THE SURVIVAL OF HUMANKIND
THE PHILIPPINE EXPERIMENT

Natural Disaster

TECHNOLOGY RESOURCE CENTER

FOREWORD

The "Conference on the Survival of Humankind: The Philippine Experiment" was a call for scientists from all over the world to work together in harnessing modern technology for development purposes. The ultimate objective of the scientific gathering was the preservation of the balance and quality of life.

Mrs. Imelda Romualdez Marcos, who was the moving spirit behind this Conference, aptly described the rationale of the Conference, when she remarked:

> *"Man deserves a fate better than mere life on this planet. Man has a right to honor, beauty, and happiness. Too long has the true meaning of life gone with paradise lost. Today, we can hope for paradise regained".*

Thus from September 6-10, 1976, scientists and decision makers searched for solutions to the pressing problems of the Philippines in the areas of energy, education, environmental protection, food, health and nutrition, housing, natural disaster, planning management, population control and distribution, and technology and science transfer. New ideas, new techniques, and new approaches to man's relationship with nature were evolved, discussed, analyzed and recommended to improve the quality of human life.

The Technology Resource Center, which was set up as a result of the conference, has undertaken the publication of this volume and ten others on the various themes of the Conference. This volume on Natural Disaster Prediction, Control and Moderation contains the papers read by foreign and Filipino scientists. Discussions revolve around the efforts to develop new approaches to and techniques of natural disaster prediction, control and moderation. Various aspects for prediction and prevention of natural disaster are presented in concrete situations. This volume includes a set of recommendations by the Theme

Committee and specific actions that may be taken to effect these recommendations.

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JAPAN METEOROLOGICAL AGENCY STRIVING FOR PREDICTION AND PREVENTION-ALLEVIATION OF NATURAL DISASTER

BY JUTARO KOBAYASHI

INTRODUCTION

Japan is one of the countries which is often hit by natural disasters. Located on the eastern fringe of the Asian Continent, Japan is composed of a chain of volcanic islands which stretch in a south-north direction, thereby subjecting the country to severe climatic changes as well as to seismic and volcanic activities. Japan often suffers ravaging disasters from local downpours induced by the *bai-u* front in early summer, typhoons in summer towards autumn, and heavy snow in winter. At times, earthquakes and volcanic eruptions which occur without warning bring serious damage. The high economic growth during recent years has rapidly spurred development of industries and transportation network thus bringing a concentration of population to the cities, etc. This situation in turn has rendered the damage caused by natural disasters even greater.

The agency keeps constant watch on the geophysical phenomena including meteorological, terrestrial, and oceanographical events and disseminates all information available throughout the country without delay, thus assisting in an improved accuracy in the prediction of natural disasters and contributing to the prevention and alleviation of damages from them.

Approximately 170 weather watching stations throughout Japan are engaged in collecting and analyzing data and disseminating the information to the public. Sophisticated instruments using electronics such as radars and automatic observation devices are installed for collecting data. High

speed electronic computers are employed for processing these data. Likewise radio, television, telephone, etc. are used for transmitting the information to the public.

Elaborated in this paper is the present status in forecasting unusual weather conditions of long or short period and in predicting occurrence of earthquakes and volcanic eruptions, activities in which the Agency is now putting its utmost efforts.

UNUSUAL WEATHER

There are two kinds of meteorological phenomena which have great impact on social activities. One of these occurs over a long period of time such as drought, while the other phenomenon exists for a shorter period, such as local severe rain. Since the scales of these phenomena are different in terms of both time and space, they are regarded as two different types of occurrences.

LONG-TERM UNUSUAL WEATHER

Long-term unusual weather exerts great influence on food and water resources, and at times, such conditions as drought and cold weather cause poor harvests as well as a curtailment of farming operations due to a lack of industrial water supply. All these have serious impacts on daily life and production activities.

