

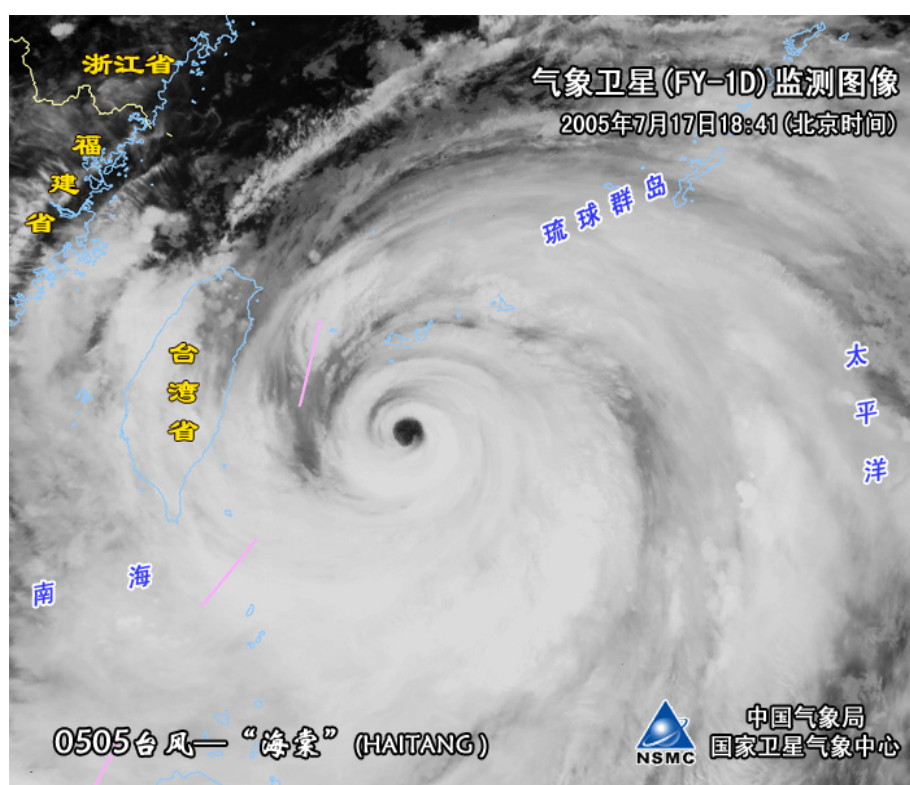
# Country Report

(2005)

For the 38<sup>th</sup> Session of the Typhoon Committee

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The People's Republic of China

# I. Overview of Meteorological and Hydrological Conditions in 2005

## 1. Meteorological Assessment

From October 2004 to October 10 2005, altogether 27 tropical cyclones (including tropical storms, severe tropical storms and typhoons) were formed over the Northwest Pacific and the South China Sea. The total number was basically equivalent to the average (27.49) in 1951-2004. Out of 27, 16 TCs were developed into typhoons, which accounts for 59.26% of the total. In other words, the total typhoon number was slightly less than normal average (17.19 accounting for 62.53%). During the same period, 2 TCs were developed over the waters around the Hainan Province, which were 4.92 less than the multiple-year average.

During this period, 10 tropical cyclones made their landfalls over China and they were Typhoon Nock-ten (0424), Typhoon Nanmadol (0427), Typhoon Haitang (0505), severe Tropical Storm Washi (0508), Typhoon Matsa (0509), severe Tropical Storm Sanvu (0510), Typhoon Talim (0513), Typhoon Khanun (0515), Typhoon Damrey (0518) and Typhoon Longwang (0519). The total number was noticeably more than the normal average number (about 7), which accounted for 37.04% of the total in comparison with the average percentage (25.46%). Moreover, in the same period there were another 4 TCs that had affected the coastal waters of China, despite of the fact they did not land over China. These TCs were Typhoon Muiha (0425), Tropical Storm Merbok (0426), Typhoon Nabi (0514) and Tropical Storm Vicente (0516). For specific tracks, please refer to Fig. 1.1.

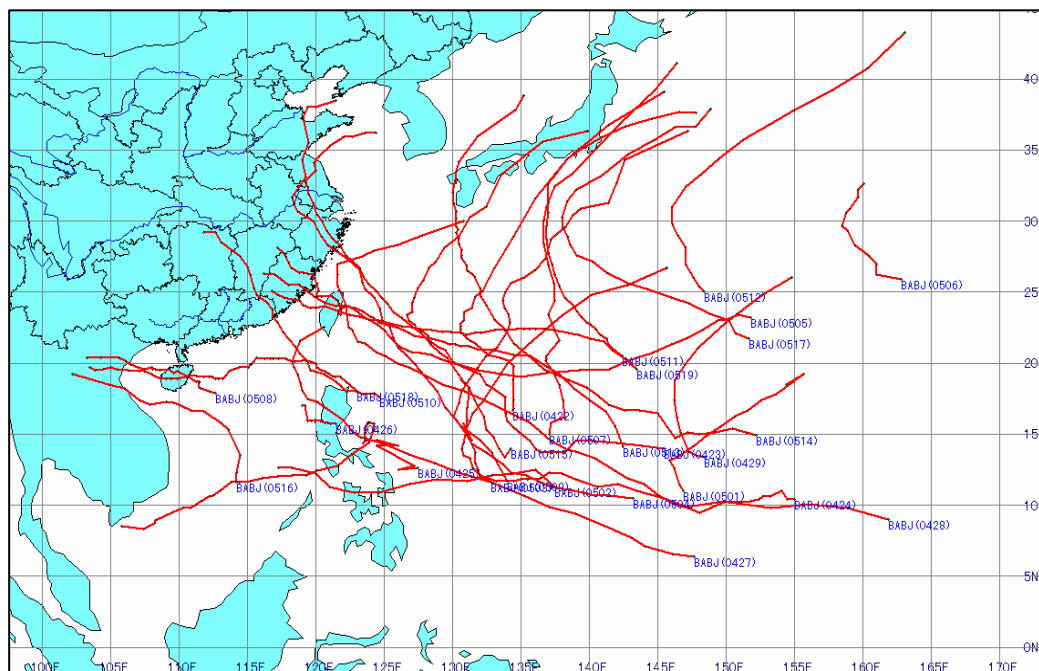


Fig. 1.1 Tropical Cyclone Tracks from Oct. 2004 to Oct. 10 2005

### ◆ The Characteristics of Tropical Cyclones' Activities in Northwest Pacific in 2005

#### ● *The originating sources were focused in a region and located more eastward.*

The tropical cyclones were mostly originated in the NW Pacific region between east Philippines and the Marshall Islands, which was located slightly eastwards compared with the normal TC originating source region. Within it, 19 TCs were originated in a area east Philippines and west of 150°E and 6 TCs over the waters east of 150°E, which were more than the average occurrence. In contrast, only 2 TCs were originated over waters around Hainan Island – an area in which TC was usually believed to be an originating source with higher TC occurrence.

- ***More typhoons with intermediate intensity.***

Compared with normal years, the total number of TCs and severe TCs developed from Oct. 2004 to Oct. 10 2005 were slightly more than normal average. There were less weak and stronger typhoons in terms of intensity, whereas there were more typhoons with intermediate intensity. The number of typhoons with maximum velocity exceeding or equivalent to 40m/s took 59.26% of the total, and it was higher than normal percentage (50.22%). However, the numbers of typhoons which maximum wind speed near center exceed 60m/s were relatively less.

