission visited the local office of MPWH at Apalit, and was given an explanation about the Pampanga river flood control project. The mission visited Labangan floodway. It contributes reducing inundation duration of downstream area from 7 days to 1 day. It is planned to be widened from 40m to 80m.

Being based on the aforesaid notice during the period of the survey and the outcome of the discussion with PAGASA staff members, the Roving Mission submited the following proposals for success of TOPEX in the Philippines.

(1) The failures of the forecasting and warning system were mainly due to troubles of the solar cells, battery charger, the sensing poles

and the stilling wells.

The solar cells used in above system were manufactured ten years ago. Deterioration of module covers is thought to be a cause of the damage of solar cells.

Deterioration of batteries is considered to have been caused by the fact that they have been left in a state of over-discharges for a long period of time without being supplied with charging current due to the damage of solar cells. The battery cables are in the same situation.

The faulty part of the battery charger in PAGASA has already been investigated, and it is expected that it will be repaired as soon as possible.

At San Isidro water-level station, the sensing poles are planned to be moved to the pier of the bridge. The observed water-level at the pier will be slightly differnt from that observed at the existing site. Correction must be introduced in the comparison of the future water levels with the past ones.

The conduits of both Arayat and Sulipan water-level stations might be blocked by sedimentation. In order to keep water gauging stations well, continual maintenance is essential.

Since the above-mentioned troubles may recur after the completion of the planned rehabilitation, the mission hopes that the Government of the Philippines will make necessary arrangements for adequate funding to maintain the system in addition to the organization of a maintenance unit. The unit should include hydrologists. The maintenance work should be carried out periodically at least once a month. In addition, an honest man living near the station should be nominated as a gauge keeper. It should be borne in mind that any system never works without adequate maintenance, and the proper amount of budget and well-trained experts should be allocated to the maintenance in order to keep the system well.

One of other environmental conditions affecting the system is a lightning which takes place very often in the Philippines. The telemetry equipment is damaged if directly given abnormal high voltage as it employs low voltage electronic circuits.

The damage due to a lightning can be greatly minimized by insertion of a lightning arrester and a good earthing method.

Namely, a coaxial lightning arrester should be inserted into the antenna line and a protector into the signal cable. If the signal cable is very long, it should be set under the ground.

(2) Rating curves should be established at the gauging sites where the discharge data are necessary for calculation and verification of the flood forecasting.

In the Pampanga river flood forecasting and warning system, Tank Model is being used. That is a run-off calculation method to get discharge value from rainfall data. What one wants to know is water-level at designated sites. The model parameters have to be determined compared with observed values. Therefore the establishment of rating curves, which are determined by observed discharge, are indispensable for correct forecasting.

The sites for discharge observation should be located at the place where neither overtopping from embankment nor unexpected diversion from the river channel would occur.

(3) The alternative method, such as stage-stage correlation method and/or a rainfall-stage correlation method should be developed as a back-up system when the data are missing or the model does not work well.

The correlations between rainfall amount in the upper stream and water-levels at Candaba swamp and Apalit should be studied first, because the target areas of the Pampanga river flood forecasting and warning system are Candaba swamp and downstream of Apalit water-level station.

3.1.6. WD/IE Component in the Philippines

The National Disaster Coordinating Council consists of twenty two ministries and important non-governmental organizations such as Philippine National Red Cross. All of them are also the members of the national committee of the WD/IE component of TOPEX. Five orgnizations listed below are major ones.

(1) OCD (Office of Civil Defense)

(2) PNRC (Philippine National Red Cross)

(3) PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration)

(4) MPWH (Ministry of Public Works and Highway)

(5) MSSD (Ministry of Social Services and Development)

Under the National Disaster Coordinating Council (NDCC) there are 13 regional DCCs, 75 Provincial DCCs, 1400 Municipal DCCs, 66 City DCCs and 42000 Barangay DCCs. All DCCs are cooperate in the WD/IE component in the Philippines.

Coordinating meetings are held at all levels, namely, the National level, the Regional level, the Provincial level, the Municipal level and the Barangay level.

The National Disaster Coordinating Council has a meeting regularly every month, while the Regional/Provincial/Municipality and Barangay Disaster Coordinating Councils have meetings before, during and after the impact of any disaster event.

The Office of Civil Defence (OCD), is a merger of two national agencies, the National Civil Defense Administration under the Office of the President and the National Disaster Coordinating Center under the Department of National Defense. Some of the functions of the OCD are to establish and administer a comprehensive national civil defense and civil assistance program, and to formulate plans and policies for the protection and welfare of the civilian population in time of war directly involving the Philippines or other national emergencies of equally grave character. The National Disaster Coordinating Council, which is the highest policy determining body for major disasters, is composed of members of the cabinet under the chairmanship of the Minister of National Defense. The members are the Ministries of Public Works, Transportation and Communication, Social Services and Development, Agriculture, Education and Culture, Trade, Local Government and Community Development, Health, Natural Resources, Public Information, Budget Ministry, Presidential Executive Assistant, Presidential Assistant on General Government, CSAFP, PNR and OCD as Executive Director.

There are twelve civil defense regional centers in regional levels in the Philippines. Regional Disaster Coordinating Councils through these centers are responsible to the Administrator for the regional preparedness programs, disaster operations and rehabilitation activities by the government and the private sector. They shall advise the National Disaster Coordinating Council through OCD's 12 regional centers on the disaster situation in the region and recommend appropriate measures.

Legislation makes it compulsory for the Local Governments from the provincial down to the barangay level to organize their respective disaster coordinating councils, and oversee the status of preparedness programs, disaster operations and rehabilitation activities by the government and the private sector in their respective areas of responsibiligy.

Philippine Atmospheric, Geophysical and Astronomical Service Adiministration (PAGASA) is a meteorological agency and has been designated as the focal point for the three components of TOPEX. The function of PAGASA related to WD/IE Component are to issue warning of typhoon, storm surges and flood to OCD and other relevant organization as well as the general pablic through the established communication networks.

The Ministry of Social Services and Development (MSSD) is the social welfare arm of the Philippine Government. It is responsible for developing, administering, and implementing a comprehensive social welfare program. The Ministry proper includes the Office of the Minister and the four staff service units: the Administrative Service, the Financial and Management Service, the Planning Service and the Training and Publication Service. All MSSD programs and services are implemented by its 13 regional offices, 78 provincial offices, 56 city branches and some 450 unit offices all over the country.

The function of Philippine National Red Cross (PNRC) are to provide relief assistance in accordance with the National Calamities and Disaster Preparedness Plan, and to assist OCD in the conduct of surveys in the experiment periods.

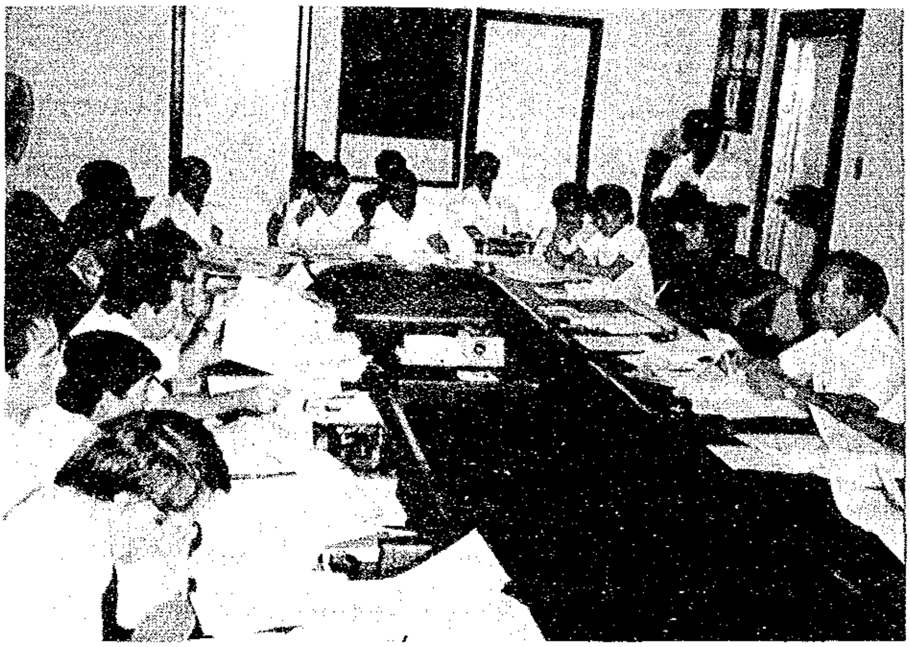

Photo 2. Meeting at OCD. By the courtesy of Col. Pagulayan.

In order to mitigate damages, the trainings concerned in disaster prevention and preparedness are very significant.

In the Philippines, two kinds of trainings are undertaken in each level. One is training for leaders of institutions related to disaster preparedness and the other is for community members.

The Office of Civil Defense set a target of 6000 disaster councils to be organized and trained for 1981. However only 5000 organizations and training were accomplished in spite of the budgetary constraint. The Roving Mission would like to appreciate this endeavor for disaster prevention.

3.1.7. Case of the typhoon Anding, November 1981.

In the pre-experimental stage 1981, a strong typhoon traversed Central Luzon. The Office of Civil Defense (OCD), Ministry of National Defense, summarized the record of the warning dissemination in the report entitled "A Comprehensive Report on Typhoon Anding, November 22 - 27, 1981".

On 22 November 1981, a tropical cyclone entered the Philippine Area of Responsibility, which was code-named Typhoon Anding, PAGASA issued the first warning bulletin and announced Public Storm Signal in the afternoon of 22 November. Typhoon Anding made a landfall in Luzon Island with centerwinds of 205 Km/hr. in the afternoon of [illegible] November and crossed over Central Luzon with centerwinds of 135 Km/hr.

The warnings were disseminated successively by PAGASA from 1700, 22 November 1981 to 0600, 27 November 1981, when the final bulletin was issued. The warning is called public storm signal (PSS), and classified into three, namely PSS #1, #2, and #3 based mainly on the expected wind speed. They were issued 21 times throughout the period from 22 to 27 November. The warnings were disseminated to all level concerned through the regional Emergency Broadcasting System in every level, the disaster coordinating councils were activated to make preparedness and preventive actions. The councils were advised to continuously monitor the typhoon conditions. In response to the timely warning dissemination, evacuation plans in likely affected areas were put into effect. A total of 7,219 families or 38,517 persons were evacuated. But it is regretful to confirm the death of 228 persons, the 95 persons injured and 102 persons missing.

Based on these experiences, it was determined that there is a necessity to the warning to mitigate the effect of disaster in the future. The first evaluation made was not conclusive due to insufficient data. The evaluation of the warning dissemination will be carried out again through adequate channels using a simple survey format. Because correct understanding of the meaning of the warning is substantial to reduce damages.

3.1.8. Proposals for success of the WD/IE Component in the Philippines

The definition of the public storm signal must be revised if the result of the evaluation concludes so. For instance, the public storm signal should be defined by not only wind speed but also rainfall amount and/or intensity. Wind speed is used for a critical factor for navigation, traffic controls, storm surge prediction and house maintenance. Rainfall amount is closely related to flood and inundation in a big river basin, while rainfall intensity is a key to foresee a local and serious hazard such as a flash flood. According to development of the social system, new factors must be introduced for warning of disasters.

Local informations should be much more taken into considerations for local levels of disaster preparedness. Although the satellite pictures and international communication data are very useful for typhoon fore-casting, a flash flood, a mud flow and a local inundation are strongly affected by a local factor, for instance, rainfall intensity in a limited area. A local phenomenon should be observed by local people. But a problem always arises to an expense. The possibilities were sought in the meeting of the mission for measuring rainfall temporally by a bucket or a metal trash box. An oil can with an orifice was introduced to the meeting to measure rainfall intensity, by collecting rain water from a roof. The definite relation between the intensity of the rainfall and the water level in the can can be calculated by the simple hydraulic formula. Setting an electrode connected to a warning lamp or a buzzer at the definite level in the can, it operates as a flash flood warning machine. Refer to the report entitled "Disaster caused by flash flood" Flash Flood Symposium, Paris 1974, IAHS Publ. No. 112, p.71. It can be made of materials easily obtained. By using this warning machine, a barangay chief can get the information about the disastrous rainfall and take an adequate action for preparedness as soon as possible even if the warning and other information are not transferred from the higher level to the barangay level by accident.