During the recent years, long-term unusual weather conditions have been attracting more and more attention from people not only in Japan but throughout the world. This interest started in 1972 when the world was hit by a drought. Australia, Thailand, India, Indonesia, Europe and the Soviet Union, which are the world's major grain producing regions, suffered from the drought that year, and consequently, the world's grain stock had been altered from excess to shortage. Japan which had been

importing foodstuffs at that time also suffered greatly from this drought. People's interest in abnormal weather increased as a result of this experience.

In 1973, the Agency conducted a "Study to Grasp the Actual Conditions of the Recent Unusual Weather in the World and of its Long-Term Perspectives" as an integral part of the "Study on the Global Supply-Demand Structure of Food and its Perspectives". The result of this study was released in March, 1974. The sum and substance are as follows:

1. The temperature in the Northern Hemisphere is changing year by year; however, in respect to the long-term trend, the temperature is becoming lower around the polar region.
2. On the basis of solar activity and the periodicity of climatic variation, it is predicted that this trend will continue for more than ten years.
3. In the regions located in the middle latitudes, the difference of temperature between the northern and southern areas will probably increase and the motion of the westerlies will tend to meander. As a result of this phenomenon, there will be a sharp contrast in the local climates such as high and low temperatures, drought and heavy rain. This trend is expected to continue for a while.
4. Various effects not only on agriculture but on many other fields are expected to be brought about with such changes in the weather as mentioned above, and therefore measures to remedy these adverse situations must be considered.

The unusual weather has become a matter of great concern throughout the world, including Japan, since the above-mentioned result of the study was made known. Following are the frequency of the abnormality values in terms of temperature and amount of precipitation which occurred during the

12 years from 1961 through 1972 on the basis of data obtained at the approximately 120 observation stations situated throughout the world: 460 cases of abnormally low temperature and 206 cases of abnormally high temperature, showing an approximately 2.2 fold difference; 427 cases of abnormally scarce rain and 295 cases of abnormally abundant rain, registering an approximately 1.6 fold difference. The above figures indicate that the characteristics of the recent unusual weather are low temperature and drought.

For example, in the summer of 1975, Bai-u, the rainy season, was over earlier than usual in Japan. The country experienced extremely hot weather and drought. On the other hand, in the winter of the same year, a cold air mass which was said to be the first in 30 years, hit an area from India to the Middle East causing heavy snow in the generally hot desert countries. Moreover, some places on the Japan Sea side recorded an unprecedented heavy snow since the observation started, and Miyako Bay froze for the first time in 10 years. Conversely, on the Pacific Ocean side of the country, there was no rainfall and a non-precipitation record of 72 days was set. In North America, damages to the agricultural products were caused by the long rain in the spring, the drought in the summer and extraordinarily early arrival of a cold air mass. In May, 1975, Central Asia was covered by an anticyclone which brought drought to the granary region in the Soviet Union. In Japan, the heat of the mid-summer lingered on to September, and in many regions new records for the number of hot days above 30°C were set while the drought also resulted in the delay of sowing of the seeds.

This year, areas around England and France suffered for several months from scarce rain, and drought has become a problem. On the other hand, the Soviet Union experienced a chilly summer due to the cold air which came in from the northern region, while the area on the coast of the Mediterranean Sea was especially hit by abnormally low temperatures.

In Japan also, the cold air flowed in several times over the northern sector of the country causing the lowest temperature ever experienced in the past 10 years and bringing about much concern for damages from the cold weather.

Since major changes in the weather have great impact on the economy, a long-term forecast is necessary. However, this is extremely difficult under the present situation; therefore as an alternative, we are placing emphasis on conveying the correct information rapidly. To cite one example, the Meteorological Agency has been keeping watch on the world's unusual weather since 1974.

