THE REPUBLIC OF THE PHILIPPINES

THE FEASIBILITY STUDY
ON
THE DEVELOPMENT PROJECT
ON
THE METEOROLOGICAL TELECOMMUNICATION SYSTEM

FINAL REPORT

JANUARY 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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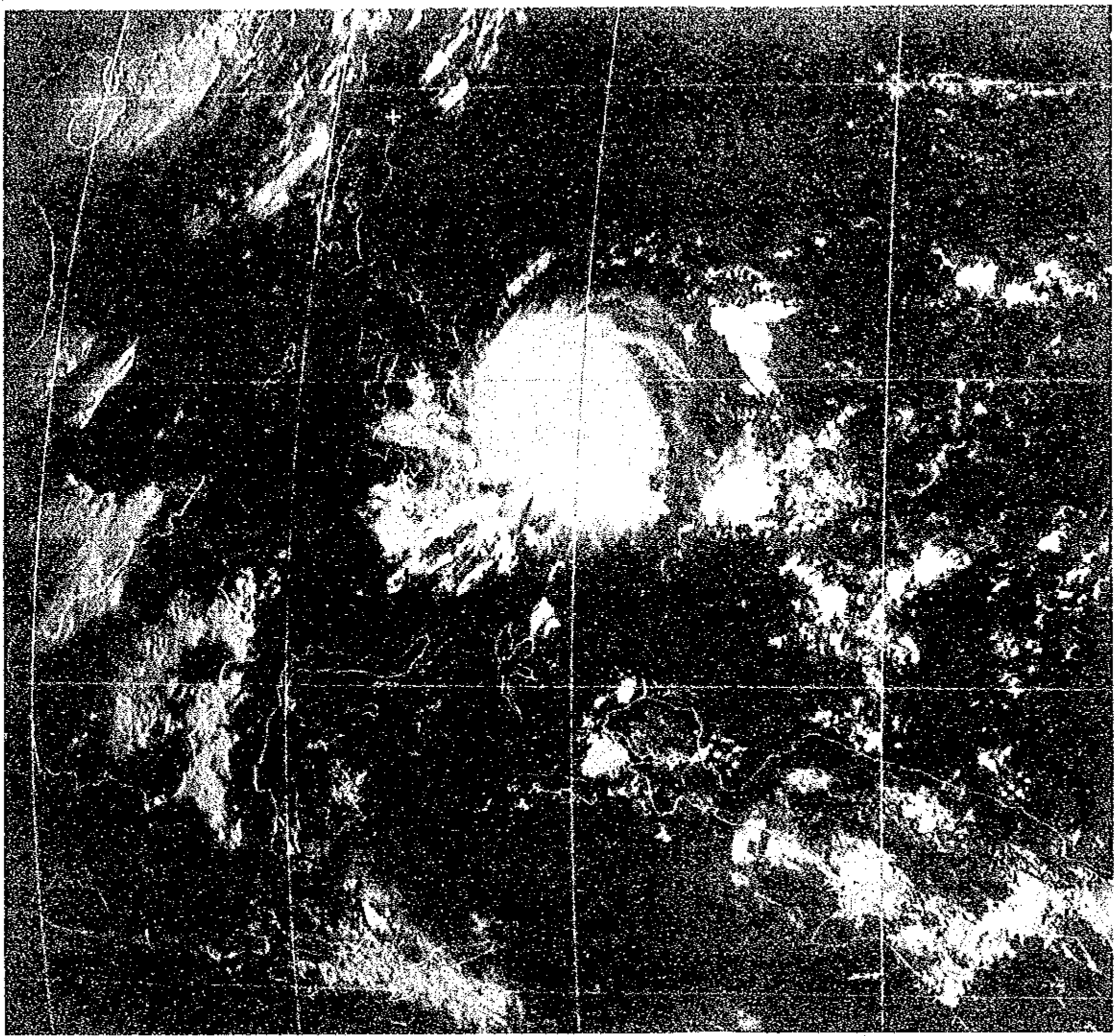
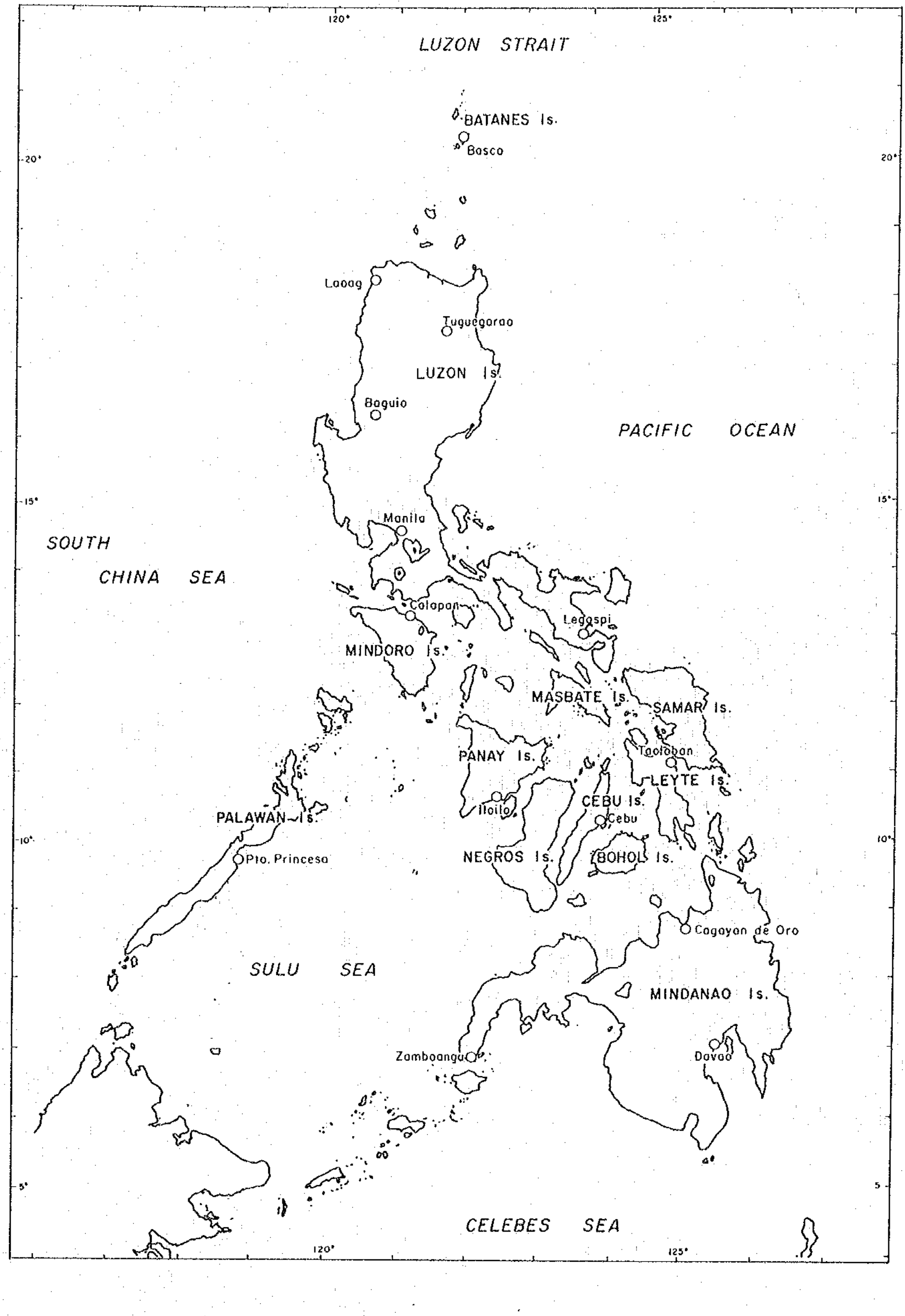


