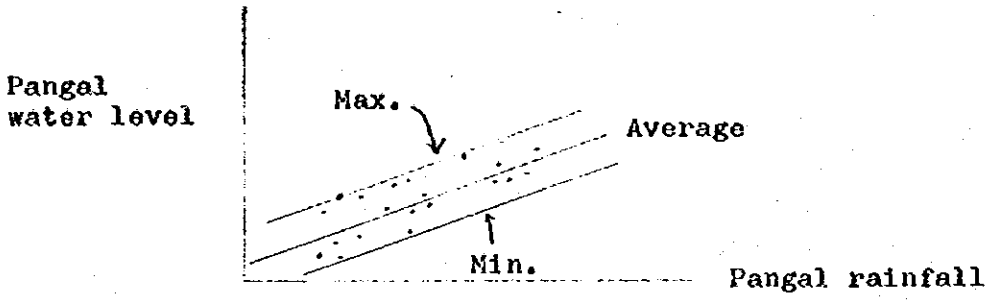
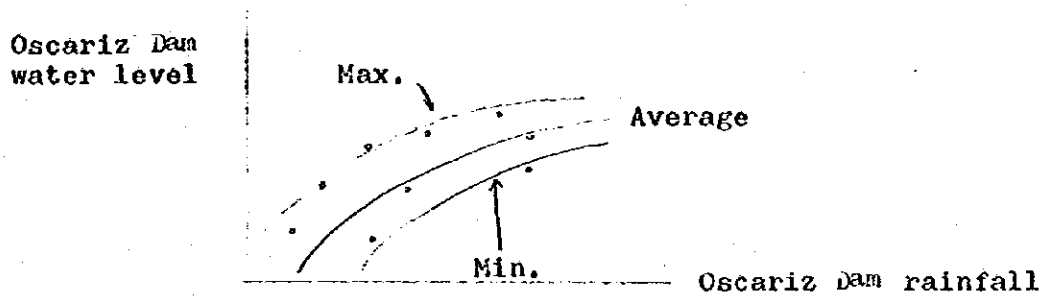
7. Flood forecasting method

In principle, forecasting is performed on the basis of correlation between rainfall and water level.

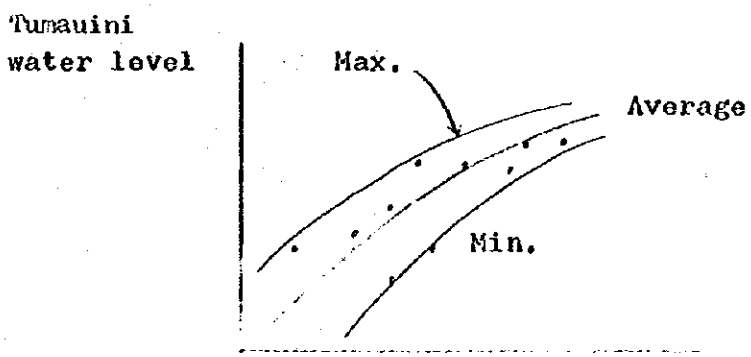
(1) . Flood forecasting procedure at Pangal.



(2) . Flood forecasting procedure at Oscariz Dam.

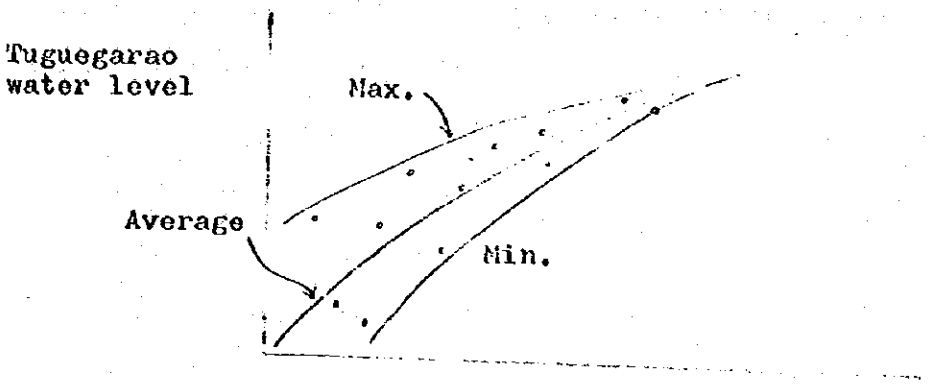


(3) . Flood forecasting procedure at Tumauini.



Average rainfall;
Pangal, Oscariz Dam and Tumauini

(4) Flood forecasting procedure at Tuguegarao.



Average rainfall;
Pangal, Oscariz Dam,
Tumauini and
Tuguegarao

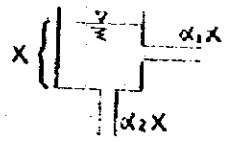
(5) Flood Forecasting Method

(1) The relationship between precipitation and the water level at PANGAL is shown in Fig. .

For estimation of the PANGAL water level, the tank model method is being studied.

Constants are $\alpha_1 = 0.2$, $\alpha_2 = 0.0$.

Original amount stored is 50 mm.



With travelling time as one day, the relationship between the precipitation and water level at PANGAL is shown in Fig. 1 .

(2) With travelling time as one day, the relationship between PANGAL water level and TUMUINI water level is shown in Fig. 2 . There is no information about the TAMUINI water level, therefore the NAGURIAN information is presented.

(3) With travelling time as one day, the relationship between the TAMUNINI water level and TUGUEGARAO water level is shown in Fig. 3 .