The resolution adopted by the last 28th Session of the Executive Committee of WMO underlined the importance of research and study on climatic variation and unusual weather. In compliance with the above-mentioned resolution, the Meteorological Agency intends to carry out studies with the cooperation of various circles. However, the causes of climatic variation and unusual weather have not been sufficiently revealed at the present stage and only conjectures on these subjects have been announced. In order to obtain some clues, the Meteorological Agency and the Meteorological Research Institute are studying weather simulation with the use of an atmospheric general circulation model. The effects of human activities on the weather are also of consequence, and therefore we are considering reinforcing the supervising system by establishing regional air pollution stations or baseline air pollution stations for monitoring background pollutants such as CO_2, dust and the amount of solar radiation. Ryori, Hirato and Chichijima are being considered for the observation sites.

SHORT-TERM ABNORMAL WEATHER

Typhoon

The greatest damage caused by a typhoon in recent years in Japan was on the night of 26 September, 1959 when typhoon

No. 15 (5915, Typhoon Vera) passed near Ise Bay. The number of dead from this typhoon totaled 5,098 throughout the country including 3,675 who died from the storm surge at Ise Bay (meteorological tide 3.5m). The Japanese government immediately convened an extraordinary session of the Diet to discuss recovery measures. At the same time it initiated a long-term plan for the prevention of disasters.

After two years of discussions, the "Basic Law for the Measures against Disasters" was promulgated in October 1961. Stipulated in this Law were rules or measures to be taken against disasters in Japan, mainly against natural disasters. In compliance with this regulation, meetings on prevention of disasters were convened by the government or by the local autonomous bodies to formulate disaster prevention plans. In case of emergency from disaster, the local autonomous bodies were to organize a "Commission for the Measures Against Disasters", while the national government formed the "Emergency Disaster Measure" to carry out preventive measures.

Japan has a long history of administration of disaster prevention but the reform on this occasion was significant in terms of comprehensiveness and planning. The activities for disaster prevention by the Meteorological Agency have been conducted on the basis of this Law to the present. Table 1 represents the changes in the number of the dead by typhoons in Japan by year. The table indicates that there has been a conspicuous decrease since the 1960s. There are many possible factors for this, but it is apparent that the comprehensive and the planned activities for the prevention of disasters which were carried out in compliance with the Basic Law for the Measures against Disasters and the investment for disaster prevention have been effective. It is conceivable that the effects of the activities on the weather forecasting have been great.

In Japan, typhoon movement forecasts are conducted

by the Forecast Department of the Meteorological Agency. From the beginning of a typhoon formation, a forecast of its movement in the form of international maritime area warning is announced every six hours, and every three hours when the typhoon enters the neighboring waters of Japan. Furthermore, when there is a possibility of the typhoon approaching or hitting Japan, a special team of forecasters is set up and typhoon information is given every three to six hours. When typhoon hits the country, announcement is made every hour to the various organizations engaged in disaster prevention as well as to the public. Also, the 70 local meteorological observatories and designated weather stations which are in charge of each local forecasting area and the specified forecasting regions give advisories and warnings for heavy rain, storm rain, storm surge, high waves, etc. to their own forecasting areas at the appropriate time based on the forecast of the typhoon movement conducted by the Forecasting Division of the Meteorological Agency. All of this information is conveyed to the public through the local autonomous bodies, various organizations for disaster prevention, and other information media, in accordance with Basic Law for Measures against Disasters or on the basis of regulations of the Meteorological Service Law. The local autonomous bodies and other organizations take up such measures such as issuing evacuation orders and rescue activities. Radio and television play an important role in conveying typhoon information to the public. Quite often, when a typhoon is approaching, public and private broadcasting stations set up a special relay station in the Meteorological Agency and in each meteorological observatory to broadcast typhoon information. Usually, a combination of data from aircraft observation and data received by the meteorological satellite is utilized to chart the typhoon's location over the sea and to track its movement. These data have proved to be extremely effective. The observation data taken by the Geostationary Meteorological Satellite which Japan will soon launch are expected to be of great

use in the near future. The twenty meteorological radars which are installed on the mainland of Japan, the southwest islands and other places greatly help in determining an approaching typhoon's location and in tracking its movement. The meteorological radar installed on the summit of Mount Fuji (3776m.) the highest mountain in Japan, especially plays a significant role because of its long range capabilities (maximum detecting distance is 800km). The primary means for the prediction of typhoon movement is a combination of kinematical extrapolation and numerical forecast methods. In 1974, the Meteorological Agency compiled all the methods for typhoon prediction which existed at that time and established new working guidelines for typhoon prediction.