- ***Longer TC Lifespan.***

During the period, The TC lifespan was longer, e.g. 17 TCs lasted beyond 5 days, which took 62.96% of the total. The typhoons with longest lifespan were Typhoon Muiha (0425) and Typhoon Nesat (0504), which both lasted for about 252 hours, or approximately 10.5 days.

- ***Landing TCs with higher intensity.***

Out of 10 TCs that made their landfalls over China, 7 TCs fell into the typhoon category. The strongest one was Typhoon Khanun (0515) with the maximum velocity of 50m/s at its centre, and it was the most severe typhoon that landed over Zhejiang Province since 1956.

#### ◆ **The Climate Background of Tropical Cyclones' Activities in Northwest Pacific in 2005**

- ***SST in the equatorial Pacific***

The index of region NINO Z (NINO 1+2+3+4) was above 0.5°C in Sep 2004, and reached the highest value 0.8°C in Dec 2004. Since then, it decreased quickly and dropped to 0.2°C in Feb 2005 (see Fig.1.2), and maintained between 0.2-0.4°C during the rest period. According to ENSO's definition, the duration and the strength of the warm process from Sep 2004 to Jan 2005 were both below the standard of El-Nino event.

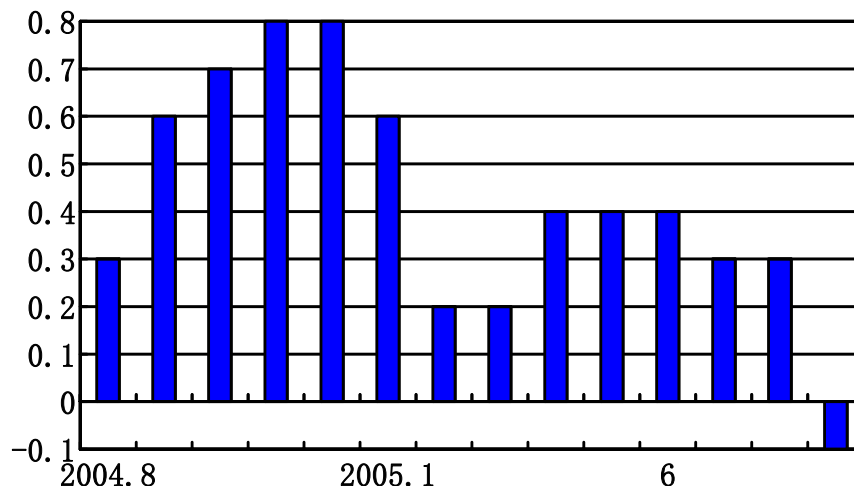


Fig.1.2 The index of Nino Z from Aug 2004 to Sep 2005

In Jul and Sep 2005, when tropical cyclones were more active, sea surface temperatures were above normal in the western equatorial Pacific, and there was a region with SST above 30°C that does not existed during the same period in 2004 (see Fig.1.3).

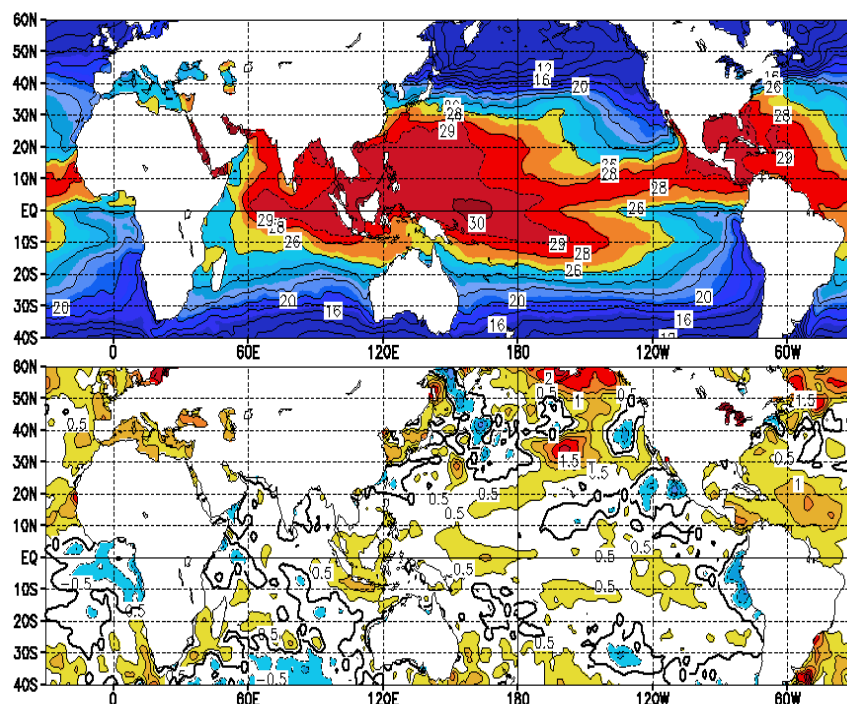


Fig.1.3 Monthly mean SST (top) and SSTA (bottom) in July, 2005

#### ● *OLR*

Tropical convection activity indicated by OLR in the Western Pacific in 2004/2005 winter was weaker than that in 2003/2004, but stronger than that in 2002/2003. In July and Sep 2005, it was stronger than normal, but weaker than normal in June 2005.

#### ● *NW Pacific Subtropical High*

In generally, the NW Pacific Subtropical High was stronger and more westward than normal from Oct 2004 to Sep 2005.

#### ● *Assessment of typhoon-induced rainfall*

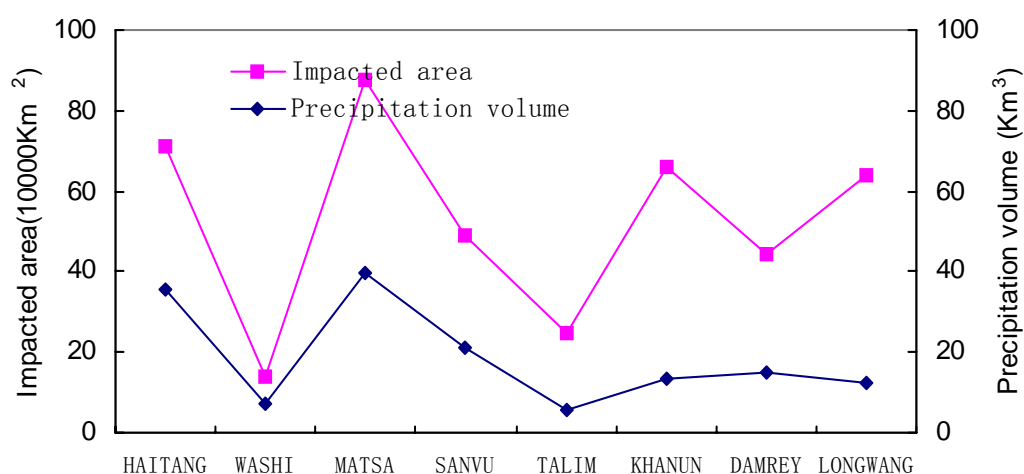


Fig. 1.4 The estimated precipitation volumes and impacted areas of typhoons which impacted China during Jan. to Oct. 10, 2005

From Jan. 1 to Oct. 10 2005, totally there were 8 tropical cyclones that impacted China and all of them made landfall in China and brought precipitation in land during this period (Haitang, Washi, Matsa, Sanvu, Talim, Khanun, Damrey, and Longwang). With regard to impacted area, typhoon MATSA was the most serious one, with a precipitation volume of  $39.5\text{km}^3$ , and the impacted area was  $874,507\text{km}^2$ . In addition, typhoon HAITANG was the second most serious case during the period, with a precipitation volume being  $35.6\text{km}^3$  and the impacted area reaching  $709,750\text{km}^2$ , which were smaller than that of Matsa. (Fig.1.4).