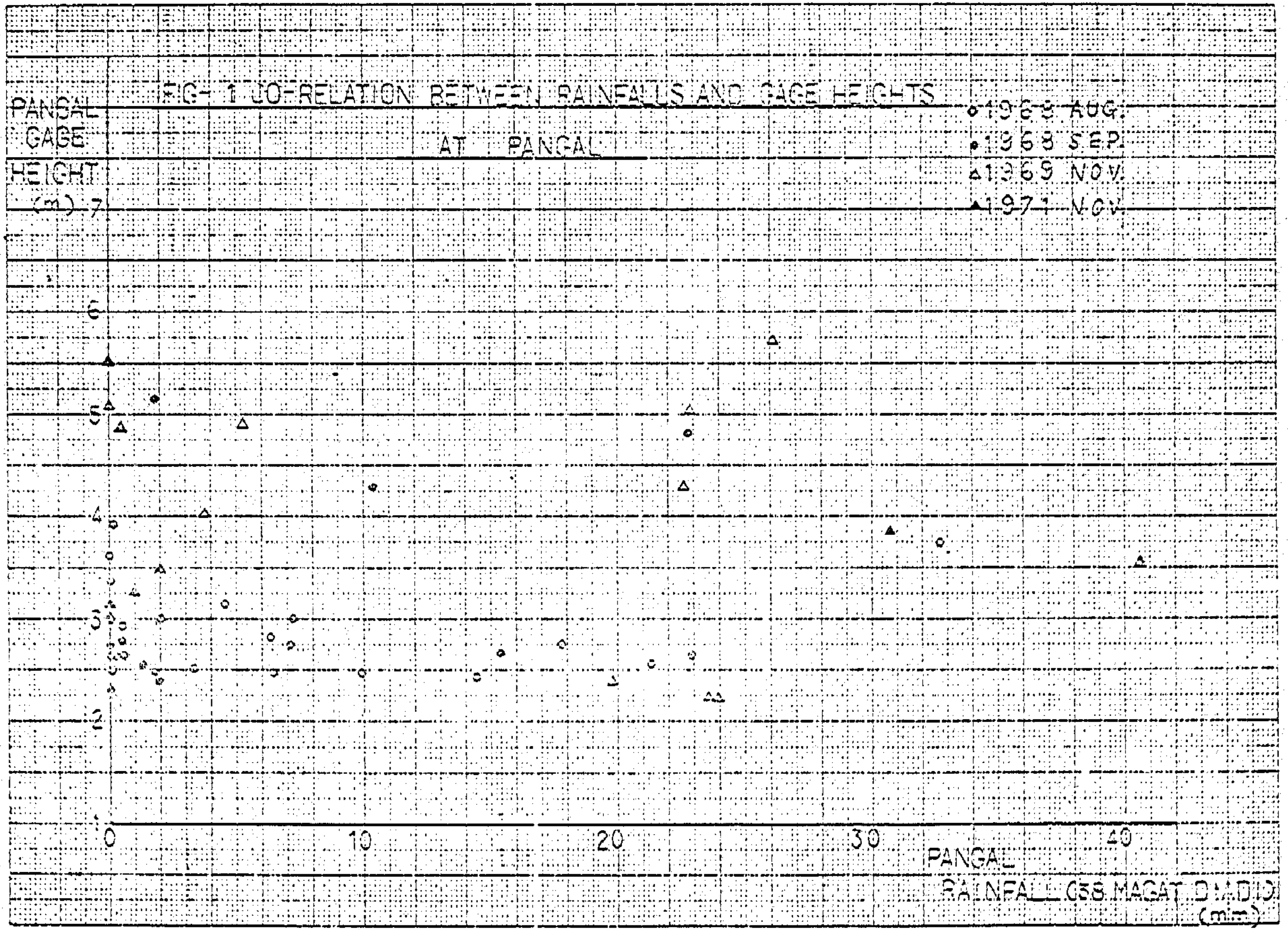
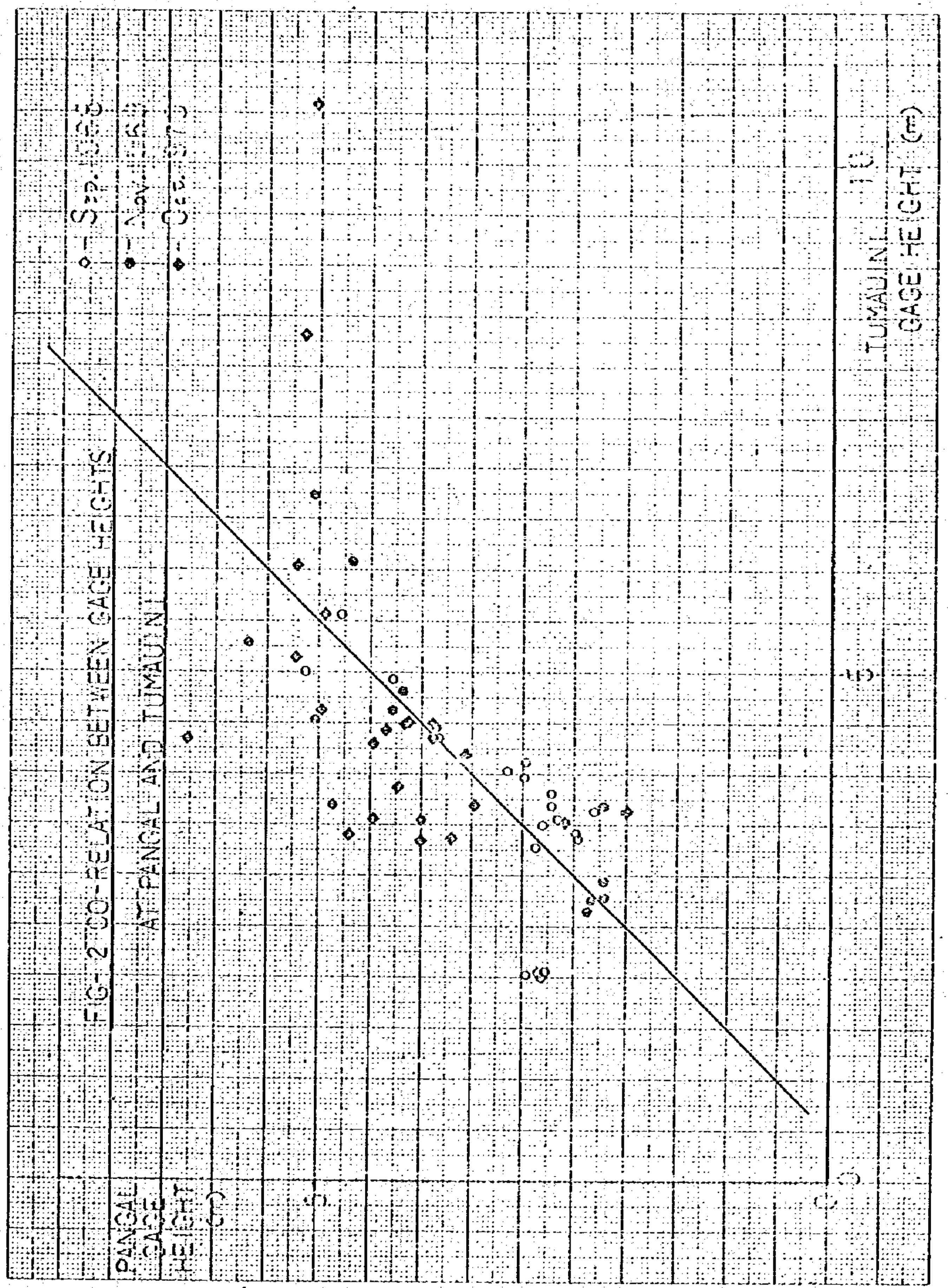


FIG-1 CO-RELATION BETWEEN RAINFALLS AND GAGE HEIGHTS
AT PANGAL
PANGAL GAGE HEIGHT (m)
7
6
5
4
3
2
1
0
10
20
30
40
PANGAL RAINFALL (58 MAGAT DIADI) (mm)
○ 1968 AUG.
● 1968 SEP.
△ 1969 NOV.
▲ 1971 NOV.