Local Severe Rain

Another characteristic meteorological disaster in Japan is that caused by local severe rain resulting from the *bai-u* front, etc. The largest value of the amount of rainfall during 24 hours was 1109 mm at Saijo, Nagasaki Prefecture on 25 July, 1957. This rain was caused by a mesoscale disturbance accompanying the *bai-u* front. Although this kind of heavy rain affects only a local area, landslides, mudflows and flash floods cause vast damages. The above-mentioned heavy rain at Nagasaki Prefecture killed 705 people. Moreover, the number of dead from local heavy rain which occurred in many areas throughout the country during the period from July 3-12, 1972 amounted to 440. Table 2 indicates that the conspicuous decrease in the number of dead as seen in the case of typhoons is not found in the case of heavy rain arising from causes other than typhoons. It must be noted that the number of the dead from local heavy rain has become greater than that from typhoons since the 1960's. The newspapers and the news broadcasts on radio and television often express the characteristics of the local heavy rain disaster by the expression "Disaster by Guerrilla". This expression comes from the nature of its development - abruptness, unexpectedness, cluster,

locality, and small scale yet great destructiveness.

The Japanese Meteorological Agency is now at the stage of establishing a 24-hour prediction of the possible development of local heavy rain by use of what is known as MOS (Model Output Statistics) and other methods. We have also employed Regional Meteorological Data Acquisition System (AMeDAS) for the early recognition of local heavy rain. This system is composed of about 1300 automatic stations with relatively fine mesh network having a mean distance of 12 km. The observed data are collected and transmitted through public telephone lines by "real-time on-line system". The Agency is also exploiting a near term forecast method (approximately within six hours) using a combination of the radar observation data and the AMeDAS data. The NWW (National Weather Watch) Program presently is being drafted to improve the effect of disaster prevention utilizing meteorological information by linking the above-mentioned data with the information system of the various organizations concerned with the prevention of disaster.

TABLE I. CHANGE IN THE NUMBER OF DEAD BY YEAR

YEARS	Number of Typhoon Hitting Japan	Number of Dead
1941 - 50 (during 10 years)	48	11,668
1951 - 60 (during 10 years)	32	10,925
1961 - 70 (during 10 years)	33	1,626
1971 - 75	13	558

TABLE 2. CHANGE IN THE NUMBER OF DEAD BY HEAVY RAIN (MAINLY LOCAL SEVERE RAIN) CAUSED BY OTHER THAN TYPHOON BY YEAR

YEARS	Number of the Dead
1941 - 50 (during 10 years)	750
1951 - 60 (during 10 years)	5,246
1961 - 70 (during 10 years	1,762
1971 - 75 (during 5 years)	774

EARTHQUAKE

Japan and its surrounding waters release approximately 10% of the world's total earthquake energy. During the past 40 years, earthquakes over M6 hit this area 11.5 times a year; those over M7, once a year, and those over M8 once in ten years on the average.