Photograph of Geostational Meteorological Satellite

Typhoon NITANG (8411), (1st. Sept. 1984 00Z)

Map of the Philippines



PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a feasibility study on the Development Project of the Meteorological Telecommunication System and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to the Philippines a study team headed by Dr. Eizou MARUYAMA, expert, Meteorological Institute of Japan Weather Association, in September 1983, under the guidance of the advisory committee chaired by Mr. Mitsuo NARUI, director of the radio communication division, forecast department, Japan Meteorological Agency.

The team held discussion with the authorities concerned of the Government of the Philippines on the project and field survey in the country. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will be served for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the authorities concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

January 1985

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

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1. Introduction

1.1 General

The Republic of the Philippines, being located between 4° and 21° north latitudes in the West Pacific, is affected by typhoons and monsoons and suffers from losses of human lives and properties every year. To minimize such circumstances and reduce typhoon damages, the improvement of the basic weather observation facilities and meteorological telecommunication system for collecting weather data and disseminating weather information is indispensable.

A great effort has been made so far by the government of the Philippines to fulfill these requirements. With the recognition of the urgency of meeting these requirements, an official request was made by the government of the Philippines to the government of Japan for the improvement of the meteorological telecommunication system (MTS). In response to the request, the official agency, Japan International Cooperation Agency (JICA), dispatched a survey team for conducting the feasibility study (the Study) on the improvement of meteorological telecommunication system (the Project) and survey results are compiled in this Final Report.

1.2 History of the Project

The Philippines has suffered from enormous damages on human lives and properties by typhoons every year. The number of deaths and missing, for instance, reached 1,820 persons in 1970 and 1,050 in 1978 respectively. The 11th Conference of the Typhoon Committee organized by ESCAP and WMO requested the government of Japan in 1978 to extend a technical assistance for the improvement of MTS in the Philippines to mitigate meteorological calamities. In response to the request, JICA dispatched meteorological experts to the Philippines in 1980 and 1981 and conducted the fundamental survey concerning the improvement of meteorological service systems in the Philippines.

The government of the Philippines requested to the government of Japan to extend technical assistance for conducting the feasibility study on the meteorological telecommunication system in June, 1982. In response to the request, the government of Japan, entrusting related matters to JICA as an official agency, dispatched the preliminary survey mission headed by Mr. Noboru Yajima in November, 1982 and concluded the Scope of Work (S/W) for the feasibility study. In accordance with the S/W, a field survey in the Philippines was conducted during the period from September, 1983 to March, 1984 by the field study team headed by Dr. Eizo Maruyama. Analysis was subsequently continued in Japan and all the survey results are compiled in this Final Report.

The reports submitted to Philippine Atmospheric Geophysical and Astronomical Service Administration (PAGASA), the implementing agency of the government of the Philippines, during the field survey include the following:

September, 1983	: Inception Report
January, 1984	: Progress Report
March, 1984	: Interim Report
October, 1984	: Draft Final Report

1.3 The Scope of the Study

The objective of the study is to conduct a feasibility study for the improvement of the meteorological telecommunication system, which mainly serves to collect and disseminate meteorological data by systematically connecting weather stations scattered all over the Philippines.

Main work items include the followings:

(1) Radiowave (UHF (OH: Over Horizon), VHF and HF) propagation tests on MTS and its preliminary design

(2) Analysis of collected data

(3) Survey and design of observation facilities and stand-by power source

(4) Preliminary design of disseminating system of weather information

(5) Operation and maintenance plan

(6) Socio-economic evaluation of the project

(7) Cost estimate and implementation plan

1.4 Implementation System of the Study

The name list of the study team, main staffs of PAGASA and the JICA Supervisory Committee is presented in Tables 1.1, 1.2 and 1.3 respectively.

1.5 Schedule of Study

The survey schedule is as presented in the Table 1.4 and summarized below:

October, 1983	Station site reconnaissance
November, 1983 - March, 1984	Site Survey
November, 1983 - January, 1984	OH radiowave propagation test for the main trunk line starting Manila to Southern Luzon, Samar, Cebu and Mindanao
February - March	VHF and HF radiowave propagation test for the above line
June - September	Analysis of collected data in Japan

July : Field survey for data collection for frequency allocation and socio-economic evaluation

October : Hearing (draft final report)

In conducting the Study, the wholehearted support and assistance to the study team was provided by the following organizations: PAGASA, OCD (Office of Civil Defense, Ministry of National Defense), MPWH (Ministry of Public Works and Highways), MTC (Ministry of Transportation and Communication), NPC (National Power Corporation), NIA (National Irrigation Administration), PNR (Philippine National Railway), PCIC (Philippine Crop Insurance Corporation), PNRC (Philippine National Red Cross).