In addition, the flow of information from the lower level to the upper level is deemed very important. As an example, a child can discover a precursory of leakage of water through a levee which eventually might lead to a serious disaster. The information obtained at a barangay level is not only useful for the barangay, especially to forecast a flash flood and a mud flow from a small basin, but also significant to the upper levels responsible for disaster preparedness. Therefore, the warning dissemination and information exchange between all levels should be further stressed.

Several kinds of pamphlets concerning disaster preparedness are distrubuted from OCD, PAGASA, MSSD and others. They are not for high-class people but for local people. Therefore they should be written in local dialects with sufficient numbers of pictures. It is preferable to include what a typhoon is, how to detect a hazardous phenomenon, what people should take with them in the case of evacuation, how to get rid of a risk for evacuation in pamphlets. But explanations must be plain and short.

3.1.9. Disaster Statistics

As for the arrangement of the country report on disaster, namely the statistics on disaster, the Roving Mission made an introduction of an example of the disaster statistics in Japan at the meeting of the Roving Mission, January 12 and explained how to collect the information.

In the Philippines, various kinds of the information on disaster collected at the barangay levels are reported to the Office of Civil Defense (OCD) through the provincial and regional disaster operation centers of the OCD, as being totalized at the provincial and regional levels respectively.

The information on disaster reported to the OCD covers such items as;

(1) Casualties

a) Dead b) Missing c) Injured d) Homeless

(2) Damages

a) Properties b) Roads and Bridges c) Private Buildings
d) Public Buildings e) Public Structures f) Crops
g) Livestocks

(3) Numbers of houses damaged

a) Totally b) Partially

(4) Numbers of victims

(5) Numbers of families affected

(6) Service rendered

a) Medicine b) Foods c) Others ; and

(7) Numbers of barangays affected

The OCD makes the country report on disasters by totalizing various kind of the information from each regional disaster operation center and putting together the information from such organizations as PAGASA, MSSD, MPWH, and PNRC.

The Roving Mission made a few comments as follows;

(1) It is impotatant for the implementation of disaster countermeasures in the future to accumulate the statistics on every disaster.

(2) The annual statistics on disasters should be also arranged by summing up statistics of individual disaster, and

(3) The statistics on disaster should be published and made public.

The OCD is now preparing the country report on disasters in 1981 in order to provide it to the Typhoon Committee Secretariat before the fifteenth session of the Typhoon Committee. Furthermore the Philippines will present the annual country report on disasters to the TCS.

3.2. Malaysia

The Government of Malaysia kindly acted as a host to the Roving Mission. All participants at the meetings in Kuala Lumpur are listed in Annex III. Those at Kota Bharu are listed in Annex IV.

3.2.1. Members of the mission

The members of this Mission were as follows:

(Hydrological Component)

Mr. Sadao Kishimoto	Water Management Officer, River Bureau, Ministry of Construction (MOC)
Mr. Kunio Ichimiya	Chief Telecommunication Engineer, Kinki Regional Construction Bureau, Ministry of Construction
Mr. Minoru Kuriki	Chief of River Planning Section, River Planning Division, River Bureau, Ministry of Construction

(WD/IE Component)

Dr. Takeo Kinosita (Co-ordinator)	Director, First Research Division, National Research Center for Disaster Prevention, Science and Technology Agency
Mr. Nobuyuki Kato (Focal Point for WD/IE Component)	Senior Staff, International Affairs Division, Promotion Bureau, Science and Technology Agency
Mr. Tsuneo Sato	Chief of Service Section, Disaster Prevention Policy Planning Division, National Land Agency

3.2.2. Itinerary

The activities of this Mission in Malaysia were as follows:

Jan. 16 (Sat)		Arrival in Kuala Lumpur
Jan. 18 (Mon)	a.m.	Courtesy call to Drainage and Irrigation Department (DID) and briefing on hydrological observations in Malaysia
	p.m.	Courtesy call to National Security Council (NSC) and briefing on machinery for flood mitigation

Jan. 19	(Tues)		Reports and discussions on the activities of TOPEX in Japan and Malaysia and lectures at DID office. (The programme is listed in Annex V.)
Jan. 20	(Wed)		Field survey of the Kelantan river basin and visit to the state DID, the state office, the workshop of state DID, (See Annex IV), the gauging station at Kuala Krai, river works at Pasir Mas, etc.
Jan. 21	(Thu)	a.m.	Final discussion on Hydrological Component of TOPEX at DID office
		p.m.	Final discussion on WD/IE Component of TOPEX at NSC office
Jan. 22	(Fri)	a.m.	Visit to Kelang Gate dam
		p.m.	Preparation of the interim report
Jan. 23	(Sat)		Leaving

3.2.3. OUTLINE OF HYDROLOGICAL COMPONENT

The contents of the Hydrological Component of TOPEX consist of the evaluation of the established system for flood forecasting and warning, the identification of simple deterministic forecasting models and the evaluation of flood risk.

In order to evaluate the existing system for flood forecasting, the TC Members are to monitor all significant flood events and record them in a standard format.

With regard to the evaluation of flood risk, Japan offers to make a report on flood risk analysis on the basis of reports submitted by the TC Members.

The Kelantan river basin has been selected as the designated river basin of TOPEX, and a detailed description of the river basin has been submitted. The Kelantan river suffered a flood in December 1981 in the downstream. The standard format for evaluation of existing model (Refer to Appendix L of PM-1) is now being prepared for the flood.

3.2.4. KELANTAN RIVER BASIN

The designated river basin, the Kelantan river basin, is located at the north-eastern corner of Peninsular Malaysia and drains an area of 12,867 km^2.

The rainfall in Kelantan is influenced by altitude differences and the highest annual rainfall, about 3,400 mm in average, occurs on the coastal mountain ranges. The average annual rainfall in the basin is about 2,700 mm. The north-easterly monsoon air stream is the main cause of floods.

5 rainfall stations and 4 water-level stations are telemeterized and data are automatically sent to the terminal station through the telemetric network every 6 hours. These data are then transmitted to the Flood Forecasting Center in Kuala Lumpur by telex. The telephone can be used as a back-up system when the telex machine is in a bad condition.

The existing flood forecasting system is operated by the Flood Forecasting Center of the Hydrology Branch at the Headquarters of the Drainage and irrigation Department, Kuala Lumpur, from October 15 to January 15 every year.

Maintenance of the telecommunication facilities is being carried out by the Telecoms Department of the Ministry of Energy, Telecommunications and Posts.

The model being operationally used in the Kelantan river basin is a Sacramento Model and Unit Hydrograph Method. It also uses stage-correlation curves for forecasting water-stages of several sites. According to the changes of water-level, the interval of flood forecast is changed and necessary action is taken.

3.2.5. Proposals for Success of the Hydrological Component

The Roving Mission visited the Flood Forecasting Center at D.I.D. office on January 18. Exactly speaking, the Flood Forecasting Center already closed its annual operation on January 15, and changed to the Hydrological Forecasting Section.

The mission got an explanation about flood forecasting and warning activities on the Kelantan river. The whole system was well organized and the room was well arranged. Data sending formats between the Flood Forecasting Center and the state D.I.D. were fixed. The waterlevel data during the operation period of the FFC were graphed and displayed on the wall. There was also a panel showing the longitudinal cross section of water-levels of large floods on the Kelantan river. It can be used for stage-stage correlation method of flood forecasting.

The Flood Forecasting Center does not forecast rainfall amount. It calculates five kinds of discharge, based on five kinds of assumed rainfall amount. The state D.I.D. office, receiving the results of forecast, decides which kind of rainfall amount is the most suitable one, comparing the assumed rainfall with the actual rain.

In other words, tables showing the relations between rainfall and discharge are made every 6-hours at the FFC considering the existing condition, and the state D.I.D. uses the table.

The mission had an impression that this way of forecast is good, because the time consumed by calculation and sending data can be compensated for the observing time of actual rainfall.

The mission visited the designated river basin, the Kelantan river basin, on January 20. It visited the Kelantan state D.I.D. office, Flood Operation Center and the Kuala Krai gauging station.

At the Flood Operation Center, the mission had a look at telemetering facilities. At that time, the system was generally in good working condition although data were missed in some outstations.

The cause of missing of data is not clear. However, it is presumed that the repeater station was interfered by the VHF signals emitted from other stations (such as Police and Telecoms). Another cause presumed is that outstations were in shortage of power supply caused by the fact that the repeater station was activated by unwanted signals sent to and started the outstations in parallel, placing them in working condition at non-measurement time. In any case, the interfering signal to the repeater station has caused no acquisition of data. It is, therefore, recommendable that band-pass filters which will stop sending unwanted signals are inserted into the nearby VHF stations owned by Police or Telecoms.

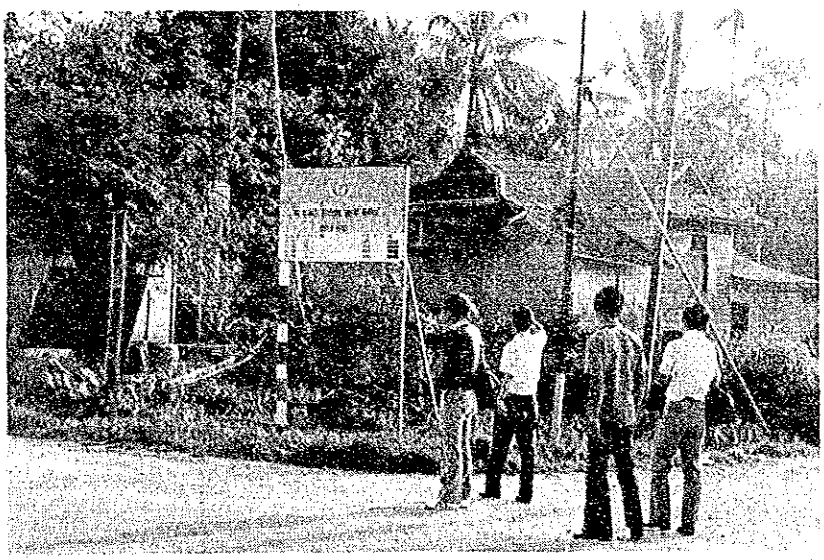

Photo 3. Notice Board in the suburbs of Kota Bharu. The height indicated by black paint corresponds to 105 feet at Kuala Krai Station shown in Photo 4.

The mission had a look at a flood notice board. It shows expected inundation level corresponding with the water-stage at the Kuala Krai station. The water-stage at the Kuala Krai station is broadcasted by radio, and people living downstream know the water-level of the place where the notice boards situate. The mission found that this method is useful as one of flood forecasting methods. If these boards are established densely, flood risk is readily analysed. The mission considered that it should be further promoted to set up the notice boards as many as possible. See Photo 3.

The Kuala Krai gauging station is the key station for flood warning to the people living downstream. The water-stage at the Kuala Krai station is forecasted using stage-correlation between Kuala Krai and Guillemard Bridge, which is a control station of run-off calculation. As Guillemard Bridge is located downstream of the Kuala Krai station, there arises a question why they do not directly calculate the water-stage at the Kuala Krai station using run-off calculation. Generally speaking, the less the procedure is, the more accurate the output of the forecast is. It was found to be very hard to observe discharge at Kuala Krai, because there was no bridge. Therefore the possibility of using the water-stage of Guillemard Bridge to directly forecast water-stage downstream should be considered.

The Kuala Krai gauging station, having been transfered from the old station to several hundred meters downstream about a year before, was well maintained. See Photo 4.

Being based on the aforesaid comments during the period of the survey and the outcome of the discussion with D.I.D. staff members, the Roving Mission submits the following proposals for success of TOPEX in Malaysia.

(1) It is advisable to improve the present model so as to consider the rainfall in the downstream of Guillemard Bridge, or

develop another forecasting system which is applicable for such a rainfall.

The present flood forecasting system cannot be available for the floods caused by rainfall in the lower basin of the Kelantan river. Because, as it is already mentioned, the discharge at Guillemard Bridge is calculated from the average rainfall within the catchment area, the water-stage at the Kuala Krai station is forecasted using stage-correlation between Guillemard Bridge and Kuala Krai, and the water-stage downstream is estimated by the stage-correlation method. In other words, the forecasted water-stages in the downstream are mainly calculated by the upstream ones. The water-stages in the downstream estimated by the upstream ones are less accurate if there is much rainfall in the downstream area.

There was a heavy rainfall in the downstream of the Kelantan river in December 1981. They had a flood downstream. Consequently the flood forecasting system did not work well at that time.