The regional characteristic of quakes which occur in the neighborhood of Japan is that most large earthquakes above M8 occur in the off-shore regions of the Pacific. As a result, Japan has been suffering severely from tsunami as well as from damages caused by the earthquakes themselves. The necessity of countermeasures against tsunami damage has always existed in Japan. At present, the tsunami warning is one of the important tasks of the seismological service of the Agency. However, large earthquakes which cause great damage also occur in Japan proper - earthquakes over M6 at an average of once in a year and a half, over M7, once in five years. Great damages are caused when the epicenter of the earthquake is located below a city. From the above facts, studies on countermeasures against fire and on earthquake-proof buildings as well as studies on earthquake prediction have been conducted for many years; related laws have also been enforced. Under these circumstances, seismology in Japan has been aimed at establishing methods for preventing earthquake disasters, whereas in Europe it has evolved from a study of earthquake waves. Therefore, data related to earthquake prediction have been collected through observations and studies by governmental facilities, such as the Meteorological Agency, and universities.

In 1960, investigation group on earthquake prediction and planning was organized by seismologists to look into the system used by agencies engaged in earthquake prediction. "Prediction of Earthquakes-Progress to Date and Plans for further Development" was proposed. This proposal served as a

guideline for the earthquake prediction studies not only in Japan, but also in foreign nations.

More recently, the proposal by the Geodetic Council, Ministry of Education was adopted and the budget was released for a program of studies for earthquake prediction. This earthquake prediction program was further intensified because of the 1964 Niigata Earthquake, the Maisushiro Earthquakes swarm which took place in 1965, and the 1968 Takachi Off-shore Earthquake. The Coordinating Committee for Hokushin Seismic Activity, where the Agency played a leading role in its establishment at the time of the Matsushiro Earthquake, was especially significant in alleviating troubles and giving confidence to the local people through information activities including earthquake prediction. This was the very first of its kind in Japan. In April 1960, the Coordinating Committee for Earthquake Prediction was established by experienced scholars from various organizations in order to put earthquake prediction into practice. Later, a Central Administration for the prevention of Natural Disaster was agreed upon, and in November 1974, the Administrative Council for the Promotion of Earthquake Prediction Research was established in order to provide close linkages within governmental agencies concerning the promotion of the earthquake prediction program. At present, the Coordinating Committee for Earthquake Prediction plays an important role in exchanging information provided by various investigation and observation bodies, and conducts specific inquiries into this information. The Administrative Council for the Promotion of Earthquake Prediction Research conducts a comprehensive, and effective promotion to utilize the data gathered on earthquake prediction while contributing to the prevention of earthquake disasters.

Thus, anti-earthquake activities in Japan include countermeasures against fire and erection of earthquake-proof buildings. As to the afflictions caused by tsunami (besides

the presence of the International Tsunami Warning System in the Pacific at an international level), it also appears necessary to expand the scale of international information exchange related to earthquakes and tsunami.

VOLCANO

There are approximately 70 active volcanoes in Japan, and viewing the situation of these volcanoes since 1950, six to seven of them are in eruption every year. Among the 20 volcanoes in eruption in the recent years of 1973, 1974 and 1975, Sakurajima has erupted almost continuously. Red-hot cinders from Sakurajima's crater caused mountain fires, and those that reached farther sometimes broke windows of cars and front windows of flying airplanes. A large quantity of volcanic ashfall, over 10 million m^3, caused great damage to crops. Nor can we overlook the secondary afflictions of ashes obstructing water permeability on the mountainside which turns into a torrent of mudstones at times of heavy rain. In 1974, this trouble occurred causing great disasters twice and killing eight workers doing river improvement construction. Again in 1974, stones erupted from the Niigata Yakeyama killing three alpinists camped at night near the area. However, recently there have been no volcano activities accompanied by disasters. At present, the Meteorological Agency equips 16 volcanoes with permanent observation facilities and is organized to call out mobile volcano watchers whenever abnormal phenomena occur in other volcanoes. Monitoring of volcanoes is mainly conducted through observatories located at the foot of a mountain. They periodically measure the vibrations received from seismeters attached to the body of the volcano. In addition to this task, the Meteorological Agency makes visual observations from distant observatories and conducts field observations.

Concerning four volcanoes (Sakurajima, Mt. Aso, Izu Oshima, Mt. Asama) whose scale and frequency of eruption as