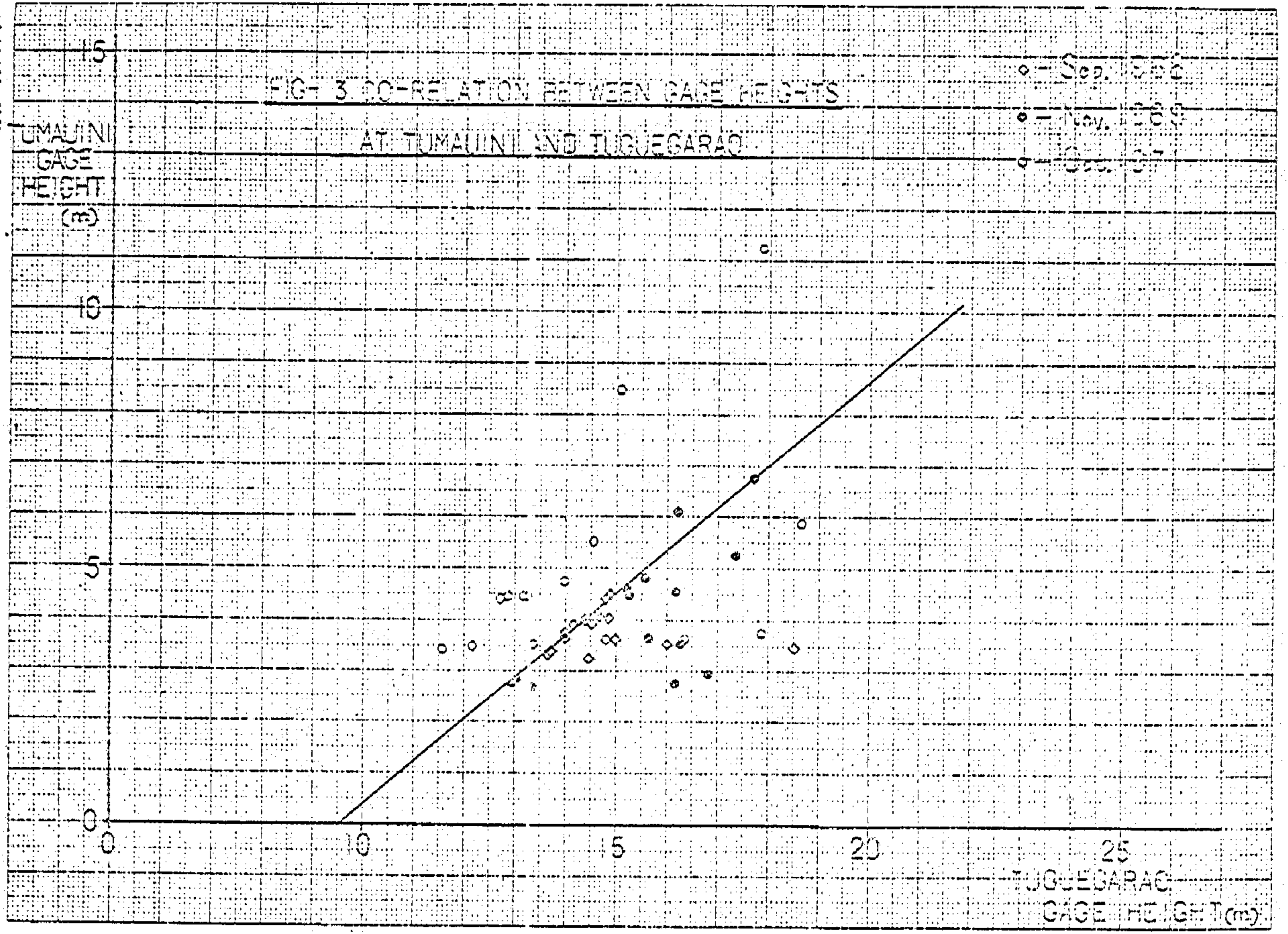
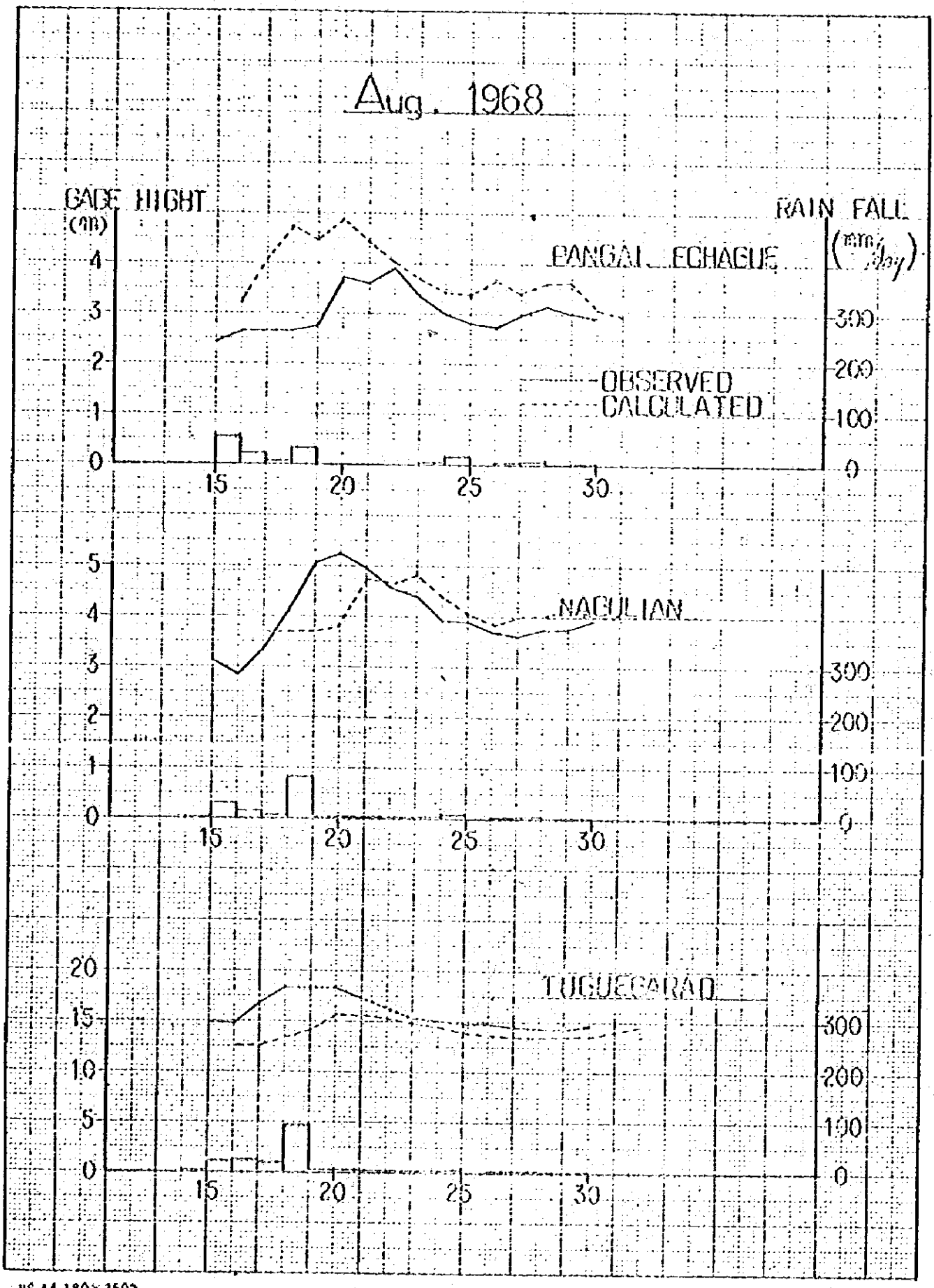
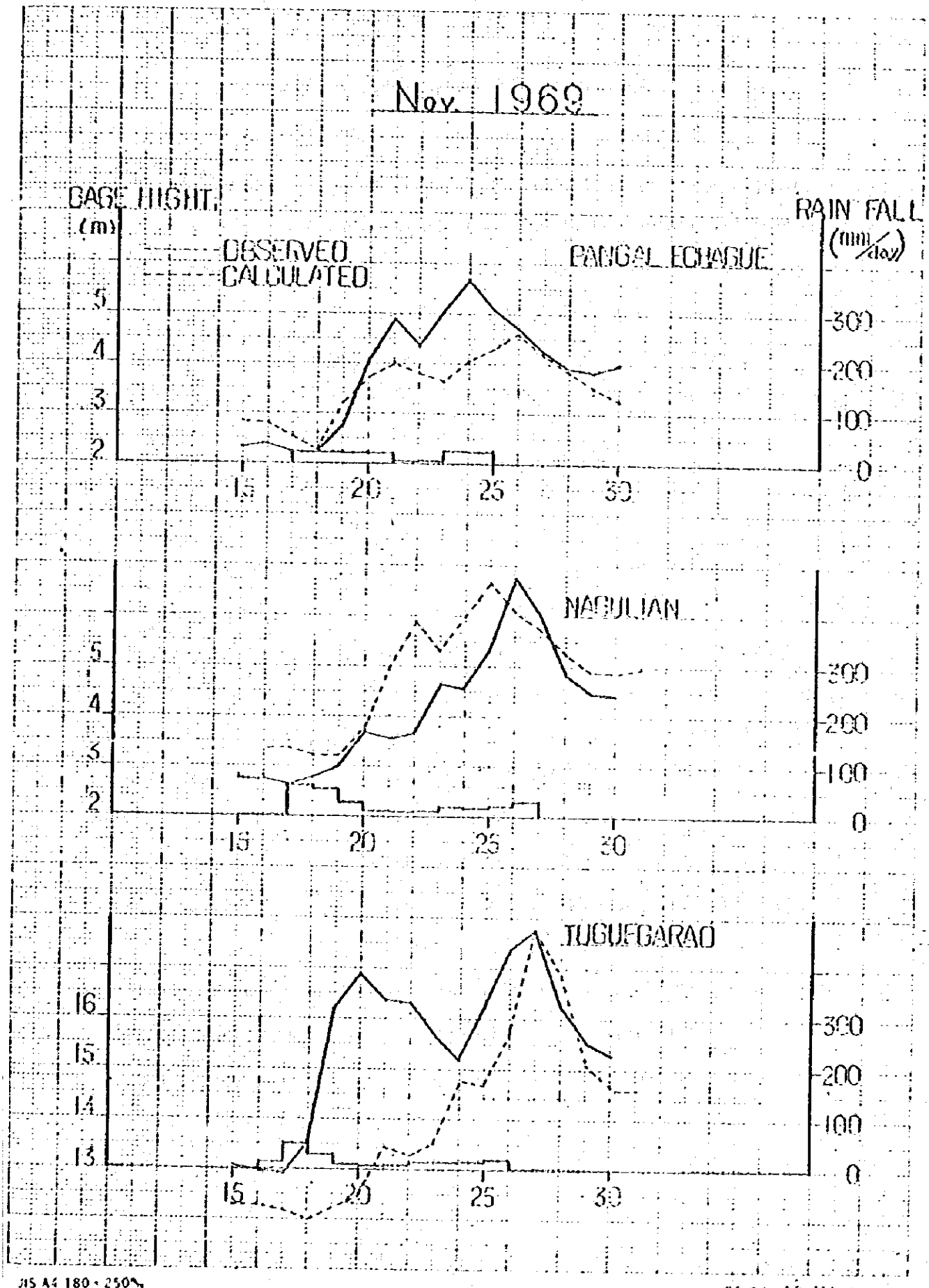