D.I.D. has developed a method for getting tables which show relations between rainfall intensity and water-stage for the Kulang river. This idea can be applied to the downstream of the Kelantan river.

(2) It should be studied whether the value of the average rainfall within the Kelantan river basin represents well the true value or not. Generally speaking, it is very hard to get the true value of the average rainfall within a river basin. It is even said that the average rainfall is useless for accurate run-off calculation, because one must consider the travel time of the flood. In the Kelantan river flood forecasting system, however, the average rainfall is necessary to calculate discharge at Guillemard Bridge. The value should give proper forecast of discharge.

At present, the average rainfall within the catchment area upstream of the Guillemard Bridge (11,900 Km^2) is calculated by using the data of 5 telemetering rainfall stations, while there are 53 rainfall stations in the whole of the Kelantan river basin. It should be carefully investigated whether any deviation can be found or not between the average rainfall observed by telemetering rainfall stations and that obtained by all stations including non-telemetering rainfall stations.

(3) For the purpose of keeping the telemetering system in good working condition for a long period , the maintenance and check is considered the most important. Therefore, more studies should be made on the period of cycle of maintenance and check, securing of well-trained expert and check sheet.

In checking the system, not only data acquisition but also comparison of measured values with standard specifications should be done as well as confirmation of supervisory information.

A precise periodical check of the system should be done once a year at least. The maintenance personnel should be trained periodically for technical level-up, taking personnel changes in consideration.

It seems there exist damages by lightning. At present the countermeasure for an induced lightning is not necessarily perfect. Those outstations having no facilities for lightning protection should be provided with a coaxial arrester in the antenna line, an anti-lightning transformer in the commercial power line and a surge absorber in the solar cell line, though the water level meter lines are already provided with lightning protection devices.

It is understood that the present system is maintained by Telecoms except the sensors and power facilities. DID should have closer relation to the services of Telecoms.

3.2.6. ORGANIZATIONS RELATED TO WARNING DISSEMINATION AND INFORMATION EXCHANGE IN MALAYSIA

Organizations related to warning dissemination and information exchange are mainly as follows:

(1) National Security Council (NSC)
(2) Drainage and Irrigation Department (DID), Ministry of Agriculture
(3) Malaysian Meteorological Services (MMS)
(4) Ministry of Information
(5) Ministry of Transport
(6) Ministry of Welfare Services
(7) Ministry of Trade and Industry
(8) Ministry of Defence

Photo 4. Kuala Krai (old) Station.
Mr. Song shows the staff gauge of 105 feet of water level.
It is the key station for the flood forecasting in the lower Kelantan Basin.

(9) Royal Malaysia Police

(10) Civil Defence Corps

(11) Ministry of Health

(12) Malaysian Red Cresent Society (MRCS)

Malaysia is divided into 13 States and a Federal Territory. Each state is divided into a number of districts. The National Disaster Relief Organization operates through a committee system set up by the National Security Council (NSC), each at Federal , State and District levels.

(1) The National Security Council (NSC) has established the Malaysian National Disaster Relief Committee (MNDRC) consisting of the following:

The Minister of Information - Chairman.

Duputy Minister of Communication.

Deputy Minister of Finance.

Chief Secretary to the Government.

Chief of Armed Forces Staff.

Inspector-General of Police.

Secretary to the National Security Council.

The function of MNDRC is to coordinate the preparation of flood relief measures at the federal level.

(2) State level

The State Executive Security Committee has established the State Disaster Relief Committee (SDRC) consisting of the following:

The State Secretary - Chairman.

The Chief Police Officer.

The Brigade Commander.

The Director of Drainage and Irrigation.

The Director of Welfare Services.

The Director of Medical and Health Services.

Secretary to the State Security Executive Committee.

Other coopted members such as representatives from the Malaysian Red Cresent Society, Youth Organization, St. Johns Ambulance and Civil Defence.

The function of the SDRC is to coordiante the preparation of flood relief measures at State level.

(3) District level

The District Executive Security Committee has established the District Disaster Relief Committee (DDRC) consisting of the following:

The District Officer - Chairman.

The Officer-in-Charge of Police District.

The local military representative.

The District Engineer.

The District Medical and Health Officer.

The District Welfare Officer.

Other coopted member such as the representatives from the Malaysian Red Cresent Society, St. Johns Ambulance, Youth Organization, and local Civil Defence Corps.

The function of the DDRC is to make preparation for relief operations and rehabilitation covering the following:

i. establishment of communication system.

ii. preparation and establishment of evacuation centre.

iii. record of flood prone areas.

iv. record of all rivers and its water levels.

v. establishment of Supply Centres and forward bases.

vi. establishment of flood warning system, and

vii. evacuation teams and transportation.

The National Security Council, State Security Executive Committee and District Security Executive Committee has established Disaster Relief Control Centres at the Federal, State and District level respectively to coordinate and provide immediate relief to flood victims. The functions of these control centres are:

i. to rescue, assess, coordinate, approve and provide request for immediate relief, and

ii. to monitor and maintain an up-to-date records of the flood situation for purpose of dissimination to the public and mass media.

If a disaster occurs in one district, information on the disaster at District level is relayed to the State level and further up to the Federal level. The Federal Control Centre receives weather forecasts directly from the Malaysian Meteorological Services. Water-stages are sent to the District or State Control Centres by the Drainage and Irrigation Departments at each level. This information is also transmitted to the Federal Control Centre. The National Security Council, headed by the Prime Minister, becomes active when disaster occurs in two more states.

The role and duties of Ministries and organizations are as follows.

i. The Meteorological Services Department is responsible for the forecasting of weather and issue of warnings of heavy rainfall to the National Security Council Secretariat and the Drainage and Irrigation Department.

ii. The Drainage and Irrigation Department (DID) is responsible for the real-time monitoring of rainfall and water levels in rivers during the monsoon months and the forecasting of impending river floods. River flood forecasts prepared by DID are disseminated to the National State and District Natural Disaster Control Centres for warning and relief operations.

iii. The Ministry of Welfare Services is responsible for the coordination and administration of evacuation centres, the preparetion for distribution of food, clothing and other supplies and rehabilitation of flood victims with the support of the Malaysian Red Cresent Society, St. John Ambulance and youth organization.

iv. The Ministry of Commerce and Industry with the cooperation of the National Rice and Padi Board are responsible for the distributing and storing of essential food supplies in various flood prone areas.

v. The Ministry of Defence, the Police and the Civil Defence Corps are responsible for the evacuation of flood victims, water, land and air transportation and the maintainance of communication network.

vi. The Ministry of Health provides the supplies and distribution of emergency stock of drugs, vaccines, and medicine and performs preventive and curative medical and health services.

vii. The Malaysia Red Crescent Society acts as one of the most important organizations of disaster preparedness programmes with the spirit of the Geneve Conventions, and provides the disaster victims with relief and assistance.

3.2.7. PUBLIC UNDERSTANDING OF THE FLOOD SITUATION

One of the most notable feature for flood warning dissemination in the Kelantan river basin is a notice board showing the flood level. The flood forecasting in the river is mainly carried out by the Drainage and Irrigation Department. The information on flood water level at Kuala Krai is broadcasted to the public. Generally it is very difficult for the public to know the future water level surrounding their houses by the forecasted water level at Kuala Krai. The notice board is painted with four colours which correspond to the four kinds of water level at Kuala Krai, namely, 75 ft, 85 ft, 95 ft and 105 ft. Therefore, the public can easily know the water level around them by referring to the notice board after listening to the forecast announcements through the mass media. There are 10 notice boards in Kota Bharu and 5 in the rural area. As this idea seems very excellent, it is preferable that more notice boards are set up especially in the rural area in the basin. In addition, the significance of the boards must be widely make known to the people through school education and community education. See Photos 3 and 4.

The records of the past floods vividly teach us the vulnerability of the floods. The records in this context include not only hydrological ones but also photographs, floods marks and verbal evidences by the aged. In a certain coffee shop in Kuala Krai, there are two photographs attached to the wall showing the serious situation of this town during the flood period of 1967. The responsible agency must make duplications of these photographs to distribute them to the flood preparedness staffs. When a flood occurs in the future, flood marks should be traced on walls of the buildings, electric poles and other convenient places with the flood date, immediately after the flood. They will be meaningful indices for the people and also useful to analyze the flood from the hydrological and hydraulical viewpoints.

When the aged give their knowledge about past floods, the knowledge must be memorized as important information for the community. It is sometimes possible to follow up the damages of the floods fifty or sixty years ago by verbal evidences.

The drills for flood fighting and evacuation must be considered. They are closely related to the local conditions and the social customs. Therefore the drills must be organized on a local basis. The real actions filling up the warning formats must be exercised at the time of the drills. Sandbags must actually be prepared for piling up at the adequate site by the flood fighting unit at the time of the drills. Volunteers must be called to join the drills.

A flash flood must be considered, even if it is not serious today. According to social development, a flash flood is apt to occur everywhere, especially in a developed basin and a deforestated basin. The time of concentration becomes short and the coefficient of run-off increases in such cases. Hence forecasting of the water-stage or the discharge is difficult and the frequency of floods increases. Moreover the warning in such cases should be disseminated promptly. The table containing all possible combination of rainfall distributions and the discharge for flash floods in the Kelang River is already prepared in Malaysia. It is useful for flash flood warning. Profound attention should be paid to the method of disseminating the warning to the public according to future development.

3.2.8. Disaster Statistics

Disaster statistics on the flood in 1981 are being prepared by the Malaysian Government based on the conclusion in the 14th session of the Typhoon Committee, because the flood season in Malaysia comes to an end in the middle of January.

Information exchange and discussion on disaster statistics were carried out between the staffs of the Malaysian Government and the Roving Mission. A short history of the report on the disaster statistics as one of the activities of the TC and the procedures and systems on making report were introduced by using the textbook and other examples.

As the Malaysian Government has just started to arrange the statistics on disasters, the mission made some comments;

(1) It is important for the implementation of disaster countermeasures in the future to accumulate the statistics on every disaster.

(2) It is necessary to determine the responsible agencies and the the flow of the procedure of statistics;

(3) The formats for collection of statistics should be confirmed by trial and error through the TOPEX activities;

(4) Sufficient information should be covered in the items of the statistics for future assessment;

(5) The annual statistics on disasters should be also arranged by summing up statistics of individual flood occurrence; and

(6) The statistics on disaster should be published and made public.

3.3. The Republic of Korea

The Government of the Republic of Korea kindly acted as a host to the Roving Mission. All participants of the Republic of Korea are listed in Annex VI.

3.3.1. Members of the mission

The members of this mission were as follows;

(Hydrological Component)

Takeshi Kobayashi	Director, Ina River Work Office, Kinki Regional Construction Bureau, Ministry of Construction,
Kotaro Takemura (Focal point of Hydrological Component)	Deputy Director, River Planning Division, River Bureau, Ministry of Construction,
Katsuhide Yoshikawa	Research Engineer, Flood Disaster Prevention Division, River Department, Public Works Research Institute, Ministry of Construction,

(WD/IE Component)

Ichiro Watanabe (Co-ordinater)	Director, the Fourth Research Division, National Research Center for Disaster Prevention, Science and Technology Agency,
Hiromu Moriwaki	Researcher, Rainfall Disaster Laboratory, the Third Research Division, National Research Center for Disaster Prevention, Science and Technology Agency,
Yoshihiro Ishida	Chief of Communication Section, Disaster Prevention Policy Planning Division, National Land Agency

3.3.2. Itinerary

The activities of this mission in the Republic of Korea were as follows;

Jan. 31 (Sun.)	Arrival in Seoul.
Feb. 1 (Mon.)	Group meeting at Bureau of Water Resources, Ministry of Construction, to finalize the mission's schedule in the Republic of Korea.
Feb. 2 (Tue.)	Report on the activities of TOPEX in Japan in 1981, lectures and discussions at Han River Flood Control Office. (The program is in Annex VII). See Photo 5.
Feb. 3 (Wed.)	Field survey on the Han River Basin visiting Gang Weon Do Construction Office and Soyang-Gang Multi-Purpose Dam Office.
Feb. 4 (Thr.)	Presentations of the flood disasters of the Ishikari River by the Typhoon No.12 in 1981, TOPEX activities in the Republic of Korea, and discussion both of them.
Feb. 5 (Fri.)	Presentation of the interim report at Bureau of Water Resources, Ministry of Construction.
Feb. 6 (Sat.)	Leaving.