2. Background of the Project

2.1 Socio-economic situation in the Philippines

2.1.1 Land and Population

The Republic of the Philippines lying between 4° and 21° north latitudes and between 117° and 127° east longitudes is composed of more than 7,000 islands and islets. The total area of the Philippines is approximately 301,000 km^2, 96% of which is covered by 11 major islands. The biggest island is Luzon whose area is 105,708 km^2 followed by Mindanao with the area of 95,587 km^2 The Philippines extends from north to south to a length of 1,850 km. It is administratively composed of 12 regions which are divided into 66 provinces. Map of the Philippines is shown in Fig. 2.1.

The population in the country is approximately 48,098 thousand persons as of May, 1980 (Table 2.1). The population in Luzon, Visayas and Mindanao is about 22,604, 14,589 and 10,905 thousand persons respectively as of May, 1980. The population in Luzon constitutes about a half (48%) of the total population. (population census)

The average population density as of May, 1980 is about 160 persons/km^2 in all the Philippines. The most densely-populated area is Metropolitan Manila Area which has a population density of 9,317 persons/km^2, followed by Central Luzon (Region 3) with 263 persons/km^2. The most sparsely-populated area is Cagayan Valley (Region 2) whose population density is about 60 persons/km^2.

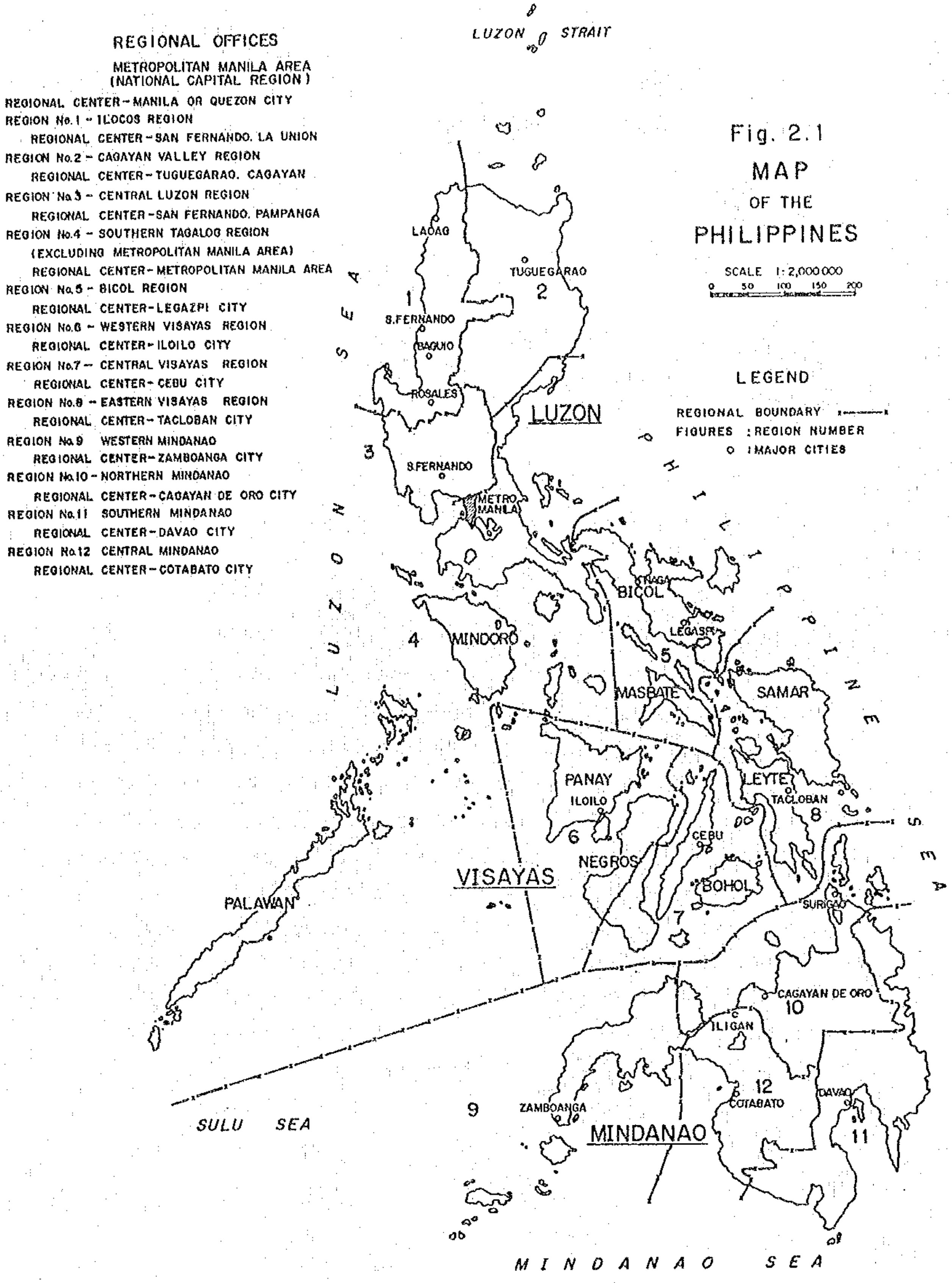

Fig. 2.1 MAP OF THE PHILIPPINES

The annual growth rate of population in all the Philippines was about 2.7% for the period of 1970 - 80. The corresponding rate of population in Metropolitan Manila Area was 4.1% for the same period.

2.1.2 The Economy of the Philippines

Macro-economic data in the Philippines are presented in Table 2.1. The economy in the Philippines has been stagnant due to the world-wide depression after the second oil crisis in 1980. While the gross domestic product (GDP) made a growth of 6.2% in real terms from 1970 to 1980, the corresponding growth rate was only 2.6% from 1980 to 1983. The GDP and per capita GDP at current price of 1983 were about ₱380.8 billion and ₱7,330 (US$660) respectively.

The composition of GDP by industrial group showed an increase in industrial sector from 30% in 1970 to 36% in 1982 and a decrease in primary sector from 28% to 23% in the same period. An indication of industrial development is expressed by increased share of GDP by the industrial sector. The percentage of GDP shared by agriculture, forestry and fishery was 23% and that by industrial sector was 36% and that by service groups 41% in 1982.