FIG- 3 CO-RELATION BETWEEN GAGE HEIGHTS
AT TUMAUINI AND TUGUEGARAO
TUMAUINI GAGE HEIGHT (m)
TUGUEGARAO GAGE HEIGHT (m)
Sep.
0
5
10
15
20
25


Aug. 1968
GAGE HIGHT (m)
RAIN FALL (mm/day)
BANGAI ECHAGUE
OBSERVED
CALCULATED
NAGULIAN
TUGUEGARAO
15
20
25
30


Nov. 1969
GAGE HIGHT (m)
OBSERVED
CALCULATED
PANGAL ECHAGUE
RAIN FALL (mm/day)
5
4
3
2
15
20
25
30
300
200
100
0
NAGULIAN
16
15
14
13

V. Telecommunication and Telemetry System

§1. Outline

The following system is recommended for collecting data required in flood forecast and warning. Subcenters should be established in the middle of each of the three basins for the collection of data in the respective regions and the operation as well as maintenance and control of the system. Necessary data should be collected by employing the telemetry system which makes use of VHF band telecommunication for the transmissions of informations from the various gaging stations to the subcenters.

A station should be set up in the suburbs of Manila for the transmission of data and other information to and from the subcenters. A multiplex telecommunication system making use of tropospheric scattering should be set up for the transmission of data from the subcenters to the station, while the transmission of data from the station to Flood Forecasting Center (F.F.C.) in Manila and B.P.W. will be facilitated by building a normal multiplex system. The team recommends the employment of this system of automatic data transmission.

These telecommunication links are the heart of the respective systems and hence they are quite important. Consequently, it is also necessary to set up short wave telecommunication system with S.S.B. (single-side band system) as a back-up measure in case the above mentioned telecommunication links are interrupted due to difficulty.

However, judging from the difficulties in the maintenance as well as

the training program for the maintenance personnel in the Panpanga Flood Forecast and Warning System since 1973, the immediate realization of the whole system is considered to be very difficult. It is necessary to enlarge the maintenance staff of the Telemetry System as well as to strengthen the fundamental framework to support the system by acquiring the new techniques in consequence of the employment of the Tropospheric Scatter Telecommunication System. At the same time, it is recommended that the budget necessary for the operation of the system should also be secured after careful plannings. Needless to say, a smooth operation of the system is impossible without the comprehension and co-operation of all related organizations, not only those immediately involved in the system.

Considering these facts, it is necessary to train the maintenance staff and at the same time to obtain the co-operation of officials concerned on the one hand, and to enlarge the system systematically on the other.

§2. Study of the Proposed System

An outline of the facilities and the systems proposed for the collection of data in each river basin is shown in Fig. 1-4. The details are as follows:

1. Agno River System (see Fig. 5-1)

PAGASA Synoptic Station in Dagupan meteorological center and B.P.W. Office in Carmen have both been studied as the location of the subcenter. With consideration of land area, the number of personnel and the vehicle available, the team recommends the subcenter be located at Agno River Control Office at Carmen, Rosales.

A repeater station should be established at PAGASA Radar Station on top of Mt. Sto Tomas on the basis of reliability of radio propagation and convenience of maintenance. The link constructions to connect each telemetering station with the subcenter are relatively easy except for Binga Dam Station. However, a large propagation loss is expected at Baay West Station and Poblacion Norte Station. An alternative plan to connect these two stations to Sto Tomas Repeater Station is possible depending on the results of the radio propagation tests.