3.3.3. The Han River Basin

The Han River Basin is located in the central part of the Korean Peninsla. It has a drainage area of 26,219 km^2, and is about one fourth of the whole teritory of the Republic of Korea.

The total length of the river is 482 km from its source in the northeastern part of the basin in the Taebeak Range to the river mouth at the Yellow Sea.

The climate of the basin is characterized by moderately cold, dry winter and hot humid summer.

Average annual rainfall ranges from 800 mm in the upstream area of the southern part to 1,300 mm in the downstream area, and the average is 1,230 mm. About 70% of the annual rainfall concentrates in the period from June to September. The average annual runoff amount is 20,910 million cubic meters out of annual rainfall of 32,280 million cubic meters.

The Han River Flood Forecasting System is as follows;

(a) Rainfall gauging stations: 38,

(b) Water level gauging stations: 17,

(c) Discharge gauging stations: 6,

(d) Control station: Han River Flood Control Office,

(e) Warning stations: 5 (Yangwha, Indogyo, Tukto, Kwangjang, Yeoju),

(f) Method of forecasting: storage function model.

The flood forecasing method is described as follows; By feeding the rainfall data and later observed ones as input to sub-watershed models, a flood hydrograph is generated at each sub-watershed, the whole basin is divided into 30 sub-watersheds, and a flood in the river channel is routed to the forecating stations. The storage function model is adopted for both sub-watershed and river channel models. Reservoir operations for flood control are also included in the forecasting procedure, since the Soyang-Gang Dam and Huacheon Dam have the exclusive capacities for the flood control and the others also influence the flood.

3.3.4. Hydrological Component in the Republic of Korea

The main activity of the Hydrological Component is the evaluation of existing flood forecasting systems in designated basins. It consists of the followings;

(1) A detailed description of the existing forecasting system in a standard format.

(2) The operation and performance (success or failure) of each of the sub-systems will be monitored in real-time basis for all significant flood events. Records for each event should be kept in a standard format. Particular emphasis should be placed on the period 1st August to 15th October of each year.

(3) Any problems encountered may be overcome by national experts, either independently or in consultation with the TCS and other sources of external advice before the start of the next wet season.

In the Republic of Korea, investigations of flood forecasting were for 6 flood events from 1980 through 1981 in the Han River Basin. The computer of the Han River Flood Control Office for flood forecasting has been newly established for improving the capacity.

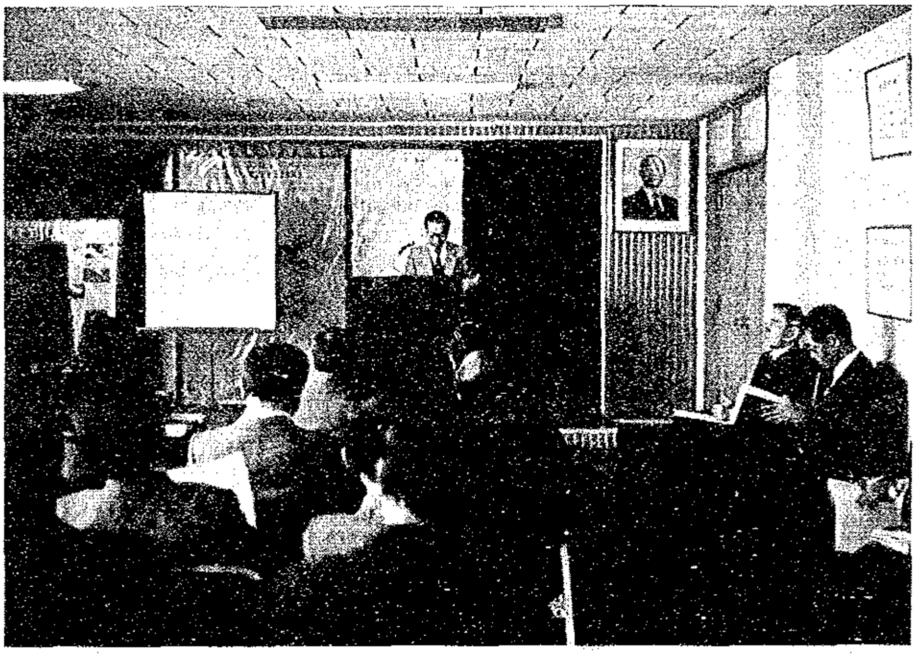

Photo 5. Meeting at the Han River Flood Control Office.

3.3.5. Suggestions for Success in the Hydrological Component in the Republic of Korea

The members of the mission obtained the explanations of the Han River Flood Forecasting System in the morning on 2nd February. They also discussed with officers concerned about the flood forecasting system in the afternoon on 2nd and 4th February.

Taking account for these information exchanges, the mission would suggest for the Government of the Republic of Korea as follows;

(1) Storage function method, which has been adopted to the Han River Flood Forecasting System by the Han river Flood Control Office, is regarded to be the most reliable one as the calculation model of the Han River.

(2) The following endevours are proposed for improving the simulation accuracy of the present model;

a) To modify and up-date the coefficients and constants in the storage function model by using newly collected flood data.

b) To increase the number of rainfall observation stations in the Han River Basin, and to establish water level gauging stations for estimating the runoff discharges from major tributaries downstream from the Ui-Am Dam in the North Han River and the Chungju Dam in the South Han River.

c) To make accurate rating curves of the discharge to water stage at main checking stations of the forecasting model.

(3) It may be also be desired that the stage-stage correlation models are used in order to assist the present flood forecasting model.

3.3.6. WD/IE Component in the Republic of Korea

(1) The Central Disaster Prevention Headquarters has the Minister of Construction as its the Controller of Headquaters and the Vice Ministers of Home Affairs and of Construction act as Vice controller of Headquaters. This Headquaters is assembled when a disaster occurred or is in danger of occurrence, and this is responsible for coordinating the various activities in case of emergency time. The Coordinating officers, who are the Director General and the Disaster prevention officer, Bureau of Water Resources, supervise various sections in Headquaters. There are 10 sections.

(2) The Local. Disaster Prevention Headquaters correspond at local level to the Central Headquaters are organized and function on similar lines but are involved in a more precise manner. The Controller of a local Headquaters is the Governor of Provincial Government.

(3) In addition to the Disaster Prevention Headquaters, a Flood Prevention Corps has been established in each local government. The corps are responsible for placing guards on levees, etc. and take emergency action and relief.

(4) Flood forecasts and warnings are issued by the Central Disaster Preparedness Center in the Central Disaster Prevention Headquaters, and disseminated to various agencies concerned, the Local Disaster Preparedness Offices, mass media, Korea Electricity Corporation and the Han River Flood Control Office. The Han River Flood Control Office is responsible for disseminating to the inhabitant near the Han River Basin through 5 warning stations.

(5) The general public will receive flood forecasts and warnings by various channels such as mass media, 5 warning stations, the local Disaster Preparedness Offices, etc. In these channels, mass media are most faster and stronger.

(6) In order to prevent flood damage, all preventions required by the law are completed before the wet season starts. For example, the Central and Local Disaster Prevention Headquaters are activated by the beginning of March each year, and communicating facilities are checked.

(7) Actions are also taken to improve public awareness of the danger. For example, a pamplet is published by the Ministry of Construction. This shows how to preserve the river circumstances, what is the purpose of dams, levees, etc.

(8) In 1980 and 1981, 8 floods cautions for 6 floods are disseminated to the general public. In these disseminations, there is not so big problem. And there is no loss of life and damage.

3.3.7. Suggestions for Success of the WD/IE Component in the Republic of Korea

The matters related to the WD/IE Component such as the existing legislation, activities of the Flood Prevention Corps, etc. are quite comprehensive in the Republic of Korea. For example, the system of the display boards in the Central Disaster Preparedness Center is designed so well that the content of the display will be able to be changed easily. Hence, only three suggestions are mentioned by the Roving Mission.

(a) A pamphlet mentioned in (7) of 6 in this repert is oriented mainly to the local government officials. It is suggested that other pamphlets oriented to the general public are produced and distributed to the general public through the local governments.

(b) " How much time is required for disseminating information to officials in the lowest level, for example, the officials in the village government" is very important, especially for quick mobilization for emergency actions. It is suggested that each organ will record the arrival time of the information and will report to the Central Disaster Preparedness Center. If these data are accumulated, some hints will be able to get from these data in order to improve the existing warning dissemination system.

(c) Past experience on disasters is very informative and suggestive for disaster preparedness. It is suggested that various old documents on disasters will be collected and analyzed.

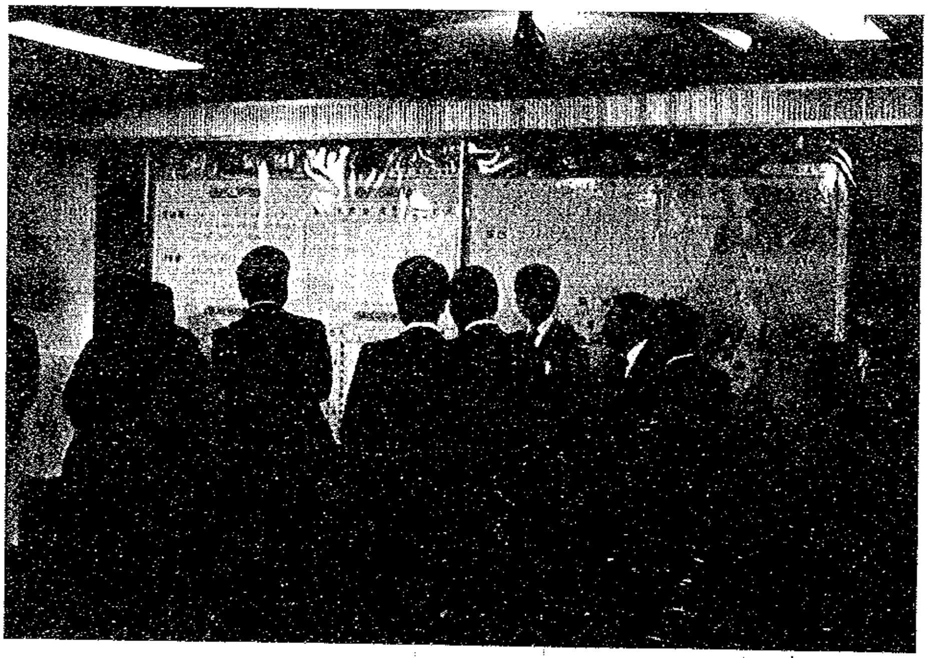

Photo 6. Discussion at the Central Disaster Control Center.

3.3.8. Disaster Statistics

The Roving Mission introduced the Japanese proposal on disaster statistics written in Chapter 2.2 and also explained the form of disaster statistics in Japan.

In the Republic of Korea, the Korean Association of Hydrological Sciences, has already collected the information of damage extensively and minutely in 1980 and reported to the Ministry of Construction.

The report includes the following contents;

general introduction

abstract of the meteorological and hydrological aspect

damage by typhoon and flood

activities of the disaster countermeasure center

disaster analyses and eternal disaster prevention planning

disaster prevention of foreign countries

annual report of disaster statistics

The Roving Mission appreciated the efforts on continuing these activities for evaluating the present situation on the disaster preparedness and promoting the disaster prevention policy, and expressed it was desirable and instructive that the Republic of Korea would send these data in a suitable form to the TCS for the Members of the TC.

3.4. Thailand

The Government of Thailand kindly acted as a host to the Roving Mission. The names of all participants are listed in Annex VIII.

3.4.1. Members of the Mission

The members of this mission were as follows;

(Hydrological Component)

Takeshi Kobayshi	Director, Ina River Work Office, Kinki Regional Construction Bureau. Ministry of Construction,
Kotaro Takemura (Focal point of Hydrological Component)	Deputy Director, River Planning Division, River Bureau, Ministry of Construction,

(WD/IE Component)

Ichiro Watanabe (Co-ordinator)	Director, the Fourth Research Division, National Research Center for Disaster Prevention, Science and Technology Agency,
Hiromu Moriwaki	Researcher, Rainfall Disaster Laboratory, the Third Research Division, National Research Center for Disaster Prevention, Science and Technology Agency,
Yoshihiro Ishida	Chief of Communication Section, Disaster Prevention policy Planning Division, National Land Agency

3.4.2. Itinerary

The activities of this mission in Thailand were as follows;

Feb. 6 (Sat.)	Arrival in Bangkok
Feb. 9 (Tue.)	Courtesy call on Director-General of ESC Bangkok, Meteorological Department, Ministry of Communication. Group meeting at the Meteorological Department to finalize the mission's schedule in Thailand. Report and lectures on the activities of TOPEX in Japan in 1981. (The program is in Annex IX) See Photo 8.
Feb. 10 (Wed.)	Hydrological Component Field survey on the Pasak River Basin visiting Klong Prieo Head Work Office, the Royal Irrigation Department. WD/IE Component Visit the Civil Defence Division, Local Administration Department and the Telecommunication Division, Ministry of Interior.
Feb. 11 (Thr.)	Final Discussion. Courtesy Call on ESCAP. Making the interim report.
Feb. 12 (Fri.)	Presentation of the interim report at the Meteorological Department, Ministry of Communication.
Feb. 13 (Sat.)	Leaving.