## 2. Hydrological Assessment

During the flood season in 2005, China experienced several severe river floods and flash floods. Devastating deluges plagued in the whole Pearl River Basin - one of 7 major river basins in China in the last 10 days of June. A catastrophic flood that usually happens once every 100 years occurred along the middle-lower reaches of the Xijiang River, leading to the highest water levels ever recorded in history on its main streams and tributaries.

During the first 10-day period of July, two tributaries of the Yangtze River, namely Fujiang River and Qujiang River, saw excessive or major floods with the water levels either breaking the historical records or exceeding the safety stage.

During the middle 10 days of July, the upper stream of the Huaihe River experienced major floods. In the same period, affected by Typhoon Haitang (0505), the Minjiang River in Fujian province witnessed a major flood that usually happens once every 20-30 years.

In the second 10-day period of August, under the effect of Typhoon Matsa (0509), heavy floods occurred in the two tributaries of the Liaohe River, namely Qinghe River and Caihe River, and the Hunhe River as well as Taizi River.

In the first 10-day period of September, due to Typhoon Tailm (0513), a flood that usually happens once every 5-10 years occurred in the middle-lower stream of the Huaihe River.

In relation to the accumulated stream water volume by 1 September for the major rivers in China, the Huaihe River and the Songhuajiang River met more stream runoff than usual, i.e. the Huaihe River had 20-40% more than usual and the Songhuajiang River had 40-50% more than usual. Nevertheless, the accumulated stream water volume for the other major rivers was decreased or close to that in normal years, among which the Haihe River Basin had 90% more runoff than usual.

The scope of hydrologic services was further expanded. Hydrologic forecasts produced significant benefits in hazard reduction during the local rainstorm floods in the Xijiang, Huaihe and Minjiang river basins. Hydrologic monitoring played an important role in water resources management in the Yellow River Basin, in water transfer from the Yangtze River to the Taihu Lake and in the water diversion in the Heihe river basin.

Statistics showed that the Bureau of Hydrology of Ministry of Water Resources, China has collected more than 1 million pieces of hydrological information, released 127 issues of *Hydrological Information* and 41 issues of Hydrological Forecasts and Predictions from 1 January to 30 September. When the floods took place in the Xijiang River, the State Bureau of Hydrology in collaboration with two provincial bureaus of hydrology issued about 400 station/time of flood forecasts, over 90% of which reached the excellent criteria, and it issued the accurate flood forecast 1 day ahead of time anticipating that flood peak level would reach 26.80m at the Wuzhou Station (the actual water level was 26.75m.). During the Huaihe River Flood period, the hydrological departments made a forecast 3 days ahead of time that the possible flood peak level could reach 29.10m at the Wangjiaba Station (the true flood level was 29.14m.). In the period of Minjiang Flood, the Fujian Provincial hydrological department

organized 3 expert groups to make hourly flood forecasts by applying a flood early warning system, and they prepared a number of schemes for flood management, which provided basis for flood control and disaster prevention.

### **3. Socio-economic Assessment**

The landfall typhoons and tropical storms in China brought abundant precipitation, and abated the agricultural drought and hot day in the southern Yangtze River and South China, and the water storage of reservoir increased. However, the violent wind, heavy rain and associated astronomical tides also brought about severe losses in the coastal areas during this year, especially in Zhejiang Province. According to the preliminary statistics, more than 94 million people and 63000 km<sup>2</sup> farmland were affected by tropical cyclones, and 360 were killed, and 70 missing and 287 thousands houses collapsed and 830 thousands houses were destroyed. The direct economic losses were about 81.5 billion RMB Yuan.

Comparing the disaster losses with those of the last 10 years, the economic losses caused by typhoon and tropical storm in China during January to September in 2005 were more severe. But the total casualties markedly decreased as the result of precise forecast and early warning provided by the Meteorological Services as well as correctly arrangements made and actively measurements taken by each level of government departments.

## II. Meteorology

### 1. Progress in Member's Regional Cooperation and Selected RCPIP Goals and Objectives

#### a. Progress in Hardware and/or Software Development and Applications

##### ◆ FY-2C Geo-stationary Meteorological Satellite

The FY-2C, China's first operational geo-stationary meteorological satellite, was launched successfully on 19 October 2004. China has so far established operations of both polar-orbiting and geo-stationary meteorological satellites.

##### ● *The FY-2C application system became operational in 2005*

Since 1 January 2005, users in China and in other countries/regions have already started to receive data from the extended-imagery broadcast by FY-2C, and from 1 June on, the data process center (DPC) provided 13 kinds of images and products.

In order to satisfy the needs for weather, climate and the disasters' monitoring and forecasting, starting from June 27, the National Satellite Meteorological Centre (NSMC) initiated the flood season observation mode of FY-2C, which can catch and deliver 48 relevant images to all over China every day, i.e. in addition to normal 28 full disc images per day (in not-flood season only), 20 additional imagery covering the north hemisphere were made available.

##### ● *FY-2C satellite data applications have scaled a new stage in remote sensing*

With the capability enhancement in satellite development and data receiving, a system for monitoring weather, environment and disasters with multiple satellites has been created at NSMC, and it is in a better position to monitor various disastrous weather and environmental changes frequently and comprehensively. As for weather systems, not only large scale weather events such as frontal cyclone, typhoon and wind shear cloud, but also local convective cloud and other meso- to small-scale weather systems like short-time thunder storm, gale and hailstone can be captured. Furthermore, the newly added FY-2C detecting channel can provide more comprehensive information for operational use in disaster and environment monitoring. The products based on FY-2C data, such as heavy fog, dust storm, snow, soil moisture, fire and water situations, have improved the timely availability of disaster and environment monitoring information from the satellite. These coverage of these monitoring has been expanded to a wider range including whole Asia and Australia, and abundant information for prediction, forecast and analysis of weather, climate and environment have been made available.

##### ● *FY-2C Data and Products*

Up to September 20, 2005, NSMC has monitored and analyzed 16 Tropical Cyclones (TCs) with the meteorological satellite data, including TC center positioning, strength estimating, track monitoring, and structure and distribution analysis of the strong wind and the heaviest rainfall zones, etc. NSMC released the real-time results of the analysis of the TCs, such as the location of the TC, its strength, track and synthetically result with the multiple data through its website (<http://dear.cma.gov.cn>).