The transmission of data from Binga Dam to F.F.C. via Sto Tomas is to be done through the automatic data transmission system i.e. the implementation of a 400 MHz band multiplex telecommunication system. Deliman is to be considered as a choice for the location of a transmitting and receiving station near Manila. It is also advisable to set up a short wave telecommunication system by using

the S.S.B. system as a back-up measure in case of a suspension.

2. Bicol River System (see Fig. 5-2, 3)

The subcenter should be located at the Bicol River Control Office, B.P.W. in Naga. Two repeater stations for telemetry, one in the Sipocot River Basin and the other in the Bicol River Basin should be established. In the case of Sipocot River, two spots on the map, situated on high grounds some 3 km north of the town of Sipocot is being considered for the site of a repeater station. Both of these two sites are believed to provide very good links.

As for the Bicol River Basin, the Cuyapi, Camaligan and Ombao telemetry stations can be directly connected to the subcenter. The other stations will be connected to the subcenter via a repeater station at Ocampo or the telemetry system will be installed by building a repeater station at the hights near Iriga. When Ocampo is chosen as a repeater station, the link between Ocampo and Ligao becomes difficult, in which case it is necessary to make Bato a secondary repeater station. However, Bato tends to become isolated in times of floods and is therefore not a very good site for a repeater station considering the maintenance difficulties. For reasons of maintenance and construction convenience, the best site for a repeater station should be the hights near Iriga and Ocampo should be chosen only as an alternative. Nevertheless final decisions should be made after propagation tests and survey works have been carried out.

In the beginning, transmission to F.F.C. should be facilitated by the short wave telecommunication system using S.S.B. and later, when the maintenance and control system of the multiplex telecommunication is completed, the multiplex telecommunication system should be introduced to facilitate the automatic transmissions of data. The S.S.B. short wave telecommunication system should be secured as a back-up measure as in the Agno River System in case of a suspension even after the multiplex telecommunication system is employed.

3. Cagayan River System (see Fig. 5-4)

The subcenter will be built either in the B.P.W. Region II Office in Tuguegarao or in the Tuguegarao Synoptic Station of PAGASA. The B.P.W. Region II Office is a preferable site considering the space and buildings available.

However, it is very difficult to make decisions in this region because when setting up a wireless system, a lot of problems will occur due to the long distance and hilly terrain from the subcenter to the upstream region in Pangal and Oscariz.

From the topographic map, two repeater stations, one in Ilagan and the other in San Mateo, are selected.

Tuguegarao Telemetering Station is in the same town as the subcenter and is very near to it, and therefore there is no problem at all.

It is difficult to construct a direct link from Tumauini to the subcenter, but a good link is expected if transmission is made via Ilagan repeater station.

A good link is possible to Pangal and Oscariz Stations first through Ilagan and then through another repeater station in San Mateo. However, calculations show that a direct connection is feasible from Ilagan to both Pangal and Oscariz and hence the necessity to build a repeater station at San Mateo should be decided after investigations and propagation tests are made.

Transmission to F.F.C. will be made through direct communication to the transmitting and receiving station using the S.S.B. system, and the multiplex telecommunication system will be introduced in the same manner as in the Bicol River System. And, since a direct connection to the transmitting and receiving station through the 400 MHz band multiplex telecommunication system is difficult, a connection will be made from the subcenter in the Cagayan River System to that in the Agno River System, and both river system will share the same multiplex telecommunication system.

The S.S.B. telecommunication system will be employed as in the former.

Fig. V-1 Agno System

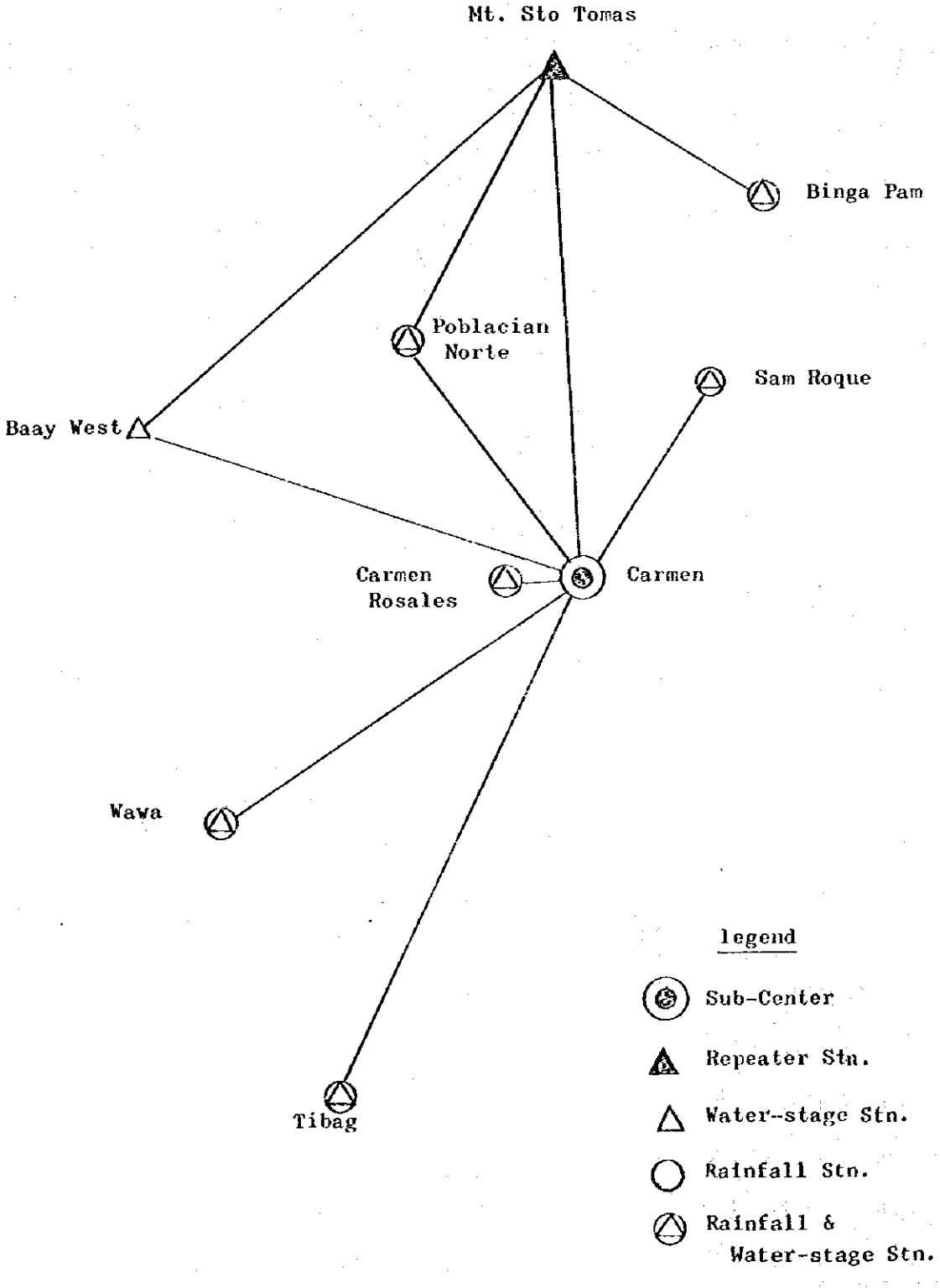


Fig. V-2

Repeater Location at Iriga No.3~No.6 (Case 1)