Exports increased from US$ 1,142 x 10^6 in 1970 to US$ 4,995 x 10^6 in 1982. Imports also increased from US$ 1,159 x 10^6 in 1970 to US$ 7,800 x 10^6 in 1982. The share of traditional export goods, major of which includes copra, sugar, and bananas, has been decreasing from 75% in 1970 to 37% in 1982. On the other hand, non-traditional manufacturing exports have increased remarkably. Intermediate goods among imports have been increasing since 1970 due to industrial development policy adopted by the government.

The overall balance of international payment has been negative since 1975. The major negative component has been the trade deficit in current account. Import has exceeded export since 1970. The trade deficit is partly because prices of primary products for export decreased due to the world recession. On the contrary, the capital balance has been positive mainly due to the inflow of long and short-term capital.

The composition of labor force employment has not changed in 1970s. There were approximately 16,118 x 10^3 persons as total number of the employed in 1978. The labor force of 52% of the total was employed in the sector of agriculture, forestry and fishery. The employed rate in industrial and service sectors corresponds to 14% and 34% in 1978 respectively. Unemployment rate was 5.1% in 1982.

2.1.3 Agriculture

The data on agricultural production is presented in Table 2.2. Agriculture is still the significant sector in the country's economy. Major agricultural crops are palay, corn, coconut, sugarcane and bananas (in the order of their production). The value of palay produced in 1982 was ₱12,335 x 10^6 at current price, while the value of all agricultural products were ₱44,406 x 10^6 in the same year.

Agricultural products can be divided into two types; food crops for domestic consumption and commercial crops for export. Major food crops are palay and corn, and major commercial crops are coconut, sugarcane and abaca. The noticeable point is that the share of commercial crops in agricultural products decreased from 41% in 1970 to 30% in 1982. This indication is in accordance with decreased share of traditional exports, majority of which is agricultural products.

Self-sufficiency in rice production was attained in 1970s. The mean yield of rice in metric tons per hectare increased from 1.68 to 2.36 during 1970 - 1982. The productivity of major food crops (palay, corn) increased, while that of commercial crops (coconut, sugarcane) indicates a stagnant growth rate.

2.1.4 Industrial Sector

The data on industrial sector are presented in Tables 2.3 and 2.4. The GDP by industrial sector increased from ₱12,581 x 10^6 in 1970 to ₱122,242 x 10^6 in 1982. Manufacturing constituted a major component (68%) of industrial sector of GDP in 1982. Major manufacturing industries were foods, petrochemical and coal, chemical and textile (in the order of gross value added). Foods have been the biggest industry whose gross value added were ₱27,189 x 10^6, followed by petrochemical and coal with its gross value added ₱11,617 x 10^6 in 1982.

2.1.5 Telecommunication System

The statistics on telecommunication are presented in Tables 2.5 and 2.6. In proportion to the development of social and economic activities, telecommunication systems such as telegraph, telephone and telex become vital and indispensable in the Philippines. Telephone services are now provided by some 219 facilities for public service. A total of 2,153 stations for public service handles telegraph services in the country.

The broadcasting stations (TV and Radio) are installed even in rural areas although many stations are concentrated in Manila and West Luzon Area. The number of licensed radio stations has been increasing; they are operated under either the government or the private ownerships. The coastal, aircraft and ship stations play an important role in disseminating weather information. An extended network of televisions and radio broadcasting also plays an important role in disseminating emergent information to the general public.

2.1.6 Economic Development Programme

Under the previous Five-Year Development Plan for 1978 - 1982, the GNP growth of 7.5% per annum was targetted. But the attained growth rate was actually 3.6%. This was mainly due to the world-wide depression originated after the second oil crisis in 1980. Despite this stagnant economy in the latter half of the planned five years, the Philippines' economy has made some remarkable progress throughout the whole plan period.

Notable economic progress was made in the field of agriculture, industrial sector and infrastructure. The expansion of agricultural products and self-sufficiency in rice was successfully attained. Industrial sector achieved the substantial growth, which led to the remarkable export growth of manufactured goods such as electrical and electronic equipments.

Under the present Five-Year Plan for 1983 - 87, the country puts an emphasis on the attainment of sustainable economic growth and more equitable distribution of wealth brought by development. For the purpose of providing balance among sectors and among regions, an efficient allocation of investment or other resources is planned to be promoted.

During the plan period, the real economic growth of 6% per annum is planned. The GNP by 1987 is planned to reach ₱749 billion, resulting in a per capita income of ₱13,199 at current prices. An annual inflation rate of around 9.0% is expected.

2.1.7 Income Level by Region

The income level by region is indicated in terms of per capita output in Table 2.7. In 1978, the per capita output was the highest in Luzon (₱2,108 x 10^3) followed by Visayas (₱1,569 x 10^3) and Mindanao (₱1,333 x 10^3). The lowest was Eastern Visayas (Leyte and Samar Islands) with ₱990 x 10^3. The high income level in Luzon is due to Metropolitan Manila Area in which the country's socio-economic activities are concentrated.

Meanwhile, according to the typhoon statistics in the Philippines from 1944 to 1983 (Table 2.8), the area vulnerable to typhoons are the whole Luzon (excluding Central Luzon in which Metro Manila is located) and Eastern Visayas. It is noted that the areas vulnerable to typhoons coincide with the low income areas.

2.2 Climate of the Philippines

2.2.1 Prevailing Winds

Prevailing winds which affecting the climate of the Philippines are the Northeast Monsoon, the Southwest Monsoon, the North Pacific Trades, Temperate Zone Westerlies, and South Pacific Trades. Of these five air streams, the first two have greater effects on the climate of the Philippines than the latter three.

(1) Northeast monsoon

This prevailing wind originates in the cold, intense Asiatic winter anticyclone and generally crosses Japan toward the western Pacific Ocean. It finally blows into the Philippines generally as a northeasterly prevailing wind, sometimes as a northerly or easterly stream. It starts to blow into the Philippines in October as a weak stream and grows up to a maximum strength in January. It gradually weakens in March and finally disappears in April. Fig. 2.2 shows the surface air flow over the Philippines in January under the influence of the Northeast Monsoon.

(2) Southwest monsoon

This prevailing wind originates in the Indian Ocean Anticyclone as Indian Ocean Trades during the winter season in the southern hemisphere. Upon crossing the equator, the winds are deflected to the right in the northern hemisphere, generally arriving at the Philippines as a southwesterly stream, sometimes coming from the west or south.