3.4.3. The Pasak River Basin

The Pasak River Basin is located in the center of upper Thailand at latitudes between 14°21'N. and 17°15'N., and longitudes between 100°35'E. and 101°30'E. The Pasak River with a length of about 720 km is one of the Chao Phraya River's tributaries joining at the Ayuttaya Province, about 100 km from the river mouth of the Chao Phraya, where Bangkok is located. The river basin has a banana shape and drains an area of about 16,120 km^2 from the eastern slope of the Phetchabun mountain range and the western slope of Khorat Marginal mountain range into the central plain.

The climate in the basin is somewhat like that of the country which is under the influence of the northeast and southwest monsoon wind regime. There is much rainfall during the southwest monsoon season. Atmospheric disturbances in the form of depressions, which are originated in the West Pacific Ocean and the South China Sea, usually affect upper Thailand including the Pasak River Basin during July to October. Flooding caused by the depression superimposed on normal storm rainfall usually occurs in the lower reaches of the Pasak River Basin. Such cases occurred in 1964, 1978 and 1980 which resulted in severe damage to rice crop and other public facilities such as roads and highways.

In 1978, continuous rains were observed at upper basin stations during 23-27 September and intense rainfall due to depression during 27-29 September produced surplus runoff. The maximum discharge of 3,200 m^3/sec at Kaeng Khoi station was about 3 times greater than normal peak flow. Farmlands in lower flood plain were flooded as long as weeks.

In 1980, two depressions during 6-7 September and 17 September, respectively, and the persistence of active monsoonal trough during September and early October caused excessive rainfall. More than 1,000,000 persons were affected by this flood. And total damage was estimated at around 0.7 billion baht. The number of people living in the Pasak River Basin is expected to be about 1,000,000 by the end of 1980.

The Pasak River has not significant flood control facilities except a few irrigation diversion, etc.

The Pasak River flood forecasting system is as follows;

The system consists of 27 hydrological stations and 21 rainfall observation stations. Those stations are operated by the Meteorological Department and the Royal Irrigation Department. At Present, the forecasting is not done systematically, but done by experiences.

3.4.4. Hydrological Component in Thailand

Generally speaking, the main activity of the Hydrological Component is the evaluation of existing flood forecating systems in designated basins. It consists of the following;

(1) A detailed description of the existing forecasting system in a standard format.

(2) The operation and performance (success or failure) of each of the sub-systems will be monitored in real-time basis for all significant flood events. Records for each event should be kept in a standard format. Particular emphasis should be placed on the period 1st August to 15th October of each year.

(3) Any problems encounterd may be overcome by national experts, either indepedently or in consultation with the TCS and other sources of external advice before the start of the next wet season.

As for the activities of the flood forecasting and warning in Thailand, the Meteorological Department has selected 6 rainfall and 5 water level stations, Lom Sak, Phetchabun, Nong Phai, Wichian Buri, Bua Chum and Chai Badan, for the purpose of the flood forecasting. The Ban Muang Nua and/or Kaeng Khoi were adopted as the control points for the flood forecasting in the Pasak River Basin.

But the period of above-mentioned observation is not so long enough to forecast floods, then the real-time operational flood forecasting is not yet initiated. It is in the stage to collect the meteorological and hydrological data and prepare a system of the flood forecasting.

The annual reports of the meteorological and hydrological data are made by the Meteorological Department and the Royal Irrigation Department. The exchanging of the meteorological and hydrological data is carried out very well by both Departments. After many meteorological and hydrological data at the 6 selected points will be accumulated and compiled, it is expected that a useful flood forecasting and warning system will be established in near future.

3.4.5. Proposals for Success of the Hydrological Component in Thailand

The members of the mission obtained the explanations of flood related activities in the Pasak River from officers concerned in the afternoon on 9th February and discussed with them on the flood forecasting system in the morning on 11th February. Two hydrologists of the mission had a field trip to the lower part of the Pasak River on 10th February.

Taking account for the information exchanges and the field trip, the mission would suggest for the Government of Thailand as follows;

(1) On the hydrological observation

It is necessary to accumulate exact hydrological data in order to establish the flood forecasting system. Regarding the water level gauging, observations using staff gauge should be also carried out during flood periods for self-recording stations in order to check the self-recorded data.

(2) On the Flood Forecasting System

Characteristics of the Pask River may be summarized from a hydrological aspect as follows;

(a) The basin shape is long and narrow.

(b) Sediment yield is scarce and the change in river bed height is not so rapid.

(c) There is no large natural retarding areas, and reservoirs in the middle and upper reaches.

Being based on these characteristics of the Pasak River, a stage-stage correlation model is proposed to be the most reliable and effective one for the flood forecasting of the Pask River. This model can be made using all available water stage data both for the upstream and downstream stations. As well as the lower reaches of the Pasak River are concerned, the effect of the Chao Phraya River should be taken account of in the model.

The stage-stage correlation model will also be usefull as a back-up system for any flood-routing model which will be newly adopted in the future.

As well as the future model is concerned, for example, a Muskingum model, a storage function model and a unsteady open channel flow model are proposed.

3.4.6. WD/IE Component in Thailand

(1) A Civil Defence Act was enacted and promulgated in Thailand in 1979. This Act allocates the Civil Defence Secretariat (Local Administration Department) to make two principal civil defence plans which relate to public disaster: Public Disaster Prevention and Relief Plan, and the Evacuation of the people and of Government Facilities Plans. These plans were then submitted to the National Civil Defence Committee (NCDC) for approval. When the Plans were approved by the NCDC, they were then announced to be used as national plans.

(2) The National Civil Defence Committee (NCDC) consists of the Minister of Interior as the Chairman, Under-Secretary of state for Interior as the Vice-Chairman, and representatives from various organizations concerned, such as Ministry of Defence, Agriculture, Public Health, Communications, and Director-General of Local Administration Department of Ministry of Interior being as the Secretary of Committee.

The NCDC has the following authority:

(a) determine Civil Defence Policy,

(b) make principle plan for Civil Defence,

(c) determine methods of inspection, follow up, evaluation according to the Civil Defence Plan including civil training,

(d) make procedures for retaliation, compensation and other expences in the matter of Civil Defence,

(e) consider and determine other activities concerning Civil Defence.

(3) The Civil Defence Division (CDD) in Local Administration Department is responsible for planning of the disaster prevention, disseminating the warning to the Local Government and other agencies and people whose duties concern in disaster prevention and preparedness, and giving information and knowledge to the general public.

(4) The Meteorological Department has the responsibility of the warning dissemination by conveying the news through telephone and printed announcements to different government agencies such as Local Administration Department (LAD) ,Public Relation

Department, Thai Red Cross Society, etc. In case of severe storms, the Meteorological Department will make its warning dissemination immediately to the people by making special announcements through televisions,radios, and newspapers.

Then the Meteorological Department will let the Local Administration Department (Civil Defence Secretariat) know about the coming of the severe weather and the area to be affected.

The Local Administration Deparment will immediately convey the warning to the provinces which are in the areas to be affected. This announcements from the Local Administration Department can be made through radio, telephone, telex, hot line telephone in the Telecommunication Division. See Photo 7.

The provincial authorities will then send orders to the districts, municipalities, etc. through radios, telephones, or printed announcements.

The method of public warning in districts or municipality level is divided into two areas. Firstly, in the communities, the officials announce public warnings three times a day through local radio stations. Secondly, in remote areas, the districts convey order through the tambol (Commune) radio stations to all tambol which are located in the area. The head of tambol should announce the news to the heads of villages. The heads of villages will announce the news to the villagers, by beating gongs, drums, and bells.

(5) Test exercises are held in the regional and local levels in order to determine the problems and difficulties that may encounter as well as solving the problems, while the Local Administration Department (Civil Defence Secretariat) is the coordinating body to follow, evaluate and support accordingly.

(6) The government has set up the Civil Defence Volunteers to help the authorities in the disaster prevention and relief against a disaster which is caused by nature or man. These volunteers are recruited from local residents. They are well trained (3,800 persons/year) in giving support to civil defence personnels. At present, there are over 600,000 volunteers.

(7) Thailand was affected by three depressions during the period 5 July to 20 August 1981. Warnings were disseminated during 5-7 July (5 times), 10-12 August (2 times) and 18-20 August (6 times). Warnings of possible flooding caused by these depressions were disseminated to the public through television, radio, newspaper, as well as the Local Administration Department. They were intended for local preparedness and flood prevention.

(8) As warning disseminstion and information exchange is mainly the responsibility of the Local Administration Department, a new focal point for this Component was designated in the Civil Defence Division.

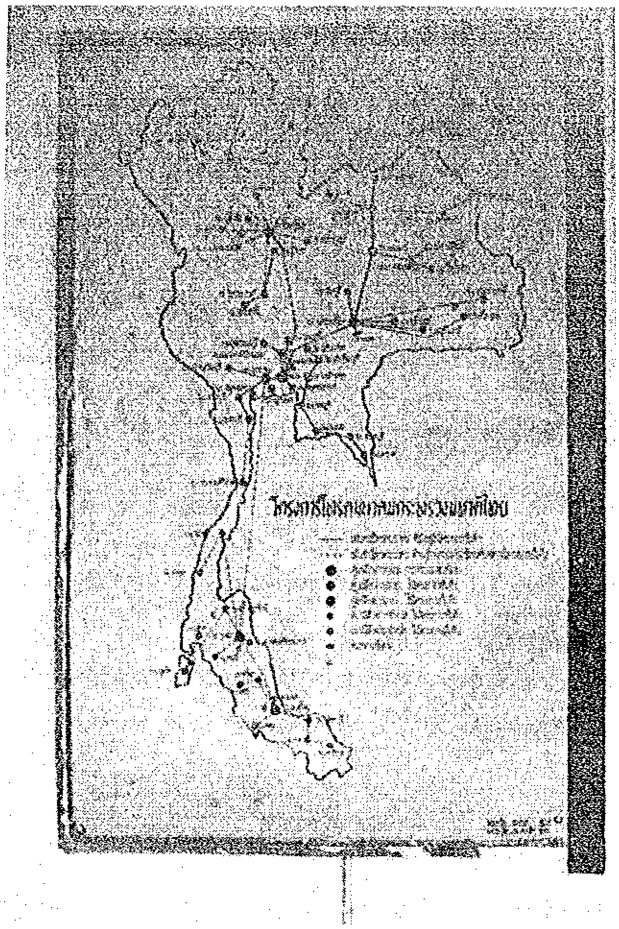

Photo 7. Map showing communications network in Thailand.

3.4.7. Suggestions for Success of the WD/IE Component in Thailand

The members of the Roving Mission heard the explanations of the WD/IE system in Thailand in the morning of 10th Feb. They also discussed with officers concerned on the WD/IE system in Thailand in the morning of 11th Feb.

Three suggestions given from these information exchanges are mentioned by the Roving Mission.

(a) It is very important that the public knows following information; how many times per 10 years the water level will reaches this line or that, in what conditions these situations will happen, how to cope with against floods, etc. It is suggested that a pamphlet which describes above-mentiond knowledge with simple words and understandable illustrations is produced and distributed to the general public through the local governments。

(b) Past experience on disasters is very informative and suggestive for disaster preparedness. It is suggested that various data related to disaster, especially various old documents, will be systematically collected and analyzed.

(c) In emergency time, the communications among various agencies will be substantially required. It is suggested that the communicating capability among various agencies, especially in town or village level, are strengthened. It is hoped that various agencies can use exclusively this comminicating facilities.

3.4.8. Disaster Statistics

The Roving Mission introduced the Japanese proposal on disaster statistics written in Chapter 2.2 and also explained the form of disaster statistics in Japan.