In 2005, the first operational stationary satellite FY-2C was put into operational use. When making TC analysis, NSMC mainly used the data and products from FY-2C, including:

✧ Position and estimated intensity of TCs by using both visible and infrared imagery from FY-2C. The positioning accuracy was so precise that it could locate a TC centre within a half pixel range. Also the detective bands of FY-2C had added up to 5 channels,

thus the structure and thermodynamic characteristics of TCs had higher resolutions. Therefore the TC intensity estimation was improved.

✧ FY-2C satellite derived wind data for analyzing the occurrence, development and motion trend. These products could reveal the distribution of the air-stream fields in the mid and upper levels of troposphere. With them, we could better understand the upper divergence of TCs and their surrounding environment. Thus we could predict TC development.

✧ FY-2C TBB data and Cloud classification data for analyzing the distribution pattern and development of the strong TC convective zones. By utilizing the quantitative processing of the multi-channel data from FY-2C, NSMC could identify the convective clouds within TCs and could understand the possible impacts of TC associated severe weather.

✧ Precipitation Estimates product for analyzing the precipitation induced by TCs over the sea. By using these products from FY-2C, which could address data scarcity issue over open sea, NSMC could know the rainfall distribution pattern of TCs.

✧ Water vapour imagery and possible precipitation product for analyzing the TC water vapor environment. FY-2C water vapour channel could reveal the moisture transport at mid and upper levels, combining with the possible precipitation product, NSMC could understand the moisture fields within a TC environment.

#### ● *FY-2C Tropical Cyclone Analysis System*

In order to cooperate with the utility of FY-2C in TCs, NSMC has improved the operational work in analyzing the TCs by satellite data. Based on the method delivered by Devorak, NSMC has proposed a new method to locate the TC center and estimate the TC strength, which is adapt to regular operational work. With the help the new method, NSMC has designed the TC analyzing system, which provide many ways to locate center and estimate strength. Besides that, NSMC created the data base of TCs.

#### ◆ **Multiple Satellite Data Comprehensive Application System**

In 2005, NSMC continued to synthetically analyze TCs by using multiple satellite data. The satellites in use include: FY-1D、NOAA-16(17、18)、EOS (AQUA、TERRA) Polar-orbiting satellites. With AMSU-B microwave data and product, NSMC tried to analyze TC structures. QUIKSCAT sea surface wind vector and AMSU microwave data were used to analyze the distribution of strong wind and the maximum rainfall zones.

#### ◆ **The Global Model for Typhoon Track Prediction (GMTTP)**

GMTTP, coupled with global medium-range spectral model T213L31, was developed at National Meteorological Center/CMA and it was put into quasi-operation in the 2004 and 2005 typhoon seasons. Unlike the previous Regional Model for Typhoon Track Prediction (RMTTP), GMTTP could produce tropical cyclone (TC) track prediction four times a day (00, 06, 12, 18UTC) for up to three target TCs at the same time covering the Northwest Pacific and South China Sea.

#### ● *TC Vortex formation techniques*

The initialization of GMTTP model still adopted bogus vortex scheme used in the RMTTP model, but some modifications, such as, the calculation of the top of the troposphere based on the global model atmosphere conditions instead of an original fixed value and the way to form background fields of typhoon vortex, was modified. The specific steps are as follows:

✧ To remove ill-defined and weak vortex from the large-scale background fields in order to get smooth environmental field.



✧ To construct a symmetric typhoon vortex based on based on a few parameters manually analyzed by forecasters: the TC central position (latitude, longitude), the central pressure and the maximum wind speed radius. The major features are the following:

- Calculate sea-level pressure profile with Fujita's(1952) formula.
- Axial-symmetrical vortex with a warmer core structure.
- Convergent circulation at the lower levels.
- Divergent circulation at the upper levels.

✧ To merge the synthetic typhoon vortex into the smooth environmental field by a blending method with a linear weighting function.

### ● *Guidance products*

Currently, the GMTTP system runs four times a day and provides every 6 hour TC center location forecast at the 120 hour time period for 00,06,12,18UTC.

### ● *Verification*

In 2004 and 2005 typhoon season, the GMTTP was put into quasi-operation instead of RMTTP. During the typhoon season, the new system operated well and could produce real time products to forecasters. It shows the typhoon Haitang (0505) forecast tracks as Fig.2.1. In 2004, the outcomes of GMTTP mean forecast track error verifications were shown hereunder:

Table.2.1 Mean Track Errors for GMTTP (unit: km)

Forecast period	12h	24h	36h	48h	60h	72h	84h	96h
Mean track errors	89.9	150.4	206.9	262.9	316.6	369.0	420.1	462.3
Number of Forecast	297	275	253	231	210	190	86	76

Note: the numbers in the brackets are the forecast times.