It usually appears in the Philippines in early May, attains a maximum intensity in August, then weakens gradually and disappears in October. Occasionally, however, the Southwest Monsoon appears in early April and persists until November or December. Fig. 2.3 shows the Southwest Monsoon over the Philippines in its peak season, in July.

2.2.2 Tropical Cyclones

The Philippines are located in such a region as is recognized to have the highest frequency of tropical cyclones* in the world. The number of tropical cyclones which made a landing or skirted along the Philippines in 40 years (1944 - 1983) was about 318 or annual mean of about 8.

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* Tropical cyclones are classified as follows:

1.	Tropical Depression	:	Maximum winds about the center not more than	60 kph
2.	Tropical Storm	:	"	60-117 kph
3.	Typhoon	:	"	118 kph or more

For these 40 years, the annual number of tropical cyclones which affected the Philippines varied from the minimum of 4 in 1950, 1955, 1958 and 1959 to the maximum of 17 in 1964 as shown in Table 2.8. The tropical cyclone season in the Philippines lasts from June to December, although the other months are not entirely free of these cyclones.

According to the records for 1944 - 1983, the period from June to December accounts for about as many as 85% of the total number of tropical cyclones which affect the Philippines during the period from June to December.

Tropical cyclones follow widely various tracks in the vicinity of the Philippines. During the period from April to June, the cyclones which hit the Philippines generally cross Visayas. During the period from July to September, most of the cyclones cross Northern Luzon and the Batanes islands. During the period from October to March, they generally cross the Visayas. Percentage frequency of tropical cyclone passage is between 31 - 40% for over Northern Luzon, Batanes, Northern Samar, Sorsogon and Masbate, 21 - 30% for Northwest Luzon, most of Southern Luzon, and Northern Leyte, 11 - 20% for Central Luzon and portions of Northern and Southern Luzon, and the greater portion of the Visayas, and less than 10% for Mindanao. The tracks of tropical cyclones that entered or formed in the PAR in 1981 are shown in Fig. 2.4.

2.2.3 Thunderstorms

Compared with tropical cyclones, thunderstorm occurs relatively less frequently and with a short period in the Philippines. Nevertheless, thunderstorms occur in the Philippines throughout all the year round owing to moist and unstable conditions of most of air streams affecting the Philippines as well as to the aid of orographic lifting. Fig. 2.5 shows the distribution of mean annual number of days with thunderstorms in the Philippines.

2.2.4 Rainfall

Rainfall in the Philippines is influenced to a large extent by air streams, tropical cyclones, the Interconvergence Zone and topography conditions.

(1) Mean annual rainfall

Mean annual rainfall in the Philippines is 2,705.4 mm, 2,295.4 mm and 2,235.2 mm for Luzon, Visayas and Mindanao respectively. HINATUAN on the east coast of Mindanao has the largest annual mean rainfall of 4,360.3 mm.

Fig. 2.6 shows the distribution of annual rainfall in the Philippines. Of the 42 stations in Table 2.9, only one station GENERAL SANTOS situated in the valley in Southern Mindanao had the mean annual rainfall of less than 1,000 mm, 14 stations between 1,000 - 2,000 mm, 17 stations between 2,000 - 3,000 mm, 9 stations between 3,000 - 4,000 mm and 2 stations more than 4,000 mm.

Of the 11 stations with the annual mean rainfall of more than 3,000 mm, 8 were directly exposed to the Northeast Monsoon and the rest of 3 were exposed to the southwest Monsoon.

Most of western coastal stations do not receive an appreciable amount of rainfall from the Northeast Monsoon and North Pacific Trades. The station showing the relatively small annual mean rainfall of less than 2,000 mm are mostly located in the valleys or places shielded from the dominant air streams by high mountain ranges (Fig. 2.6).

(2) Monthly mean rainfall

Rainfall records of 42 stations indicate that August has the highest mean of about 300 mm and April has the lowest with about 100 mm. Period between June and December is the rainy season, while the dry season covers the period from January to May. It is evident from the record that most of eastern coastal stations have a marked rainy season during the period from October to March when the Northeast Monsoon is dominant. The western coastal stations have their rainy season during the period of June to October in the Southwest Monsoon and the tropical cyclone season.

(3) Number of rainy days

Rainy day is defined as the day with rainfall of 0.1 mm or more. The mean monthly and annual number of rainy days for 42 stations in the Philippines are shown in

Table 2.10. It is observed from the table that the mean annual number of rainy days counts about 173. Most of the stations in the eastern coastal area have the mean annual number of rainy days of more than the national average, while the majority of the stations in the western coastal area has a lower mean annual number of rainy days. Stations located in inland areas and mountain sides also show the number below the national average. The periods with many rainy days coincide with the periods of the greatest rainfall amount as shown in Fig. 2.7.

2.2.5 Floods and Drought

Heavy rainfall, especially at the passage of tropical cyclones and intensification of monsoons, results in the overflow over banks of the big rivers in the island, especially in Luzon and Mindanao and frequently floods persist for 1 to 5 days. The flood occurs almost every year in big rivers.

During the dry months, on the other hand, rainless days last for more than 30 successive days, and sometimes exceeding 100 days, especially in the western coastal area of Luzon, resulting in droughts. In 1983, a severe drought occurred in Northern Mindanao, causing a big damage on agricultural products. Unlike flood, however, droughts take place infrequently.

2.2.6 Air Temperature

Table 2.11 shows the record of mean monthly and annual temperature. As the Philippines is situated in a tropical zone, no remarkable difference caused by area is observed.

2.3 Present Situation of Meteorological Services and Its Problems

PAGASA is under the National Science and Technology of Authority (NSTA), and its Headquater is located at Quezon City, Asia Trust Bank Building. The most important function of PAGASA is to contribute to the improvement of public welfare, particuraly, to the prevention and mitigation of natural disaster. The location of the weather stations is shown in Fig. 2.8.

Meteorological services in the Philippines cover such fields as meteorological observation, weather forecast and meteorological telecommunication. The present state of meteorological service and its problems are decribed hereunder.