In Thailand, Local Administration Department (LAD) collects the following information from every province monthly;

number of fire, lost value, number of dead and injured persons by fires.

lost value, number of dead and injured persons by cyclones

lost value, number of dead and injured persons by floods

The Roving Mission expresses the hope that LAD would continue this institution and try to make the data form and content more applicable to the analyses of causality of disaster and transition according to the change of social and economic activities, because these analyses are necessary to evaluate the present situation on the disaster preparedness and to promote the disaster prevention policy.

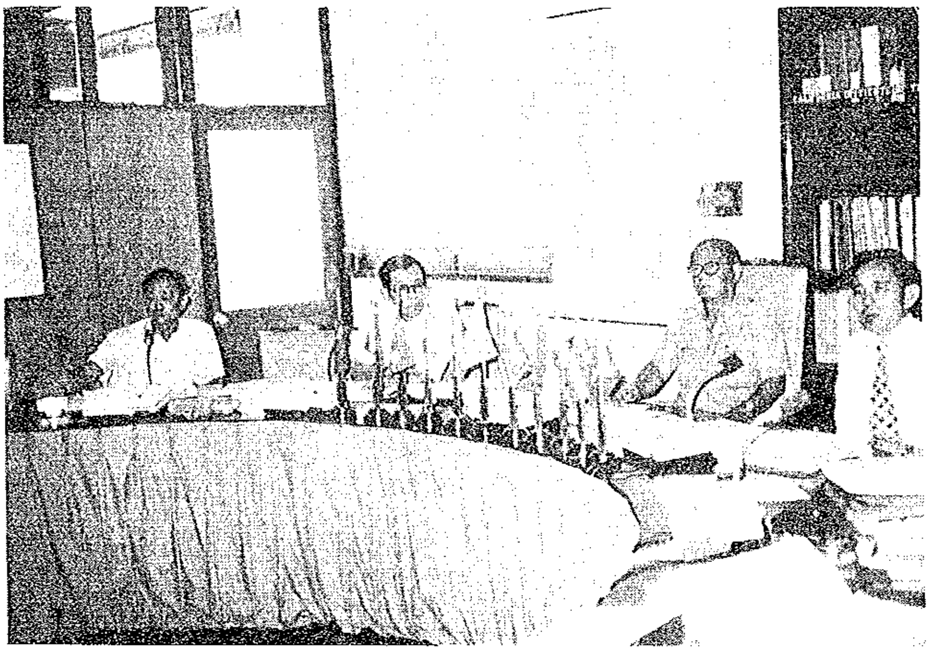

Photo 8. Meeting at the Meteorological Department.

4. General Conclusion

The Roving Mission had significant discussions about the topics of Hydrological and WD/IE Components of TOPEX. Most of them are reported in Chapter 3. Country Report. It seems also necessary to summarize them for the convenience of all experts of Hydrological and WD/IE Components of TC Members in order to promote the Experiment. All useful ideas and suggestive hints commonly applicable to other Members are extracted from the country reports. They are reproduced in this chapter. The mission is very happy if any idea or any hint can be available to mitigate flood damages for better implementations of TOPEX.

4.1. Hydrological Component.

4.1.1. Observation Station

Concerning hydrological observations, the first priority is given to how to get data without missing even if they are less accurate. Data must be acquired continuously for their wide utilities and urgent needs of both operational and statistical purposes. If any data are missed, they can never be observed again.

Careful attentions should be paid to location of a gauging site and a method of installation. In the case of the float type water gauge, a stilling well should have sufficient height and depth to allow the float to rise and fall over the full range of the river level. The recorder should be placed higher than the expected highest flood level and be protected against weathering and interference by unauthorized men. The bottom of the well and the intake pipe must be set below the lowest river level, considering future degradation of the river bed. But a blockage by sedimentation in and around the intake pipe should be perfectly removed.

In order to keep an observation system well, continual maintenance is essential. It should be borne in mind that any system never works without adequate maintenance, consequently the proper amount of budget and well-trained experts should be allocated to the maintenance of the system.

4.1.2 Runoff Calculation

Rating curves should be established at the gauging sites where the discharge data are necessary for calculation and verification of the flood forecasting.

What one wants to know is water-level at a certain site. The model parameters have to be determined compared with observed values. Therefore the establishment of rating curves, which are determined by observed discharge, are indispensable for correct forecasting.

The sites for discharge observation should be chosen at such places where overflow from embankment or river course would occur as rare as possible. Because the rating curve cannot be got if overflow occurs.

The alternative method, such as a stage-stage correlation method and a rainfall-stage correlation method should be developed as a back-up system when the data are missed or the model does not work well.

One of the best proceduresof stage-stage correlation method is described in Annex X.

4.1.3 Telemetering system

A telemetering equipment is damaged if directly given abnormal high voltage as it employs low voltage electronic circuits. Therefore, it is necessary to suppress the induced current at minimum. The damage due to an induced lightning can be greatly minimized by insertion of a lightning arrester and a good earthing method. A coaxial lightning arrester should be inserted into the antenna line and a protector in to the signal cable. If the signal cable is very long, it should be set under the ground.

In case that the system fails, efforts to immediate restoration should be taken. Therefore, necessary spare parts should be stocked to be supplemented as may be required.

In order to keep the telemetering system in good condition for a long period of time, appropriate attention should be paid to the hardware and to the operational aspect, namely the software as well. As the telemetering system is composed of electronic parts, special attention should be paid to ambient temperature, humidity and other environmental conditions. The most important thing for keeping the system in good working condition all the time is to carry out daily maintenances and checks. For this purpose, the determination of the period of cycle of such services, securing of maintenance personnel and arrangement of check sheet are requisite. A precise periodical check is required once a year at least. The maintenance personnel should be trained periodically for technical level-up purposes in consideration of personnel changes.

4.2. WD/IE Component

4.2.1. Public Understanding of Warnings

It is important to disseminate warnings to the public as soon as possible. In addition, it is also important to let the public know the meanings of warnings correctly. The mission collected useful examples for public understanding of warning during the periods of its stay. They will be introduced below.

(a) Pamphlets (leaflets) should be distributed to the public to let them know the frequency of the flooding (Thailand) and importance of levees and dams (Korea). The information about the nature of a typhoon and the community preparedness is already prepared for the public in the Philippines. A pamphlet should be written in local dialect with sufficient numbers of illustrations for understanding of local people.

(b) The records of the past floods, for instance photographs, vividly teach us the vulnerability of the floods. In a certain coffee shop in Kuala Krai, there are two photographs attached to the wall showing the serious situation of this town during the flood period of 1967. The responsible agency must collect the photographs and make photo albums to distribute them to the flood preparedness staffs.

(c) When a flood occurs, flood marks should be traced on walls of the buildings, electric poles and other convenient places immediately after the flood, with the flood date. They will be meaningful indications for the people and also useful to analyze the flood from the hydrological and hydraulic viewpoints.

(d) Past experiences on disasters are very informative and suggestive for disaster preparedness. It is desirable that various data related to disaster, especially various old documents, will be systematically collected and analyzed. When the aged give their knowledge about past floods, the knowledge must be memorized as important information for the community. It is sometimes possible to follow up the damages of the floods fifty or sixty years ago by verbal evidences.

(e) Notice Board

One of the most notable features for flood warning dissemination in the Kelantan river basin is a notice board showing the flood level.

The flood forecasting in the river is carried out by the hydrological agency. The information on flood water level at the key station is broadcasted to the public. Generally it is very difficult for the public to know the future water level surrounding their houses by the forecasted water level at the key station. This notice board is painted with four colours which correspond to the four kinds of water level at the key station, for instance 75ft, 85ft, 95ft and 105ft. Therefore, the public can easily know the water level around them by referring to the notice board after listening to the forecast announcements through the mass media. As this idea seems very excellent, it is preferable that notice boards should be set up in flood-pone areas. In addition, the significance of the boards must be widely made known to the people through school education and community education.

4.2.2. Trainings

Disaster preparedness is basically carried out by people's actions supported by the spirit of self-reliance. Making a group at a grass-root level against disaster is essentially important. Moreover the numbers of governmental staffs and red cross (crescent) staffs are limited for their wide activities during the disaster period, accordingly a volunteer group should be set up to help the authorities for disaster prevention and relief. These volunteers are usually recruited from local people. They should be well trained.

The exercise is required once or twice a year to improve their skill in warning dissemination, flood fighting, evacuation and other activities. Governmental staffs and red cross (crescent) staffs should join the exercises. These disaster preparedness activities are closely related to the local conditions and the social customs, so it is desirable to hold test exercises in regional and local levels in order to know the solution of the problems and difficulties that may encounter in the real operation. The local administration must act as a co-ordinating body to follow up the project of exercises.

The real actions filling up the warning formats must be exercised at the time of the exercises. Sandbags must actually be prepared for piling up at the adequate site by the flood fighting unit at the time of the exercises.

4.2.3. Information Exchange

(a) In emergency time, the communications among various agencies will be substantially required. It is stressed that the communicating capability among various agencies, especially in town or village level, are strengthened. It is hoped that agencies concerning disaster preparedness can use exclusively this communicating facilities. "How much time is required for disseminating information to the lowest level, for example, the level of the village government" is very important, especially for quick mobilization for emergency actions. It is proposed that each organization will record the arrival time of the information and will report to the central disaster preparedness center. Some hints will be given from these accumulated data in order to improve the existing warning dissemination system.

(b) Local information should be much more taken into consideration for local levels of disaster preparedness. A flash flood, a mud flow and a local inundation are strongly affected by a local factor, for instance, rainfall intensity in a limited area. A local phenomenon should be observed by local people. But a problem always arises to an expense. The possibilities were sought in the meeting of the mission for measuring rainfall temporally by a bucket or a metal trash box. An oil can with an orifice was introduced to the meeting to measure rainfall intensity, by collecting rain water from a roof. The definite relation between the intensity of the rainfall and the water level in the can can be calculated by the simple hydraulic formula. Setting an electrode connected to a warning lamp or a buzzer at the definite level in the can, it operates as a flash flood warning machine, made of materials easily obtained in local levels. By using this warning machine, a village chief can get the information about the disastrous rainfall and take an adequate action for preparedness as soon as possible even if the warning and other information are not transferred from the higher level to the local level by accident.

(c) In addition, the flow of information from the lower level to the upper level is deemed very important. As an example, a child can discover a precursory of leakage of water through a levee which eventually might lead to a serious disaster. The information obtained at a village level is not only useful for the village concerned, but also significant to the upper levels responsible for disaster preparedness. Therefore, the warning dissemination and information exchange between all levels should be further stressed.

4.2.4. Flash Flood

A flash flood must be considered, even if it is not serious today. According to social development, a flash flood is apt to occur everywhere, especially in a developed basin and a deforestated basin. The time of concentration becomes short and the coefficient of run-off increases in such cases. Hence forecasting of the water-stage or the discharge is difficult and the frequency of floods increases. Moreover the warning in such cases should be disseminated promptly. The table containing all possible combination of rainfall distributions and the discharge for flash floods in the Kelang River is already prepared in Malaysia. It is useful for flash flood warning. Profound attention should be paid to the method of disseminating the warning to the public according to future development.

5. List of Materials distributed by the Roving Mission

The Roving Mission presented some materials explaining the activities of Hydrological and WD/IE Components of TOPEX in Japan. "Textbook of TOPEX Roving Seminar" compiled by JICA was distributed to all participants in each countries. But it was regretful that it was not available to the participants at some local meetings because of limitation of copies. In this textbook, the outline of TOPEX for all components, flood forecasting, flood-loss mitigation, observation systems, telemetering systems, storm surges and flood calculations, flood fighting, legal system of disaster prevention of Japan with emergency measures, relief and rehabilitation, and importance of warning dissemination and information exchange are all explained.

Other materials were presented by the Roving Mission. They were also useful to understand not only TOPEX but also all activities related to flood disaster mitigation. They are listed below for memories of the contribution of the Roving Mission.