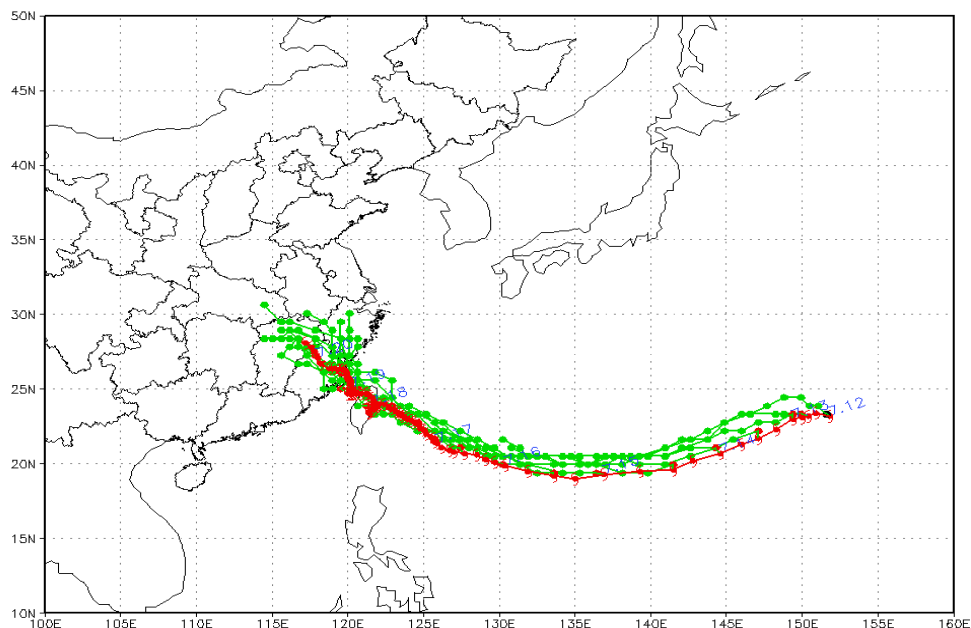


Fig. 2.1 Tracks of Typhoon Haitang (0505) predicted by GMTTP

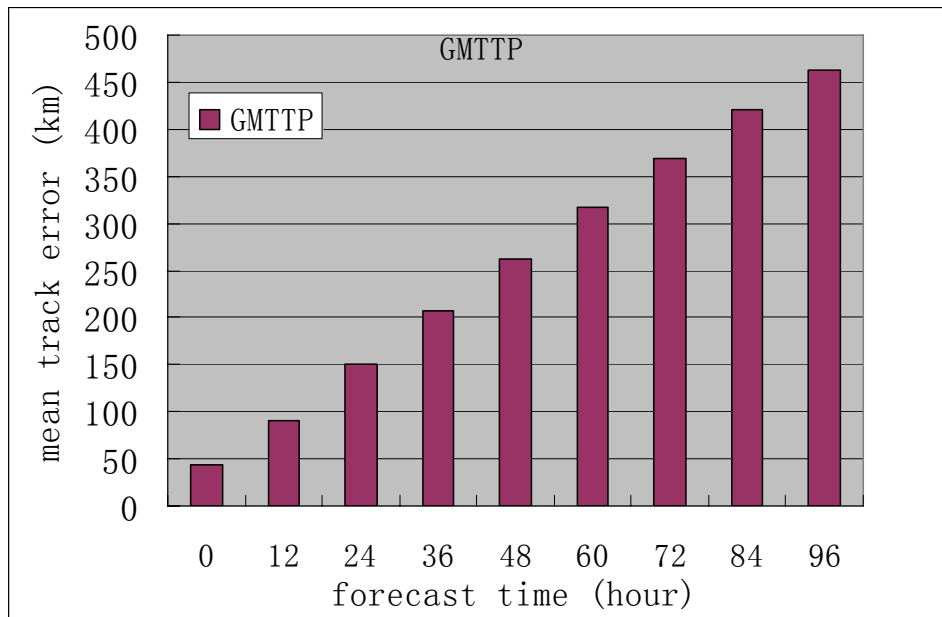


Fig. 2.2 Mean Track Errors for GMTTP (unit: km)

Compared with the RMTTP model, the GMTTP model makes good improvement in track forecast errors during the 2004 typhoon season. The detailed results are shown in the Fig. 2.3.

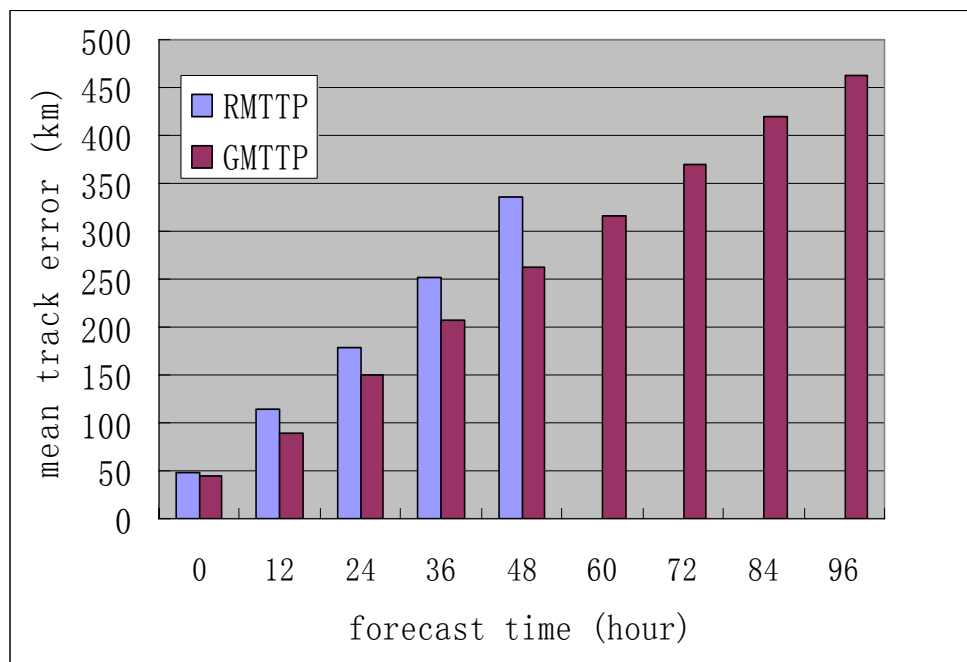


Fig. 2.3 Comparison of mean track error between GMTTP and RMTTP in 2004

Fig. 2.3 indicates a decrease in the global mean track errors for the 48-hour forecasts. The improvements shows that, to some extent, the new GMTTP model gives a better performance than the RMTTP model at least in 2004 typhoon season.

## b. Implications to Operational Progress

### ◆ Satellite Data DVB-S Broadcasting System

The NSMC's Satellite Data DVB-S Broadcasting System (SDVBS) has run stably for more

than a year, 78 receiving stations have set up across all China, and user terminal's receiving, processing and application software have been configured. Users in China have then conveniently obtained data of multi polar orbit, stationary satellites and their products by SDVBS. SDVBS will further promote the applications of satellite remote sensing data and the process in establishing China's remote sensing operational systems and networks nationwide.

#### ◆ **The Environmental Satellite Data Archiving and Retrieval System**

NSMC has continued to provide all-around satellite data services free of charge to users via meteorological special line, internet and satellite broadcasts, etc., sharing the environmental satellite data from the networks among meteorological offices in China. The satellite data archiving and serving system serves as a powerful platform through which the meteorological satellite data can be shared.

#### ◆ **IBM High Performance System**

CMA decided to buy IBM High Performance System (IBM HPCS) in June, 2004. All the equipments arrived in November, 2004. IBM HPCS was put in real-time operation on June 1, 2005. IBM HPCS is a new generation high performance parallel computing system, and provides a fundamental computational & storage platform for real-time operations and scientific researches in atmospheric sciences fields like weather, climate. It consists of 376 computing nodes, 3152 CPUs, and has a capacity of about 21 TFLOPS in total. Up to now, IBM HPCS is the most powerful computer system in China, ranking 18th on the Top500 list of June 24, 2005. IBM HPCS makes up an important part of CMA's infrastructure and considerably enhances computing capability of China's meteorological operation systems.

#### ◆ **National Meteorological Data Storage System (MDSS)**

National Meteorological Data Storage System is the national level data center system of CMA, with responsibility for storage, archiving the meteorological data and providing data services. NMIC (National Meteorological Information Center) takes on the construction of MDSS.

MDSS is composed of RDB (Real-time Database system), IDB (Integrated Database system) and SDB (Sharable Database), which provide meteorological data management and services respectively for national real-time operational system users, the internal professional users and the public society users. MDSS use RDBMS management integrated with the external file system, that RDBMS is ORACLE 9i.

At the present time, the  $\beta$ 1.0 version of RDB and SDB have been already put under test-running successively. The  $\beta$ 2.0 version of RDB would begin its test-running in Oct. The construction of MDSS would be finished within Jun 2006.

#### **c. Interaction with users, other Members, and/or other components**

In 2005, CMA's VSAT based domestic telecommunication network is running stable. There were 10 new PCVSAT receive-only stations installed, including the station installed in Myanmar in August, 2005. Currently, the PCVSAT system totally has 2450 remote stations, and its average daily broadcasting data volume is over 2.5Gbytes.

At RTH Beijing, the GTS links to Ulan Bator and Moscow were upgraded in February and March, 2005 respectively. The Beijing- Ulan Bator circuit has been upgraded from 75 Bauds to 14.4Kbps. The Beijing- Moscow link, which used to operate at 9600bps leased circuit, has been replaced and upgraded by a FR link with a symmetric CIR of 8/8kbps. And, the WMO FTP procedure is being used on the two links.

The CMA's new GTS system became operational in May, 2005. It supports the protocols of TCP/IP, X.25 and ASYNC, and has the capabilities of collecting and sharing data via Internet E-mail and Web services.