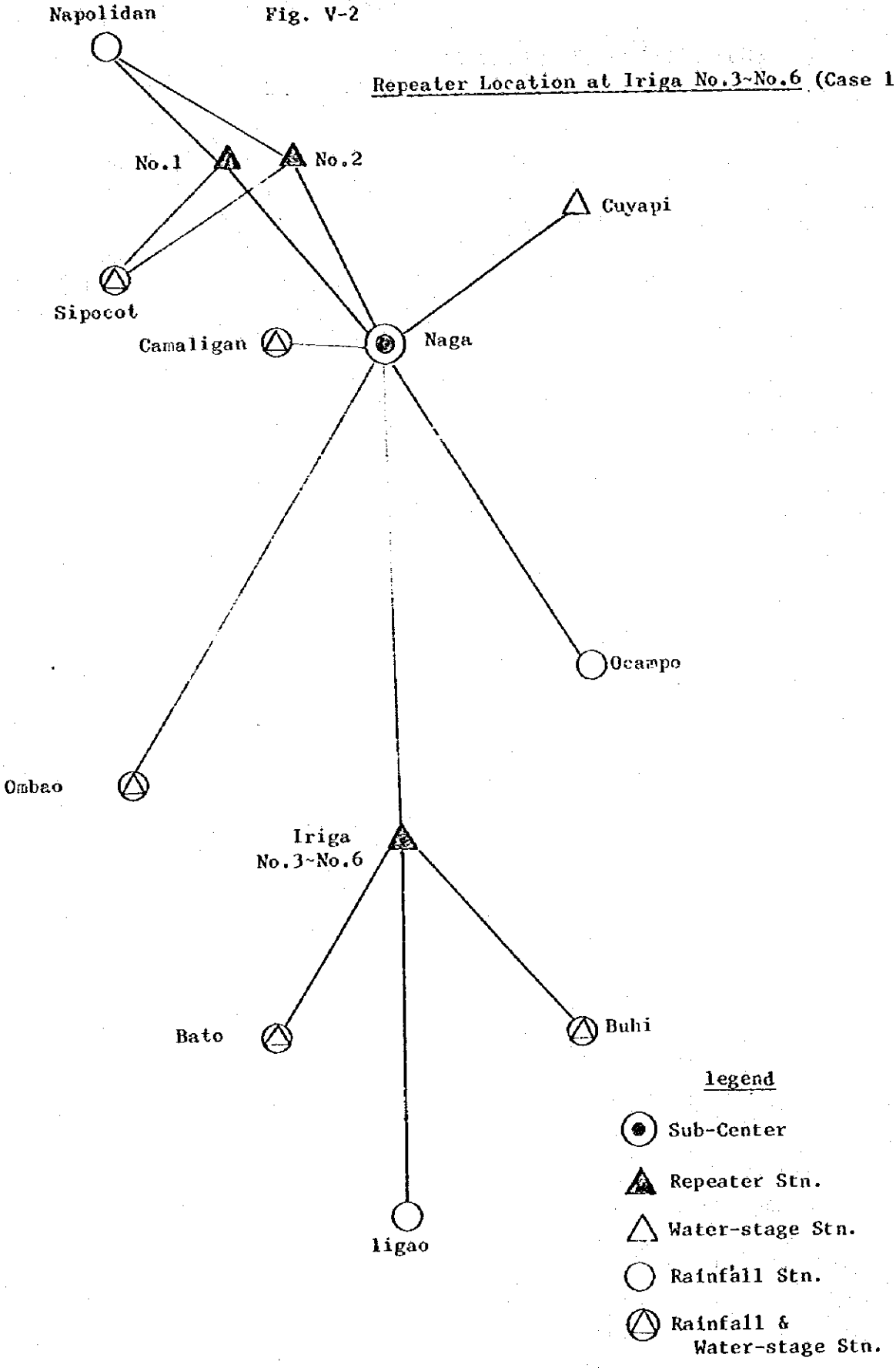


Fig. V-3 Bicol System

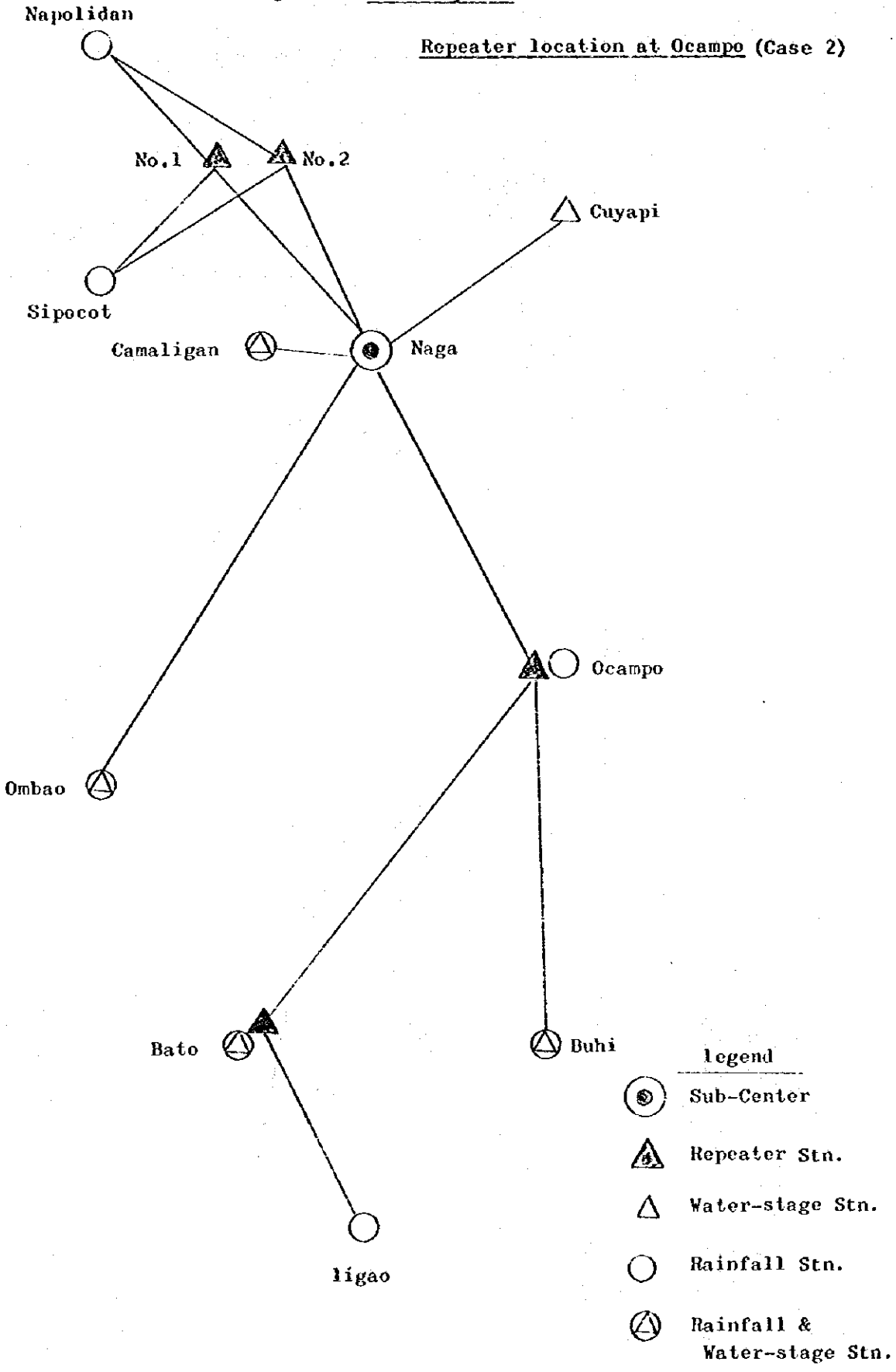
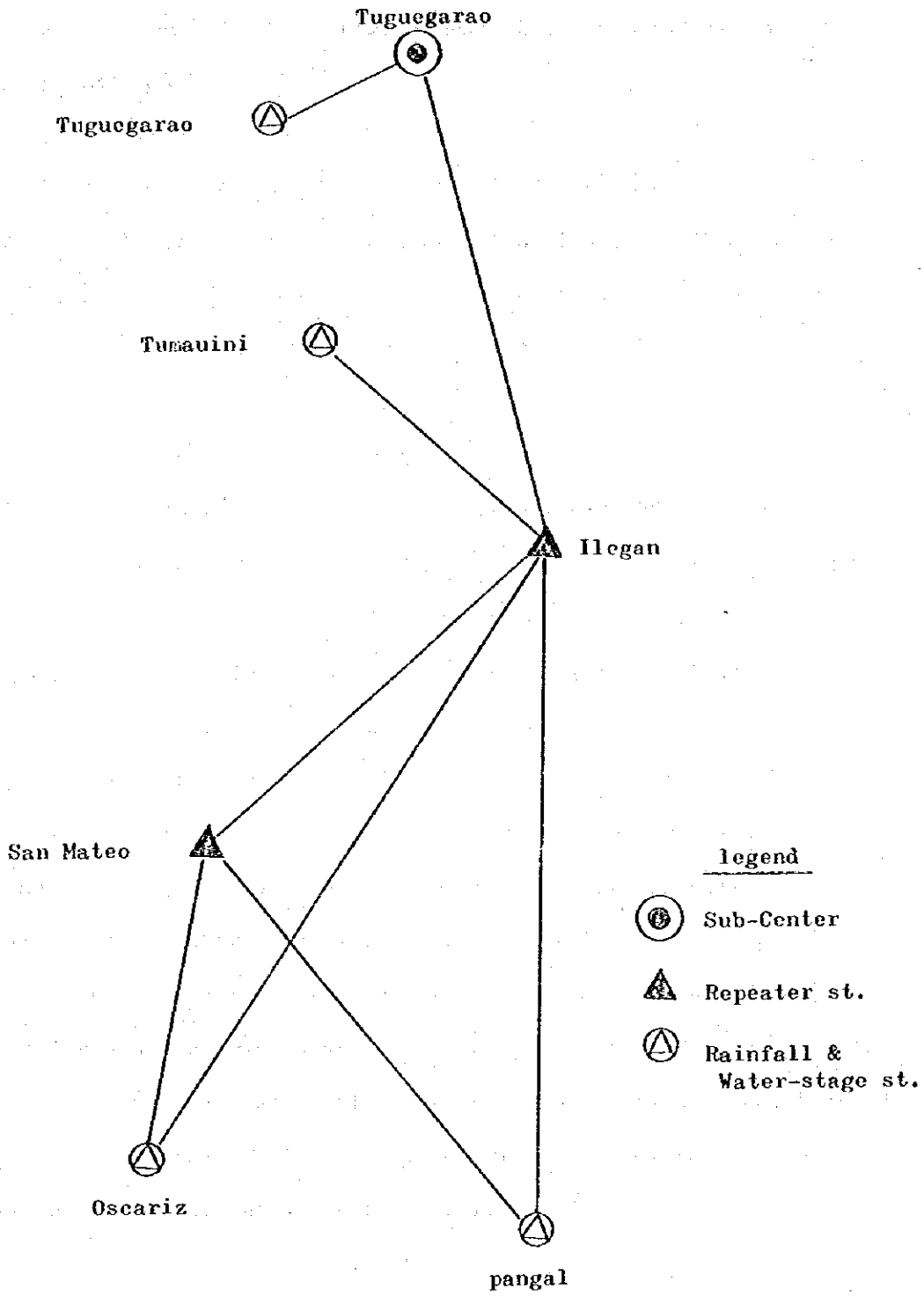


Fig. V-4 Cagayan System



§3. Design of Telecommunication Links

A desk plan is drawn according to the data obtained to date, and the results are listed below. However, amendments are still to be made by radio propagation tests.