(1) Textbook of TOPEX Roving Seminar: JICA

(2) Prepare against Typhoon and Severe Storms (Illustrated pamphlet): National Research Center for Disaster Prevention (NRCDP)

(3) Hydrological Observation Explained in Pictures (Illustrated booklet): Ministry of Construction (MOC)

(4) Estimated Inundation Map of Tsurumi River Basin: MOC

(5) Rivers in Japan: MOC

(6) Technology for Disaster Prevention Vols. 4 and 5: NRCDP and JICA

(7) Warning Dissemination Format: MOC

(8) Others

6. Acknowledgement

All the members of the Roving Mission for TOPEX would like to express hearty thanks to the Governments of the Philippines, Malaysia, the Republic of Korea, and Thailand for their warm hospitalities and co-operations extended to the mission during the period of their stay. The Roving Mission was given useful ideas and experiences for Hydrological and WD/IE Components preserved in each country, and had many helpful discussions about TOPEX with all counterparts of the Philippines, Malaysia, the Republic of Korea, and Thailand. Their contributions to the mission were substantial. All the members of the Roving Mission took pleasure in acknowledging the important roles played by all the counterparts.

The Roving Mission is also thankful to Japan International Co-operation Agency (JICA) which gives the financial supports for sending the mission and opening the seminar on TOPEX, and other relevant Japanese organizations which kindly lead the mission.

Annex I

List of the Participants in the Philippines

Mr. Manuel C. Bonjoc	Director, NAGADO, PAGASA
Mr. Catalino P. Afafiles	Director, NIAGAS, PAGASA
Mr. Jesus F. Flores	Director, TMRDO, PAGASA
Mr. Juanito F. Lirios	Director, NWO & OIC, NFFO, PAGASA
Mr. Zacarias C. Macaraig	Asst. Weather Services Chief, NFFO, PAGASA
Mr. Rolu P. Encarnacion	Weather Specialist, NIACAS, PAGASA
Mr. Cipriano C. Ferraris	Asst. Weather Services Chief, NAGADO, PAGASA
Mr. Juan F. Asuncion	Asst. Weather Services Chief, NWO, PAGASA
Mr. Hiroshi Ozawa	JICA Expert, PAGASA
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Mr. Romeo E. Valera	OCD, MOND
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Mr. Rosito V. David	Bureau of Flood Control & Drainage, MPWH
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Mr. C. H. Tang	Typhoon Committee Secretariat
Mr. Osamu Machida	Typhoon Committee Secretariat
Mr. Crisostomo C. Reyes	Typhoon Committee Secretariat
Mr. Claro S. Doctor	Typhoon Committee Secretariat

The Roving Mission

Annex II

Program of Report and Lecture on the Seminar in 1981

Date : January 12, 1982, Tuesday

Place : PAGASA Conference Room

Program

10:00 Opening Address, Chaired by M. C. Bonjoc

10:00 Purpose of the Mission by T. Kinosita

10:20 Outlining of TOPEX by N. Kato

10:40 TOPEX in Japan

(a) Preliminary Experiment in 1981:
The case of the flood in Ishikari River by M. Kuriki and T. Sato

(b) Seminar in 1981 by N. Kato

11:10 TOPEX in the Philippines by C. P. Arafiles

11:30 Discussion

Lunch Break

13:30 Lecture Session

(a) Hydrological Component

Flood forecasting system . . . S. Kishimoto

Flood observation & flood computation . . . . M. Kuriki

Flood Data Transmission . . . K. Ichimiya

(b) WD/IE Component

Institutional system of disaster prevention . . . . . T. Sato

Disaster preparedness . . . . T. Kinosita

Rehabilitation & Relief of victims . . . . N. Kato

15:30 Disaster Statistics---Importance and method---by T. Sato

16:00 Discussion

16:30 Closing Address.

Annex III

List of the Participants in Malaysia

Ir. Cheong Chup Lim	Deputy Director General of DID
Ir. Shahrizaila bin Abdullah	Assistant Director General of DID, Malaysia
Ir. Tan Hoe Tim	Chief Engineer, Hydrology Branch, DID
Ir. Teh Siew Keat	Senior Engineer, Hydrology Branch, DID
Ir. Chong Sun Fatt	Acting Senior Timescale Engineer, DID (Hydrological Application)
Ir.Hj.Ahmad Jamalluddin b.Shaaban	Flood Forecasting Engineer (Hydrological Application Section), Hydrology Branch, DID Headquarters
Ahmad Fuad Embi	Engineer, Field Operations (Hydrology), DID
C. M. Lee	Civil Engineer, DID Kuantan, Pahang
How Say Sze	Technical Assistant, DID Wilayah, Federal Territory
Leong Tak Meng	Engineer (Water Resources Assessments Section), Hydrology Branch, DID Headquarters, Kuala Lumpur
Ahmad Fuad Embi	Engineer, Hydrology Branch, DID
Ir. Mohd. Fadzlillah Hj. Mahmood	Engineer (Hydrological Design Section), DID Headquarters (Hydrology Branch)
Lim See Lin	State Hydrological Officer, DID Perak
A. Hamid	State Hydrological Officer, DID Pahang
Azmi Md. Jafu	DID Headquarters (Hydrology Branch)
Ferdaos Hj. Mohamed	Groundwater Section (Hydrology Branch), Ampang, Kuala Lumpur
Abdul Razak Mohd. Noor	DID Headquarters (Hydrology Branch)
Ibrahim bin Jusoh	State Hydrological Officer, DID Kuala Trengganu

Song Teng Hock	DID Kelantan
Foo Fook Huan	DID Johor
Ng Soo Ha	State Hydrological Officer, DID Johor
Husin Ishak	DID Headquarters
Paridah Anun Tahir	DID Headquarters (Hydrology Branch)
Yap Kok Kai	DID Headquarters (Hydrology Branch)
Tadashi Tanimoto	Colombo Plan Expert, National Water Resources Study, Malaysia
Shafie Yahaya	Deputy Secretary, National Security Council
Ramli bin Kamarudin	Principal Assistant Secretary National Security Council
Tahrab Mahbudin	Assistant Secretary, National Security Council
K. Rajendran	Civil Defence Department
ASP Amiruddin Bistamam	Federal Police Headquarters, Bukit Aman, Kuala Lumpur
Tung Nam Ping	Meteorologist, Malaysian Meteorological Service
Yong Pok Wing	Malaysian Meteorological Service
Lau Lee Ching	Director, City Secretariat, City Hall, Kuala Lumpur
Alias Bin Udin	Assistant Director, Telecoms (Traffic), Headquarters, Telecoms, Kuala Lumpur
Mohamad Kaus Salleh	Director, Press and Liaison, Information Department, Malaysia
Yu Am Ping	Deputy Director, Press & Liaison Division, Information Services Federal Department of Information

Wong Choong Pow	Assistant Director, Ministry of Welfare Services, Malaysia
Leong Wan Kai	Director of Welfare Services, Ministry of Welfare Services, Malaysia
Lim Meng Ah	Malaysia Red Crescent Society
Nobuji Abe	JICA Kuala Lumpur Office
Tomoo Aoyagi	First Secretary, Embassy of Japan in Malaysia

The Roving Mission

Annex IV

List of the Participants at KOTA BHARU MEETING 20 Jan., 1982

Name of Participant	Present Post of Participant
Hj. Ahmad Jamalluddin b. Shaaban	Flood Forecasting Engineer, DID, Kuala Lumpur
Song Teng Hock	DID Kelantan
Ramli Kamarudin	National Security Council
Chua Soon Poh	PWD Kelantan
PPP Omar Hj. Abdullah	Representative, Chief of Police, Kelantan
Taib Hj. Mahmood	Trade Enforcement Division
Kapt. Abdul Manaf b. Kasmuri	Army Representative
Hj. Taufik Kang	Kelantan State Security Committee
Hj. Ayoub Zakaria	Welfare Services, Kelantan
Othman H. M. Amin	Representative, Telecoms Controller, Kelantan
Nik Ramzi	DID Kelantan
Hassan Abdullah	Secretary of Secretariat, State Security Committee
Hj. Kamaruddin	Member of Secretariat, State Security Committee
Mejar Nasir	Member of Secretariat, State Security Committee
Mustafha Mohammed	Member of Secretariat, State Security Committee
Hassan b. Hj. Hussein (Chairman)	Chief Assistant Secretary of Kelantan State
The Roving Mission	

PROGRAM OF REPORT AND LECTURE, D.I.D. KUALA LUMPUR

19 Jan., 1982

0900	Opening Address
0910	Purpose of Mission by Dr. T. Kinosita
0920	Outlining of TOPEX by N. Kato
0940	TOPEX in Japan
	(a) Preliminary Expt in 1981: The case of the flood in Ishikari River by T. Sato
	(b) Seminar in 1981 by N. Kato
1010	Discussion
1020	Break
1040	TOPEX in Malaysia
1100	Discussion
	Lunch Break
1300	Lecture Session:-
	(a) Hydrological Component
	Flood Forecasting System - S. Kishimoto
	Flood Observation and flood computation - M. Kuriki
	Flood Data Transmission - K. Ichimiya
	(b) WD/IE Component
	Institutional system of disaster prevention - T. Sato
	Disaster preparedness - T. Kinosita
	Rehabilitation and relief of victims - N. Kato
1530	Break
1550	Disaster Statistics - Importance and method - T. Sato
1620	Discussion
1650	Closing

Annex VI

List of the Participants in the Republic of Korea

Lee, Yun Sik	Disaster Prevention Planning Officer, Ministry of Construction
Lee, Sun Ho	Director, River Planning Division, Bureau of Water Resources, Ministry of Construction.
Kim, Young Hwan	Director, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Lee, Mun Kyu	Assistant-Director, River Planning Division, Bureau of Water Resources, Ministry of Construction.
Jung, Dong Sung	Assistant-Director, River Planning Division, Bureau of Water Resources, Ministry of Construction.
Cheong, Soo Heung	Assistant-Director, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Yoon, Yoo Hack	Chief, Administration Section, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Chung, Ho Young	Chief, Telecommunication Section, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Moon, Don Sik	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Choi, Dong Sik	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Kim, Ki Kon	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Song, In Soon	Engineer, River Planning Division, Bureau of Water Resources, Ministry of Construction.
Kim, Jin Yeong	Engineer, River Planning Division, Bureau of Water Resources, Ministry of Construction.
Park, Hi Gon	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.

Chai, Woong Gi	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Oh, Min Whan	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Shin, Eun Woo	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
You, Young Chang	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Myung, Noh Kil	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Kim, Dae Kyu	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Kim, Seung Kyu	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Park, Ryong Jae	Engineer, Disaster Prevention Division, Bureau of Water Resources, Ministry of Construction.
Kang, Hung Sik	Engineer, Water Planning Division, Bureau of Water Resources, Ministry of Construction.
Kwong, Lim Young	Engineer, Water Planning Division, Bureau of Water Resources, Ministry of Construction.
Oh, Dal Young	Director, Han River Flood Control Office, Ministry of Construction.
Park, Yung Il	Chief, Section of Investigation, Han River Flood Control Office, Ministry of Construction.
Hong, Tai Do	Engineer, Section of Investigation, Han River Flood Control Office, Ministry of Construction.
Kang, In Seo	Engineer, Section of Investigation, Han River Flood Control Office, Ministry of Construction.
Jeong, Jin Yang	Engineer, Section of Investigation, Han River Flood Control Office, Ministry of Construction.
Kazunari Ishizuka	JICA Expert, Han River Flood Control Office, Ministry of Construction.

Yoshio Iida	JICA Expert, Han River Flood Control Office, Ministry of Construction.
Park, Sang Kil	Director, National Construction Research Institute, Ministry of Construction.
Baik, Ki Woo	Engineer, Seoul Regional Construction Office, Ministry of Construction.
Choung, In Soung	Engineer, Seoul Regional Construction Office, Ministry of Construction.
Lee, Sang Tae	Engineer, Seoul Regional Construction Office, Ministry of Construction.
Shin, Hyon Zin	Chief, Climate and Publication Section, Central Meteorological Office.
Chung, Eul Young	Senior Forecaster, Central Meteorological Office.
Choi, Jung Boo	Engineer, Forecasting Operational Section, Central Meteorological Office.
Jung, Chul Jong	Engineer, Flood Control Division, Bureau of Water Works and Sewerage, Seoul Metoropolitan Government.
Choi, Uk Sun	Director-General, Construction Bureau, Kang Weon Do, Ministry of Home Affairs.
Lee, Sang Ho	Former Director-General, Construction Bureau, Kang Weon Do, Ministry of Home Affairs.
Kil, Chung Mu	Director, Water Control Division, Construction Bureau, Kang Weon Do, Ministry of Home Affairs.
Kang, Seok No	Director, Road Division, Construction Bureau, Kang Weon Do, Ministry of Home Affairs.
Chang, Ki Ho	Director, Soyang Gang Multipurpose Dam Office, Industrial Sites and Water Resources Development Corporation.
Beon, Jin Ohn	Engineer, Computer Section, Industrial Sites and Water Resources Development Corporation.
Shin, Hong Sub	Engineer, Dam Operational and Maintenance Section, Industrial Sites and Water Resources Development Corporation.