#### **d. Progress in Training**

##### **◆ Training Course for Meteorological Satellite Data Application**

From December of 2004 to January of 2005, CMATC held 2 Training Course for Meteorological Satellite Data Application and 144 trainees attended it. The training activities mainly covered the basic principles of satellite meteorology and analysis on the cloud imagery, production of weather forecasts based on satellite data, the production and application of sea surface temperature (SST) and TOVS data, locating a TC center and estimating TC intensity by using satellite image, the interaction between typhoon and the mid latitude weather systems, precipitation estimation by satellite data as well as analysis and application of water vapor imagery, etc.

##### **◆ Study Group of How to Apply Mathematics in Meteorology**

From May 16 to 27, 2005, CMATC held a Workshop on Application of Mathematics to Meteorology. 21 trainees attended it. The training focused on the vector calculation methods used for satellite data retrieval and heavy precipitation forecasts, etc.

##### **◆ Training Seminar on Increasing Meteorological Knowledge for the Directors of Local Meteorological Bureaus**

From Jan. 24 to 30, 2005, CMATC held the training seminar and 54 local directors attended it. The training included the application of radar and satellite data to weather forecast, and application of the new NWP technology, etc.

##### **◆ Improving the Training Materials**

###### **● *Multimedia Courseware for Application of Meteorological Satellite Data***

In 2004, in order to meet the increasing demands for the training programs, CMATC prepared the web-version multimedia courseware entitled *Satellite Imagery-based Weather Identification and Analysis*, introducing the features of cloud patterns of the significant weather systems, analysis of tropical weather systems, mesoscale cellular convection (MCC) cases developed through merging of a typhoon with cold air mass, etc.

###### **● *Satellite Data Application-oriented Training Materials***

Also in 2004, CMATC compiled such training materials as *Vector Machine-based Methodology and its Application to Meteorology* and the *User's Guide on Vector Machine-based Forecasting Platform: CMSVM*, instructing on application of vector computers to the satellite data retrieval, forecast of heavy precipitation, etc.

#### **e. Research Progress**

##### **◆ Objective Tropical Cyclone Positioning System**

Based on GIS technology, an objective TC center positioning system was developed to integrate different data and algorithms. All kinds of vector and raster layer data, including QuikSCAT ocean surface wind, weather station observations, numerical model outputs, and satellite imagery, could be analyzed and super positioned simultaneously by this system, which was useful in showing TC features from different points of view. Several TC center positioning methods, such as cloud-structure analyzing method, TBB extremum method, and

ocean surface vorticity extremum method and so on, were incorporated to make the positioning process more objective, precise and automatic. The system had been tested for 121 cases in 2003 and 2004 with average error within 21km, comparable to the operational positioning error, showing that the system was useful for operational applications.

#### ◆ Tropical Cyclone Formation

The background circulation in the process of TC formation over the Northwest Pacific was classified into 5 categories according to the synoptic analyses and satellite observations. Results showed that, from 1995 to 2002, there were 183 TCs (71.2%) that were originated in the ITCZ, 17 (6.6%) under the easterly waves, 29 TCs (11.3%) were formed under TUTT, 18 TCs (7%) were associated with baroclinic disturbances, and another 10 TCs were related to trans-ITCZ tropical cyclone.

#### ◆ Climatology of Tropical Cyclones

Correlations of TC frequency with some possible factors, including 500hPa height, sea level pressure, 200hPa wind speed, SST, were calculated. Stronger signals for seasonal TC predictions were detected. The TC frequency forecast for 2005 was made by using these signals. The predicted outlook indicated that the TC number would be slightly less than normal.

#### ◆ Tropical Cyclone Intensity Variations

Using equivalent black body temperature (TBB) data retrieved from GMS-5, the correlations between TBB factors and all Northwest Pacific (120°E-155°E, 0°N -50°N) TC samples, excluding those landed and off-shore TCs, together with their 0-48 hour intensities from 1996 to 2002 were analyzed. It was found that some TBB factors such as total TBB located at about south-eastern eye-walls, the average symmetrical TBB (Symtbb) and asymmetrical TBB components within 0.8 and 1.7 degrees from TC center have significant anti-correlation with TC intensity, especially, Symtbb and asymmetrical TBB intensities have the best correlations with 24h and 48h TC intensities respectively. It was also found that the pixel counts were colder than -45°C within 2 degree from TC center and the maximum of total TBB between 1.1 and 1.5 degree from TC center had good correlations with TC intensity respectively. Multiple regression schemes to forecast TC intensity in NWP based on samples from 1996 to 2002 were developed and verified in the context of climatological persistence, synoptic and TBB factors. It showed that the results from the scheme including 3 categories of factors to forecast the 12h and 24h TS intensity, 48h TS or STS intensity were more close to observations than that from the other schemes without TBB factors in regression equation. This scheme improved the 12-h TC intensity forecasts at intensity of above 15m/s, 24-h TC forecasts with almost unchanged intensity, and 48-h TC forecasts with an increasing intensity above 10m/s.

### f. Other Cooperative/RCPIP Progress

#### ◆ 37<sup>th</sup> Session of Typhoon Committee

The 37<sup>th</sup> Session of Typhoon Committee was held in November 16<sup>th</sup>, 2004. Over 100 participants and representatives from the United Nations, WMO and more than 10 countries and regions along the Pacific Rim were present at the conference. Academician Qin Dahe, Administrator of the China Meteorological Administration (CMA) and Mr. Hu Yanzhao, Vice Mayor of the Shanghai Municipality attended the Opening Ceremony and addressed the meeting.

#### ◆ Regional Workshop on Tropical Cyclone Warning of Typhoon Committee

The Regional Workshop on Tropical Cyclone Warning of Typhoon Committee was held in Shanghai from April 24<sup>th</sup> to 28<sup>th</sup>, 2005. 40 experts in the fields of meteorology, hydrology and disaster prevention/mitigation from 15 countries and regions including Republic of Korea, USA,

Malaysia, China Hong Kong and China Macao took part in the workshop, discussing the accuracy and reliability of typhoon forecast, the amount of precipitation likely to be caused by typhoon as well as the forecast of typhoon radius. Dr. Xu Xiaofeng, Chairman of the Typhoon Committee, Deputy Administrator of CMA attended the Opening Ceremony and addressed the workshop. He emphasized that through international exchanges and cooperation, the ability in TC monitoring and early warning would be improved, and it could contribute to reduction of the weather-induced disasters and to the safety of people's lives and properties.

#### ◆ **2004 WMO Typhoon Committee Roving Seminar**

2004 WMO Typhoon Committee Roving Seminar was held in CMA from November 22<sup>nd</sup> to 23<sup>rd</sup>, 2004. Nearly 30 people from Democratic People's Republic of Korea, China Hong Kong and some provincial meteorological bureaus attended the seminar. Mr. Nobutaka from the Japan Meteorological Agency and Professor Johnny Chan from City University of Hong Kong were invited to give lectures at the seminar respectively on typhoons in 2004, disasters induced by typhoons, multi-model typhoon ensemble forecast techniques, intergovernmental cooperation and forecasting theories on formation mechanism of tropical cyclones, etc.