1. Telemetry Network

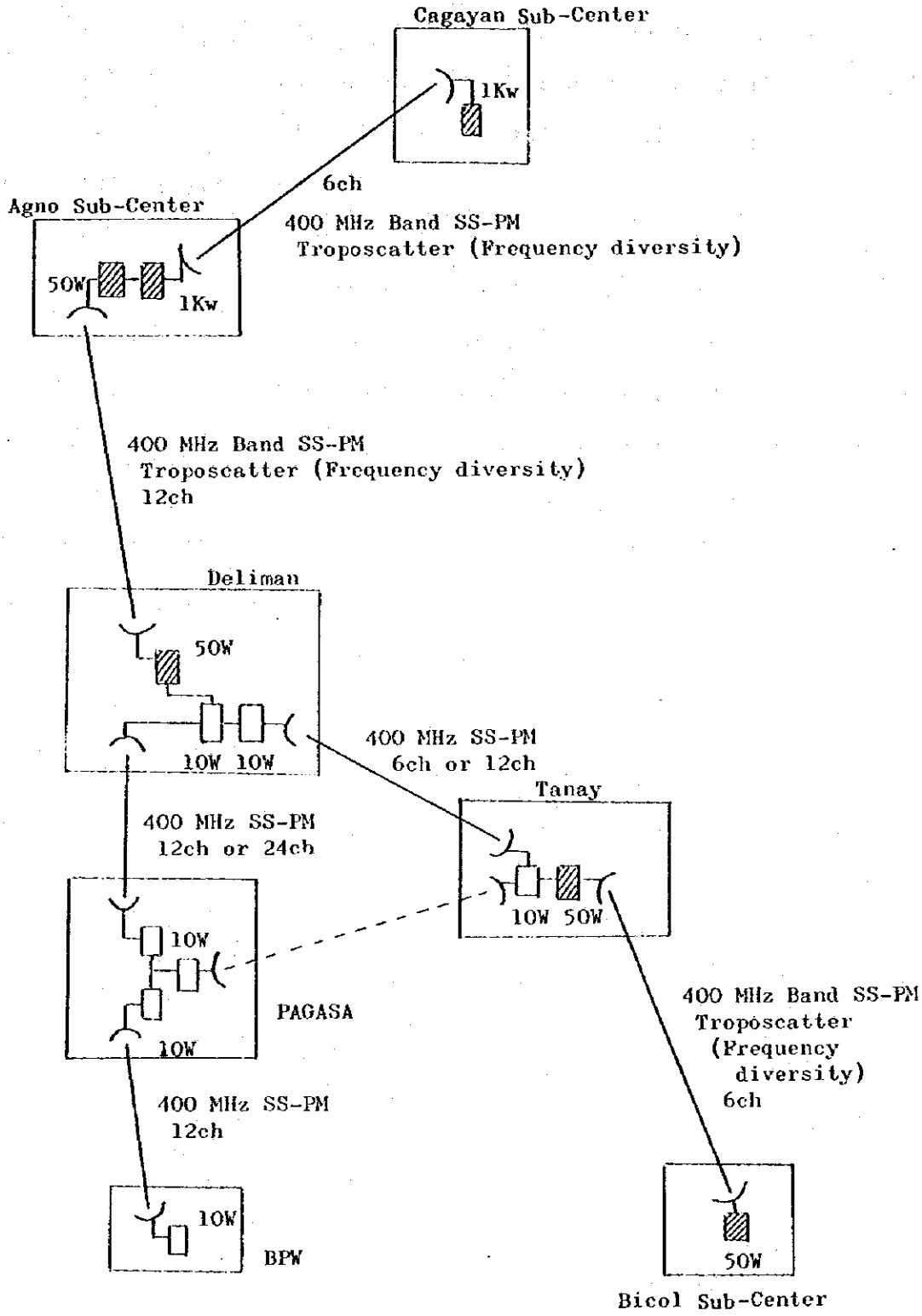
An explanatory map drawn on a scale of 1/50000 is shown in Fig. V-5. The results of the construction of a telecommunication system based on the map is shown in attached sheets. The frequency range of the telecommunication system is assumed to be 170 MHz.