PAGASA WEATHER STATION'S LOCATION

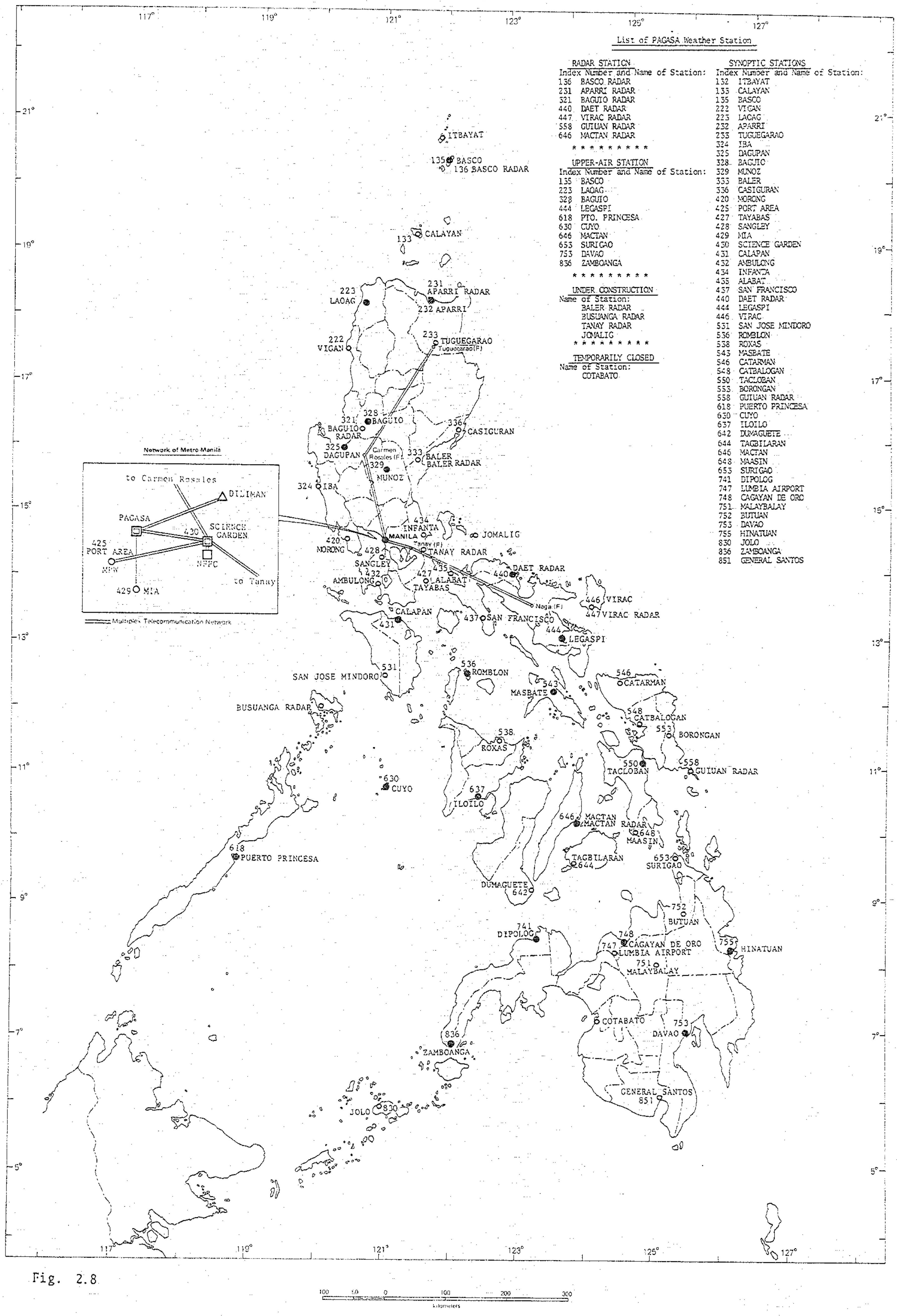

Fig. 2.8

2.3.1 Present State of Meteorological Services

The meteorological observations such as surface and upper air, weather radar, seismological and marine meteorological observations are carried out.

The weather forecast for the whole country and regions is originated from the National Weather Office (NWO) of the PAGASA based on the analysis of the collected weather data. The collection of observed data and the dissemination of weather information are carried out through Single Side Band (SSB) connecting the PAGASA Forecast Center (PFC) and weather stations.

2.3.2 Problems of Meteorological Services

(1) Meteorological observations

(i) Many observation instruments are so old that many of them are in deteriorating conditions, and that their replacement and spare parts are difficult to obtain.

(ii) The whole observation system is conventional. It is desirable that an automated system should be introduced gradually to facilitate acquiring observation data speedily.

(2) Telecommunication services

(i) Means of telecommunication rely on SSB (surface observation, radar observation and seismological observation: one radio wave, respectively). Therefore, telecommunication operational failures sometimes occur, due to interferences and time restrictions.

(ii) Facilities are in bad state, resulting in a weak systematic function and network.

(iii) Spare parts for repair are no longer available.

(3) Weather forecast

The collection ratio of national observation data needed for weather forecast is so low to get high accuracy in weather forecast.

(4) Stand-by generator

Many of stand-by power generators are so old that they can not be used when the commercial power supply is interrupted.

2.4 Necessity and Objectives of the Project

2.4.1 Natural Disasters in the Philippines

The Philippines is the most suffering country from natural disasters among the Asian countries. Enormous damages are especially brought by typhoons every year. For example, Typhoon Nitang (Typhoon No. 8411) formed over the Caroline islands on August 27th of 1984, moved west with growing momentum and struck the Central Visayas region after passing over the northeastern part of Mindanao. Subsequently, it proceeded northwest across the South China Sea and finally dissipated over the South China. This typhoon had recorded the lowest pressure of 955 mb at about 300 km east of Mindanao at 00Z on September 1st. On September 2nd and 3rd, it crossed over the Philippines, moved to the westwards and brought about tremendous damages. The number of deaths and missing reached to about 1,000 persons. House destruction, land slide and high tide followed. The track of this typhoon is shown in Fig. 2.9. The GMS (Geostational Meteorological Satellite of Japan) photograph is also presented in photograph 1.

The historical records of natural disasters in the Philippines for the period from 1970 to 1983 are presented in Table 2.12. The said records comprise such natural disasters as thphoon, drought, flooding, earthquake, tornado, land slide, sea mishaps and air mishaps.