Meteorological experts from the Central Meteorological Research Institute of the Democratic People's Republic of Korea, Hong Kong Observatory, Guangdong Provincial Meteorological Bureau, Zhejiang Provincial Meteorological Bureau, Fujian Provincial Meteorological Bureau and the National Meteorological Center also conducted academic exchanges with other participants on such subjects as operational TC forecasts, NWP, meteorological service, improvement of operational forecast systems, etc.

## **2. Progress in Member's Important, High-Priority Goals and Objectives**

### **a. Progress in Hardware and/or Software Development and Applications**

#### ◆ **Doppler Radars Network**

According to the Weather Radar Development Plan (2001-2015), 158 new-generation Doppler radars (CINRAD) will be deployed across China establishing a nationwide network. So far, 84 CINRAD radars have already been installed for operational use in China, capable to detect hail, rainstorm and typhoons. They have made positive contributions to the weather-related disaster prevention and mitigation efforts in the country.

CINRAD radars installed along the southeast coast of China, more specifically at Zhoushan, Changle and Xiamen have provided timely and useful information for TC monitoring and for preparing more accurate forecasts and they are playing an important role in mitigating TC-induced disasters.

The new-generation Doppler weather radars proved to be effective in monitoring precipitation and wind, which provided useful information for decision-makers in forest fire control and flood relief efforts in the Sichuan Province.

By the end of 2005, altogether about 93 CINRAD radars will have been installed in the mainland, and another 29 CINRAD radars will be installed in 2006.

#### ◆ **Surface Observation**

125 Automatic Weather Stations (AWSs), which were established under the Automatic Atmosphere Monitoring System project, became operational as from January 1, 2005. Thus, about 1800 AWSes operated by CMA has been installed by 2005.

#### ◆ **Other Non-conventional Observations**

In addition, some new observing systems were installed across China in 2005. The following observations and products are available at NMC.

- ✧ Soil moisture (from 60 automatic soil moisture observing stations)
- ✧ Lighting detections (from 80 lighting detection stations)
- ✧ Acid rain observations (from 89 acid rain observing stations)

All these data have been utilized by NMC's operational forecast systems and NWP systems. And the Doppler radar products proved to be the most important data for analyzing and forecasting the typhoons Matsa and Haitang at the Central Meteorological Observatory, CMA.

#### **b. Implications to Operational Progress**

◆ In order to fulfill the responsibilities in TC forecasting and related services, NMC has begun to make hourly positioning for the tropical cyclones, which enter the 24-hour warning zone since January 1, 2005, following to the recommendation of the 5<sup>th</sup> National Typhoon and Marine Meteorological Panel. The TC positioning information was issued through GTS and internet within 15 minutes after the hour.

◆ Based on the new-generation NWP system - GRAPES, a typhoon model named GRAPES\_TCM was developed in 2004 and it was put into quasi-operational tests in 2005. By the end of August, it made 24- and 48-hour forecasts for 92 and 73 times respectively targeted on 15 TCs, and the mean 24-h forecast error was 158.1km, and 48-h error was 214.5km.

◆ The upgraded TC model developed by the Shanghai Typhoon Institute (STI\_TCM) based on BDA (Bogus Data Assimilation) initialization technique was put into operation in 2005. Till the end of August, it produced 114 24-h forecasts and 88 48-h forecasts targeting on 15 TCs, with the 24-h mean error of 135.2 km and the 48-h error of 224.9km.

◆ The first operational sea wave numerical forecast system of CMA was established by Shanghai Typhoon Institute based on a hybrid wave model and a meso-scale atmospheric model. Statistics showed higher accuracy and more skillful for wind and wave forecasting. This system has been used in Shanghai Weather Center for more than two years and it began to be applied to other meteorological bureaus or weather offices in the coastal provinces from early 2005.

#### **c. Interaction with users, other Members, and/or other components**

◆ The CMA's domestic broadband network entered at the implementation phase. Currently, the broadband connections from NMIC to 25 provincial forecast centers, including with Tianjin, Fujian and Guangdong, have been implemented. All 25 links have been put into operation, and they are used to disseminate Doppler radar products. Each link has a bandwidth of 2Mbps. On average, there are about 4.5GBytes radar data transmitted from provincial centers to NMIC over the broadband network per day.

◆ National Weather Forecast Video Conference System is an operational system based on VSAT communication, wide-band terrestrial network and international standard audio/video encoding technology. The main system has one hub station, which is located at CMA headquarter in Beijing, and 31 two-way terminals at provincial meteorological centers. It can support distanced face-to-face meeting and discussion on point-to-point, point-to-multipoint manner. At present it is used for daily weather discussion on agro-meteorological weather, technological training and emergent weather events like TC landing, etc. The live program of daily weather discussion generated by this system is also broadcasted to over 2000 meteorological establishments under CMA framework through on-way VSAT broadcast

system and Internet simultaneously. Its program is also recorded into multimedia programs and can be accessed and downloaded through Web.

#### **d. Progress in Training**

##### **◆ The New-Generation Doppler Radar Application Training Course**

From October of 2004 to September of 2005, China Meteorological Administration Training Centre (CMATC) held 6 training courses on the New-Generation Doppler Radar Application, and about 300 trainees in total attended the courses. The training mainly covered the principles of the new-generation weather Doppler Radar, TC center-locating, intensity or wind-speed estimation with Radar data, the analysis on radar echo characteristics and cases study on convective weather, typhoon-induced rainfall estimation and early warning techniques used for forecasting severe convective weather related to typhoon.

##### **◆ Seminar on New NWP Technology**

From March 23<sup>rd</sup> to April 5<sup>th</sup>, 2005, CMATC had a Seminar on New NWP Technology, and 55 people participated in it. The training contents focused on ensemble forecast, GRAPES system introduction, statistical interpretation of NWP products - Vector Machine, as well as research efforts on meso-scale NWP modeling, etc.

##### **◆ The Seminar on GRAPES Meso-scale Regional NWP Model**

The training course on GRAPES Meso-Scale Regional NWP Model was held at CMATC from April 7 to 21, 2005. 63 people attended the course. The contents mainly concentrated on the application of the new generation numerical forecast system—GRAPES, ensemble forecast, statistical interpretation of NWP products, and meso-scale NWP models, etc.

##### **◆ Advanced Training Class for Chief Weather Forecasters**

From September to December of 2004, CMATC organized the Advanced Training Class for Chief Weather Forecasters and 24 forecasters were trained. The training covered locating the typhoon center and estimating the intensity or wind speed of typhoon by making use of radar echo and satellite image, analyzing satellite image, estimating typhoon precipitation, interaction between typhoon and mid latitude weather systems, heavy rain forecast and severe convective weather prediction, TC forecast, small system of torrential rain and severe convective forecasts, the analysis on radar echo characteristics and case study on convective weather, etc.

##### **◆ Training Materials and Courseware for Application of New-Generation Doppler Weather Radars**

According to the “Specification of the New Generation Weather Radar System” of CMA and the characteristics of the disaster weather events in China, beginning from the year of 2004, teaching materials for the New-generation Doppler Weather Radar was revised. The new edition was about 600,000 words and specially focused on cultivating the students’ ideas and skills on using the radar echo images, and understanding of the echo characteristics in terms of severe convective systems. And it was planned to add some special cases of typhoons in it in 2005.