2. Multiplex Telecommunication Network

The 400 MHz band multiplex telecommunication links which connect each subcenter with F.F.C. and B.P.W. in Manila via the transmitting and receiving station are now under evaluation, but at this point the network shown in Fig.V-5 is recommendable. The Agno River System and the Cagayan River System will be connected to F.F.C. and B.P.W. through the transmitting and receiving station in Deliman. Direct connection to Deliman Station from the Cagayan River System will be difficult. Hence, the Cagayan River System will be connected to the Agno Subcenter and share the Agno telecommunication system.

In the case of the Bicol River System, the connection to Deliman transmitting and receiving station will be difficult. Therefore, it is recommended that a transmitting and receiving station be established at Tanay, so that the Bicol River System will be connected via Tanay to Deliman or PAGASA, whichever is better.

Fig. V-5


Cagayan Sub-Center
1Kw
6ch
400 MHz Band SS-PM
Troposcatter (Frequency diversity)
Agno Sub-Center
50W
1Kw
400 MHz Band SS-PM
Troposcatter (Frequency diversity)
12ch
Deliman
50W
10W 10W
400 MHz SS-PM
6ch or 12ch
Tanay
400 MHz SS-PM
12ch or 24ch
10W 50W
10W
PAGASA
10W
400 MHz Band SS-PM
Troposcatter
(Frequency
diversity)
6ch
400 MHz SS-PM
12ch
10W
BPW
50W
Bicol Sub-Center

It is necessary to build two transmitting and receiving stations since neither Deliman nor Tanay could connect three systems at the same time. Details of the investigations of this network will be proposed in the Progress Report II.

3. Back-up Telecommunication Links

Short wave telecommunication system should be constructed from each subcenter to, F.F.C. and B.P.W. as a temporary measure before the establishment of a multiplex telecommunication system and as a back-up measure in case of a suspension after the establishment of the multiplex telecommunication system. Consequently, the transmitting and receiving station for this short wave system is planned at Deliman.

The frequency range will be 3 MHz, 5 MHz and 7-8 MHz. Alternative use of these three frequency ranges will ensure a satisfactory telecommunication system throughout the year.

VI. Schedule of Implementation

The survey team considers it difficult to construct the whole system immediately and recommends a "step by step" method, divided into 5 steps. The period of each step should be determined by the progress of the maintenance system and the bodget.

Step 1

Construction of multiplex telecommunication system from the subcenter to F.F.C. and B.P.W. to facilitate data transmission, telemetry station of Agno River, and S.S.B. short wave telecommunication system as a back-up measure.

Step 2

Establishment of telemetry facilities in either the Bicol or Cagayan Basin and establishment of S.S.B. short wave telecommunication system as a temporary measure for data and information transmission to Manila.

Step 3

Establishment of telemetry station in the basin where the station was not built in Step 2, and establishment of S.S.B. short wave telecommunication system as a temporary measure for data and information transmission to Manila.

Step 4

Establishment of multiplex telecommunication system to facilitate data and information transmission to F.F.C. and B.P.W. from the subcenter built in Step 2.

Step 5

Establishment of multiplex telecommunication system to facilitate data and information transmission to F.F.C. and B.P.W. from the subcenter built in Step 3.

VII. Operation and Maintenance

It is important that all instruments, in particular the telemetry equipments must be maintained in perfect condition and improved incessantly to best suit the objectives so that the Flood Forecast and Warning System can function smoothly. For this purpose, not only is the employment of maintenance personnel and endless training to improve the techniques important, the provision of the necessary budget for maintenance and operation is also important. The maintenance expenditure generally differs from year to year, but the minimum requirement will be an annual 3 to 5% of the new installation cost.

Two qualified engineers and two technicians are required at each sub-center in the river basins, and one technician is needed to manage the multiplex telecommunication linking F.F.C. to the subcenter. These employees will reside in the various subcenters and they will draw up a long term plan for investigations as well as its execution, repair the equipments in case of failures, and check the parts, wear-out instruments and meters, etc. Besides, the maintenance staff for the telemetry system at the Pampanga River system, three qualified engineers and two technicians are required to maintain and operate the transmitting and receiving stations at Deliman and Tanay, the monitor station for F.F.C. and B.P.W., and their jobs will be the co-ordination of the entire system and plannings for maintenance, renovations, training, equipment supply, provision of measuring instruments and its execution.

A systematic plan of the above will be shown in Table VI-1.

Table VI-1 Staffing Schedule

	Chief Engineer						Supervising Engineer						Qualified Engineer						Technician						
	Present	Step 1	Step 2	Step 3	Step 4	Step 5	Present	Step 1	Step 2	Step 3	Step 4	Step 5	Present	Step 1	Step 2	Step 3	Step 4	Step 5	Present	Step 1	Step 2	Step 3	Step 4	Step 5	
PFC Pampamga River							1							1					3						5
Other River		1						1						1			1			2					6
Agno River								1						2						2					5
Bicol River									1						1		1				2				5
Cagayan River										1						1		1				2			5
Total		1					1	2	1	1				4	1	1	2	1	3	4	2	2			26

	Chief Engineer	Supervising Engineer	Qualified Engineer	Technician	Total
Present		1		3	4
Step 1	1	2	4	4	11
Step 2		1	1	2	4
Step 3		1	1	2	4
Step 4			2		2
Step 5			1		1
Total	1	5	9	11	26