The number of casualties including deaths and missing caused by typhoons alone ranged from 47 persons in 1975 to 1,823 persons in 1970 or an average of 459 persons in 14 years; due to flooding, the number of casualties, deaths and missing, caused by flooding amounted to about 4,600 persons in 1980 and the earthquake which occured in Moro Gulf in Mindanao counted about 5,700 deaths in 1976.

The damage caused by natural disasters is abstracted from Table 2.12 and rearranged by each cause in Table 2.13 and is depicted in Fig. 2.10. Total damages of all the natural disasters ranged from ₱19.7 million in 1975 to ₱2,325.3 million in 1980. The ratio of damage of natural disasters to GDP ranged from 0.02% in 1975 to 1.18% in 1970 with the estimated average of 0.5%. As Table 2.13 shows, the damage caused by typhoon has been dominant among all the damage by natural disasters in the Philippines.

The historical record of natural disasters in Japan is presented in Table 2.14 for comparison purpose; the number of deaths and missing ranged from 153 to 524 persons in these 6 years up to 1982.

2.4.2 Typhoon Damage in the Philippines

As mentioned in the preceeding section, a typhoon is the biggest natural disaster in the Philippines. The historical record on monthly frequency of passage of tropical cyclones by region for the period from 1948 to 1977 is shown in Table 2.15. With respect to the regions, about a half of the total typhoons visited the three regions 1, 2 and 4 as shown in Fig. 2.1 which are located in Northern and Central Luzon.

The individual data on 42 tropical cyclones which entered the Philippine Area of Responsibility (PAR) in the period from 1970 to 1983 are presented in Table 2.16. Based on these data, the correlation between the magnitude of each typhoon in terms of its lowest pressure in PAR and the number of casualties including deaths and missing is depicted in Figs. 2.11 and 2.12.

The said correlation is depicted by two linear regression lines for the two periods of 1970 - 1976 and 1977 - 1983 in Fig. 2.11. The gradient of linear regression for the period of 1970 - 1976 is steeper than that of the period of 1977 - 1983. This shows that, as the time passed, the number of casualties by the typhoon that passes with the same magnitude has been lessened. This means that the development of resistance of the whole society concerning typhoon-resistance capacity has been enhanced during these years of 1970 - 1983.

The same correlation is depicted by two linear regression lines for the two areas of North/Central Luzon and South Luzon/Visayas/Mindanao in Fig. 2.12. The gradient of these two linear regression lines does not show any significant difference. This means that, between these areas, there is no significant difference in terms of typhoon resistance capacity of the whole society.

Typhoon damage to various kinds of properties is presented in Table 2.17 in which the damage caused by destructive typhoons in each year from 1978 to 1983 is shown. A significant damage has been observed in agricultural crops, livestocks and fishponds; the percentage share of the damage to the total typhoon damage was 49.5% in the period from 1978 to 1983.

Government properties including port, pier or sea wall, school building, public buildings, flood control facilities, irrigation facilities and roads and bridges have been damaged next to the above primary sector; the percentage share of government property damage to the total typhoon damage was 31.1% in the same period. The percentage share of the damage to private houses to the total typhoon damage was 19.4% in the same period.

2.4.3 Various Mishaps Caused by Adverse Weather and Conceivable Effects of the Project

(1) Agriculture and fishery

A typhoon may cause damage to agricultural crops through heavy rain, flooding or strong wind. Damage of palay in monetary value caused by typhoon and floods was the highest in the whole damage of agricultural products in 1983; the percentage of palay damage to the total damage of agricultural crops was 40% in 1983. The damage of coffee, sugarcane, banana and coconut followed that of palay.

Aiming at protecting individual farmers suffering from adverse weather, the Philippines Crop Insurance Corporation (PCIC) has been established in 1981. The objectives of this crop insurance are limited to palay and corn at present. The seeds, fertilizer, chemicals and labour that have been put in and lost due to typhoon, floods, drought and plant pest are to be compensated to the farmers by the PCIC. The household of 220,000 farmers corresponding to about 20% of the total farm household joined the crop insurance in the whole Philippines in 1983.

As for the conceivable effects of the Project, it was informed through the interviews during the field survey that, if a typhoon track can be forecasted more correctly and a longer lead time can be available for farmers to harvest before a typhoon hits the field, the damage of agricultural crops caused by typhoon might be significantly mitigated.

If the coming of a typhoon can be forecasted in advance, more livestocks might be moved to safe places and the gate operation of a fish pond might be done to lessen the loss of cultured fish.

(2) Houses and buildings

According to the damage record of Typhoon Bebeng (8302), the damage to private housings, school buildings and public buildings occupied 12% of the total damage. Private houses specially with a nipa roof are generally weak to strong wind. However, through the interview during field survey, the survey team was informed that the damage due to typhoons could be saved if some protection measures had been taken before the coming of typhoon. Although both Japan and Philippines are the countries vulnerable to typhoons, the premium for typhoon insurance is actually higher in the Philippines than in Japan.

If the coming of a typhoon can be forecasted in advance with an enough lead time for a dweller to reinforce his house, the extent of destruction might be mitigated.

(3) Railway, road and bridges

The Philippines National Railway (PNR) extends from Manila 265 km northwards and 460 km southwards. It is not electrified yet and dieselized trains run on a single track. There are in the northward line a number of temporary bridges which were washed out many times in the past when typhoons visited. These washouts of temporary bridges are habitual and they are being monitored all throughout the year. The typhoon damage of PNR is estimated at ₱2.0 million per year on an average.

A bulletin will be delivered to PNR from PAGASA whenever a typhoon is approaching. When the Storm Warning Signal No. 3 is blasted, all the trains will be under stop-running regulation and shelter at the nearest station.

If a typhoon track can be forecasted more accurately, PNR might transport various kinds of rescue goods including emergency supply of foods, drinking water and materials and machinery to be needed for restoration of the washed-out bridges.

As for roads and bridges, according to the Ministry of Public Works and Highways (MPWH) (Bureau of Maintenance), the cost required for the repair and rehabilitation of various highways and public works facilities damaged by typhoons in the three years of 1981 - 1983 was estimated at ₱365.4 million with the breakdown shown below.