Nahm, Sum Woo	Professor, Dongguk University.
Kim, Chi Hong	Professor, Civil Engineering Department, Sung Kueng Kun University.
Lee, Chong Nam	Assistant Professor, Civil Engineering Department, Kyoung Hi University.
Lee, Mun Haek	Vice-president, Sam An Construction Technology Corporation.

The Roving Mission

Annex II Program on 2nd Feb. 1982

Date : February 2, 1982, Tuesday.

Place : Han River Flood Control Office, Ministry of Construction.

Program

10:00	Discussion about the Han River System with the staff of Han River Flood Control Office, Ministry of Construction.
12:00	Lunch Break.
13:30	Opening address, Election of Chairman.
13:40	Purpose of the Mission by I. Watanabe.
13:50	Outlining of TOPEX by K. Takemura.
14:00	TOPEX in Japan.
	(a) Preliminary Experiment in 1981: The case of the flood in Ishikari river by K. Takemura.
	(b) Seminar in 1981 by I. Watanabe.
14:25	Lecture Session.
	(a) Hydrological component
	Flood forecasting system ... T. Kobayashi.
	Flood observation and flood computation ... K. Yoshikawa.
	Flood risk map ... K. Yoshikawa.
	(b) WD/IE Component
	Institutional system of disaster prevention ... K. Takemura.
	Disaster preparedness ... I. Watanabe.
	Emergency countermeasures ... Y. Ishida.
	Rehabilitation and relief of victims ... H. Moriwaki.
16:10	Disaster Statistics ... Y. Ishida.
16:20	Discussion.
17:00	Closing Address.

List of the Participants in Thailand

Sawai Suwanpong R.J.N.	Director, Meteorological Observation Division, Meteorological Department, Ministry of Communication.
Sumeth Hinsheranan	Director, Studies and Research Division, Meteorological Department, Ministry of Communication.
Jate Chailapo	Director, Hydrometeorology Division, Meteorological Department, Ministry of Communication.
Tawatchai Brikshavana	Chief, Hydrological Forecast Section, Hydrometeorology Division, Meteorological Department, Ministry of Communication.
Damras Chongdarakul	Chief, Analysis and Statistics Section, Hydrometeorology Division, Meteorological Department, Ministry of Communication.
Amorn Chantanavivate	Meteorologist, Technical Cooperation Section, Studies and Research Division, Meteorological Department, Ministry of Communication.
Somsri Huntrakul	Meteorologist, Technical Cooperation Section, Studies and Research Division, Meteorological Department, Ministry of Communication.
Sehadacha Klinharmhual	Meteorologist, Technical Cooperation Section, Studies and Reaearch Division, Meteorological Department, Ministry of Communication.
Pranee Benjakul	Meteorologist, Hydrometeorology Division, Meteorological Department, Ministry of Communication.
Natcharee Virapun	Meteorologist, Hydrometeorology Division, Meteorological Department, Ministry of Communication.

Suntanee Wattanapeateep	Meteorologist, Hydrometeorology Division, Meteorological Department, Ministry of Communication.
Jiraporn Jutakorn	Meteorologist, Meteorological Department, Ministry of Communication.
Narong Piyabhan	Forecaster, Forecasting Division, Meteorological Department, Ministry of Communication.
Pisan Peintrup	Meteorologist, Meteorological Department Ministry of Communication.
Charkree Supanasang	Meteorologist, Meteorological Department Ministry of Communication.
Sompong Chang-Ian	Meteorologist, Meteorological Department, Ministry of Communication.
Bubpha Pongsawat	Meteorologist, Meteorological Department, Ministry of Communication.
Sumalee Samootsakorn	Meteorologist, Meteorological Department, Ministry of Communication.
Bamrung Piyawatin	Forecaster, Forecasting Division, Meteorological Department, Ministry of Communication.
Damrong Jaraswathana	Director, Hydrology Division, Royal Irrigation Department, Ministry of Agriculture and Cooperatives.
Prasert Milintangul	Chief, Research and Applied Hydrology Section, Hydrology Division, Royal Irrigation Department, Ministry of Agriculture and Cooperatives.
Prasong Jitsern	Hydrologist, Royal Irrigation Department, Ministry of Agriculture and Cooperatives.
Songkramchai Bamroongchati	Director, Civil Defence Division, Local Administration Department, Ministry of Interior.

Thannaddej Chokesuwattanaskal	Chief, Study and Research Section, Civil Defence Division, Local Administration Department, Ministry of Interior.
Nipohn Maneeprawati	Chief, General Executive Section, Civil Defence Division, Local Administration Department, Ministry of Interior.
Uthai Nittayachoti	Chief, Preventive and Relief Disaster Section, Civil Defence Division, Local Administration Department, Ministry of Interior.
Pote Srinual	Study and Research Official, Civil Defence Division, Local Administration Department, Ministry of Interior.
Prinya Nakchudtree	Director, the Telecommunication Division, Ministry of Interior.
The Roving Mission	

PROGRAMME OF REPORT AND LECTURE ON THE SEMINAR IN 1981

10.30	*Opening Address, Election of Chairman*
	Purpose of the mission by I. Watanabe
	Outline of TOPEX by K. Takemura
	TOPEX in Japan
	(a) Preliminary experiment in 1981 : The case of flood in Ishikari River by K. Takemura
	(b) Seminar in 1981 by I. Watanabe
	TOPEX in Thailand
13.30	*Lecture Section*
	(a) Hydrological Component
	Flood Forecasting System, flood observation by T. Kobayashi
	Flood Risk Map by T. Kobayashi
	(b) WD/IE Component
	Institutional System of Disaster Prevention by K. Takemura
	Disaster Preparedness by I. Watanabe
	Emergency Countermeasures by Y. Ishida
	Rehabilitation and Relief of Victims by H. Moriwaki
	Disaster Statistics by Y. Ishida
	Discussion
	Closing Address

Annex X

Stage-stage correlation Method

1. Preparation

Provided that two observed hydrographs are given at the upstream and downstream gauging stations as shown in Fig. 1, the stage-stage correlation method for flood forecasting can be prepared by the following steps.

Step 1: Determine the corresponding points and the lag-time.

1) Two points are selected as A_1 and A_1' at the same water stage h_{a1}=2m for instance in Fig. 1, consequently the time interval Δt_1 between A_1 and A_1' is measured 13 hr.

2) Two points B_1 and B_1' on the downstream hydrograph are found correspondingly to A_1 and A_1' by means of the procedure in which the time interval $\Delta t_1'$ is assumed to be Δt_1 as illustrated in Fig. 1. The water stage at both points B_1 and B_1' becomes known as h_{b1}=3.8m Therefore the stage relation between h_a and h_b at h_a=2m is written by (2, 3.8).

3) The lag-time T_1 is determined as 2.5hr by the time from the point A_1 to B_1 (or A_1' to B_1') in Fig. 1.

4) The other two points are selected as A_2 and A_2' at h_{a2}=3m for instance in Fig. 1. The time interval Δt_2 between A_2 and A_2' is measured 9.5hr.

5) Two points B_2 and B_2' on the downstream hydrograph are found correspondingly to A_2 and A_2' by means of the procedure in which the time interval $\Delta t_2'$ is Δt_2. The water stage at B_2 and B_2' becomes known as 4.8m. Therefore the stage relation between h_a and h_b at h_{a2}=3m is written by (3, 4.8)

6) The lag-time T_2 is 2.6hr in Fig. 1.

7) The different sets of the stage relation (h_{a3}, h_{b3}), (h_{a4}, h_{b4}) . . . . . can be obtained.

Step 2: Draw the stage-stage correlation curve. Plot the stage relations (h_{ai}, h_{bi}) where i=1,2, . . . on the h_a-h_b coordinate. Then the stage-stage correlation curve is obtained as shown in Fig. 2.

Curves should be drawn by observed flood data as many as possible to improve the forecasting accuracy.

Step 3: Draw the lag-time curve. Plot the stage lag-time relation (h_{ai}, T_i) or (h_{bi}, T_i), where i=1,2, . . . , on the h_a-T coordinate or the h_b-T coordinate. Then the stage lag-time correlation curve is obtained.

It can be noticed that the lag-time T is almost constant for any upstream water stage h_a. This fact means that, in practice, the stage relation can easily be obtained by overlaying the downstream hydrograph on the upstream one.

2. Operation

The downstream water stage h_b and the lag-time T can be obtained by the upstream water stage h_a based on Fig. 2.

When the upstream water stage h_a observed is 4m, the downstream water stage h_b can be forecast 5.2m and the lag-time T 3.2hr by Fig. 2. It can be simply said that 3.2hr later the downstream water stage will reach to 5.2m.

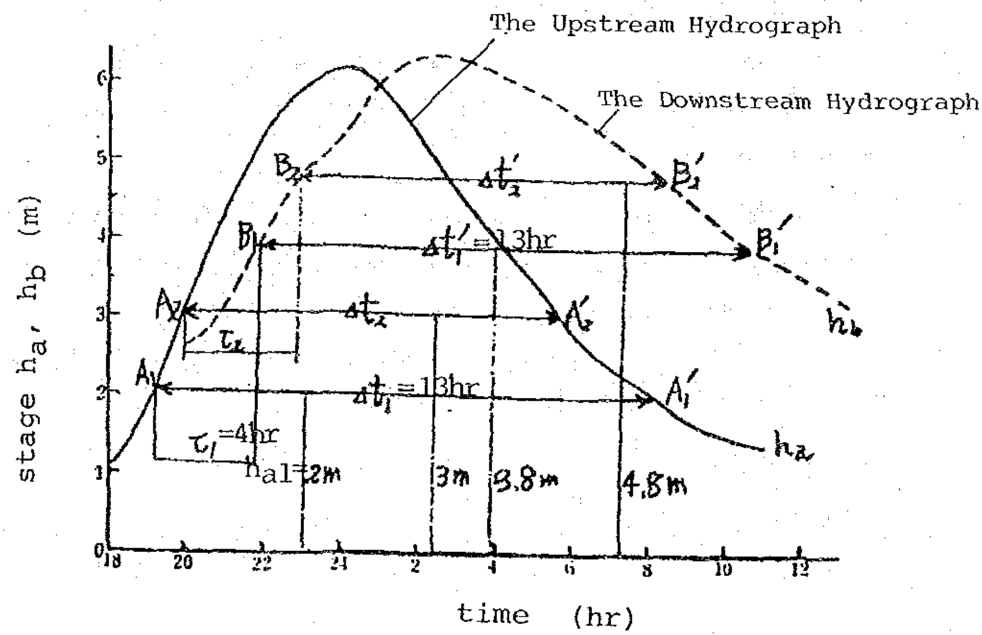

Fig - 1

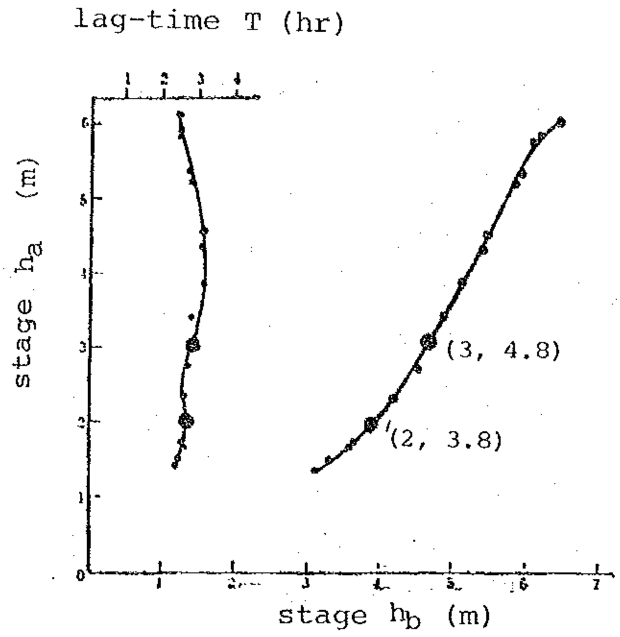

Fig - 2 h_a-h_b, and h_a-T corration curves