	Category	Estimated Cost of Repair
1.	National Highways & Bridges	₱134.3 million
2.	School Buildings	166.0
3.	Other Public Works Facilities	65.1
	Total:	₱365.4 million

The restoration of the road broken by a land slide might be considerably facilitated through preposition of rescue party and machinery if a typhoon track can be forecasted faster and more accurately.

(4) Aviation

According to the Bureau of Air Transportation (BAT), the accident statistics showed 12 aircraft accidents with fatality in the Philippines during the three years of 1981 - 1983. Of the above 12 aircraft accidents, only three accidents briefly described below were considered to have been related to adverse weather.

(i) On February 9th, 1982, a DC-3 aircraft with 36 passenger seats has made a forced landing due to bad visibility in the mountains of Sicogon Island at the north-west of Panay Island. Two crews and one passenger were killed and many other passengers were wounded.

(ii) On May 9th, 1982, a cessna plane fell into the sea near Cotabato in Mindanao due to adverse weather and one crew and three passengers were killed.

(iii) On September 26th, 1983, a light airplane collided with a hill near Batangas in Luzon due to adverse weather and one pilot was killed.

The Philippines Air Lines (PAL) receives weather data of the whole Philippines three times every day from PAGASA. When the destination airport is in bad weather condition for landing, the aircraft usually postpones its departure or cancell its flight schedule. Sometimes, when the airport is in so bad weather conditions that the landing is deemed dangerous, the aircraft will be directed to an alternate airport.

An accurate weather forecast would save fuel consumption of an aircraft through avoiding either the shift to an alternate airport or the forced detour due to bad atmospheric conditions during flight.

(5) Navigation

According to the statistics of sea mishap field in the Board of Marine Inquiry (Table 2.18), there are not so many marine accidents caused by adverse weather; of the total marine accidents 2,254 in the period from 1972 to 1982, only 283 which corresponded to 13% of the total were considered to be weather related sea mishaps. Most of the marine accidents were categorized into those caused by boisterous weather, which means big waves and swells generated by the strong wind during typhoon. In the monsoon season, many small boats meet with accidents caused by big waves and swells.

Shipping companies receive weather information two times a day from PAGASA. When a typhoon is approaching, shipping companies collect weather information from such an organization outside the Philippines as Japan Maritime Commission (JMC), U.S. Navy bases in Okinawa and Guam Islands and Hong Kong. The vessels navigating send the information of weather and sea conditions to the Manila headquarters twice a day.

When Storm Warning Signal No. 1 is hoisted, all the vessels navigating within the area related are directed to shelters like ports. When Storm Warning Signal No. 2 or 3 is hoisted, all the vessels sheltering in the ports are to go out of the ports to avoid possible destruction of pier facilities.

An improvement of weather information in its accuracy and speed of dissemination would make it possible for shipping industries to shorten the navigation time and consequently save expenditures on fuel cost, personnel cost and other variable costs. The probable loss in the costs for fuel, personnels and ice for freezing resulting when a fishing boat is forced to return to the port prior to operation due to adverse weather could be avoided by a fishing company.

(6) Power industry

The data on damage to power industry caused by adverse weather such as typhoon, heavy rain and lightning were not available during the field survey. However, according to the "Line Outage Report" prepared by NPC, there were significant incidents of power interruption due to typhoon, lightning, strong wind and heavy rain several times a year.

An improvement of typhoon track forecast would facilitate the restoration of power outage through the advance alert to maintenance staff. A dam reservoir operation for hydropower generation would be carried out effectively when a telemetering of the water level will be incorporated in the meteorological telecommunication system.

(7) Disaster operations

Disaster operations when required are carried out under CDOC (Civil Defense Operations Center) established in OCD (Office of the Civil Defense, Ministry of National Defense).

The procedures of disaster operations are presented in Fig. 2.13. Upon receipt of a warning/bulletin from PAGASA, the situation will be analyzed in the Intelligence and Disaster Analysis Section, which will give an alert or advice thereafter to the Plans and Operations Section (POS). Implementation plans for disaster operations will be delivered from POS for action to OCD Regional Centers and to various implementing national agencies including MPWH, NPC, PNR, PNRC and other related agencies. The communication measures that OCD obtains are SSB radios for long distance and telephones for inside-town communications. The PNRC has no communication measures connecting its Manila headquarters and its regional centers.

An improvement of meteorological telecommunication system will reinforce the present insufficient communication capacity of OCD for disaster operations; a quick and sufficient communication between Manila and the affected area would facilitate the rescue activities and may save human lives otherwise jeopatized by a delay of medical care and food supply.

2.4.4 Necessity and Objectives of the Project

It is strongly requested from the points of view of humanity and of socio-economy in the whole Philippines to mitigate the losses of human lives and damages to properties caused by natural disasters mentioned in the preceeding sections. The effective dissemination of weather forecast and warnings to the general public would contribute to the mitigation of meteorological disasters.

As mentioned in 2.3, however, there are many problems in the meteorological telecommunication system and observation facilities at present, and then the quick and effective dissemination of meteorological information is found very difficult. An urgent improvement and consolidation in the meteorological telecommunication system is therefore requested.

This Project based on the above request aims at constructing an appropriate meteorological telecommunication system and at improving observation facilities. A quick collection of data, accurate forecast and warning will be possible by this Project. Consequently, the considerable mitigation of meteorological calamity will be achieved. The Project will also contribute to the improvement of not only the property and welfare of the people but also the development of meteorological services in the neighboring countries of the Philippines.

3. Study Results and Analytic Evaluation

3.1 Meteorological Telecommunication System

The present communication system of the PFC has not provided effective routine data exchange, and caused a hindrance to meteorological services.

To improve the present communication system, survey was undertaken to contribute toward the construction of an effective and economical meteorological telecommunication system while taking account of the geographical features of the Philippines consisting of many islands.

This section describes the present state of the meteorological telecommunication system, radiowave propagation tests, their results, analysis, and analytical estimation and so on.

3.1.1 Present State of Meteorological Telecommunication System

A SSB simplex radio communication link is being used as the only means for communication between every weather station throughout the country and the PFC.

The collection of observed data by SSB is performed at the PFC, MIA, and DILIMAN under the control of DILIMAN, while the system has been designed to provide a back-up if any outage occurs in the SSB.