#### **e. Progress in Research**

The tropical cyclone research carried out in 2004 mainly focused on TC structure, TC intensity change, TC track forecasting techniques, mechanism and estimation of TC rainfall, numerical simulation and modeling techniques etc.

##### **◆ Tropical Cyclone Structure**

Various observational data were applied to reveal TC structure and structural change in 2004. For example, with intensive surface observational data, Doppler Radar data and satellite cloud



imageries, the structure and structure variation of the eye of typhoon Utor and its adjacent area were analyzed. It was found that there existed straight-line type of echoes with maximum length of 150 km, in which strong convective cells were embedded, in the typhoon eye and its adjacent area. It was considered that the straight-line type of echoes was related to deformation of the vortex structure in the inner region of the typhoon. Besides, the data from NOAA-16 Advanced Microwave Sounding Unit (AMSU) were employed to analyze the thermal structure of 12 tropical cyclones occurred over the north Western Pacific. Results showed that the AMSU observation might be able to reveal the main thermal characteristics differences of typhoons

The evolution and structure of two organized meso- $\alpha$ -scale convective systems (MCS) developed sequentially in the depression system of the landing typhoon Herb during 3-5 Aug. 1996 was simulated successfully using MM5. Based on model output, the structure and characteristics of MCS were investigated in details, and the air trajectories around MCSs were calculated. Finally, a conceptual model for MCS in landing typhoon was proposed. With Doppler radar echoes and disturbance of physical parameters from the simulated output, the structure and propagation of typhoon meso-scale spiral rain band and the corresponding embedded deep convective belt were studied. Based on the differences of characteristic scale of physical parameters in various regions, the imbalanced phenomenon of super gradient flow in lower typhoon eye wall region was analyzed.

Tropical Rainfall Measuring Mission data [TRMM Microwave Imager/Precipitation Radar/Visible and Infrared Scanner (TMI/PR/VIRS)] and a numerical model are used to investigate the structure and rainfall features of Tropical Cyclone (TC) Rammasun (2002). Based on the analysis of TRMM data, which are diagnosed together with NCEP/AVN [Aviation (global model)] analysis data, some typical features of TC structure and rainfall are preliminary discovered. Since the limitations of TRMM data are considered for their time resolution and coverage, the world observed by TRMM at several moments cannot be taken as the representation of the whole period of the TC lifecycle; therefore the picture should be reproduced by a numerical model of high quality. To better understand the structure and rainfall features of TC Rammasun, a numerical simulation is carried out with meso-scale model MM5 in which the validations have been made with the data of TRMM and NCEP/AVN analysis.

#### ◆ Tropical Cyclone Intensity Change

The mechanism of TC intensification over offshore region and TC attenuation after landfalling was a priority area of focus in research. The strengthening process of typhoon Lily (2001) over Taiwan Strait was analyzed using satellite images and conventional observation data. Results showed that the overlapping of upper layer divergent stream, the increase of temperature and humidity over the south ocean of Taiwan Strait and existence of suitable cold air in the north of TC periphery were responsible for the re-intensification of typhoon Lily.

Numerical simulations were implemented to study TC intensification over offshore and TC dissipation process after landfall. Results of several sensitivity experiments indicated that topographical factors (terrain height, roughness length, sea-land distribution) in the western part of South China had an important impact on TC intensity change at landfall. Numerical studies on typhoon Utor (0104) also indicated that the decay of landfalling typhoon was mainly due to the decrease of water vapor supply from the surface following the surface frictions. The precipitation distribution was considerably affected by the topography in South China. So topography might have some effects on the asymmetric structure of typhoon Utor.

A set of analyses data at the resolution of  $1^\circ \times 1^\circ$  is used to diagnose the large scale conditions favorable for the abrupt intensity change of Typhoon Rananim (2004) with special attention being paid to the interaction between an upper level cold vortex and the tropical cyclone. It is

found that the existence of a warm core ring, sufficient vapor transportation, low vertical wind shear and upper level cold vortex work together in providing Typhoon Rananim a favorable environment for a sudden pre-landfall intensification. The upper level cold vortex plays an important role by increasing downward motion surrounding the tropical cyclone and the environmental instability.

#### ◆ Tropical Cyclone Track Prediction

TC Track Prediction and analysis were carried out based on mesoscale model MM5, satellite infrared images and observational data. Results showed that Typhoon Sinlaku (0216) and tropical depression, which occurred in eastern part of Sinlaku, were rotated each other, and resulted in that the Sinlaku was moved southwestward. The orography in Taiwan, coastal trough and subtropical high east to the cyclone were the main factors resulting in the northwestward movement of Sinlaku.

A non-divergent barotropic model with no flows was employed to simulate interaction of binary typhoons in northwest - southeast orientation in order to understand how asymmetric theory influenced on interaction of the two typhoons. Results showed that asymmetry could explain the motion feature of twin typhoons. The movement of each typhoon was governed by the ventilation flow that passed its center. On the other hand, the motion can react to their asymmetric structures. A quasi-geostrophic three-layer model was developed to investigate the motion under various basic flows and diabatic heating. Results indicated that tropical cyclone was mainly steered by basic flow. However, the asymmetric disturbance interfered the motion of tropical cyclone. Besides, diabatic heating affected tropical cyclone remarkably, which tended to move towards the center of heating field.

Several numerical experiments with different domain size, horizontal resolution or cumulus parameterization schemes were performed using MM5V3 to investigate the abnormal track of typhoon Aere (2004). Results showed that the unusual track of Aere could be simulated quite well with MM5V3 and the abnormality might be caused by sudden changes in the environmental flow. The asymmetric structure of Aere itself was not a key factor. Changes in the mid-latitude circulation caused the first westward turning of Aere, while typhoon Chaba that existed more than 15 degrees lat/lon away to its east showed no direct impact upon Aere's track. With the same horizontal resolution, the westward turning of Aere could be simulated better using Betts-Miller cumulus parameterization scheme in the outer domain than using GRELL scheme.

#### ◆ Tropical Cyclone Precipitation

Many researches were carried out to investigate precipitation mechanism and quantitative precipitation estimation of tropical cyclones in the past year. Numerical experiments on rainfall associated to typhoon Sinlaku (0216) were conducted using MM5 model. Results showed that the cold air invaded in the periphery of tropical cyclone can increase rainfall quantity in the areas of TC periphery and inverse trough. However, when invading into the vicinity of typhoon center, the cold air would weaken the TC intensity dramatically and result in remarkable decrease of rainfall near TC center, while the rainfall occurred in the TC periphery and inverse trough areas would still be increased. The topography had some impacts on the distribution of rainfall with more asymmetric features.

Both typhoon Chebi (0102) and Toraji (0108) had similar tracks, while the intensity and distribution of rainfall induced were significantly different. Comparative analyses found that the prior environmental circulation, interaction and collocation between tropical westerly trough and the subtropical high were three main factors responsible for the difference of precipitation.

The quality of quasi-global, near-real-time, TRMM-based data of precipitation estimate related to TC was tested with rainfall records of automatic weather station network in

Guangdong province. Results showed that they had good relationship and TRMM product could reveal the feature of 3-hour temporal variation of TC precipitation. Besides, the radial distribution of TC rain bands was variable during its landfalling process. The quality of rainfall data observed by the Global Positioning System (GPS) was also investigated for typhoon Ranasun (2002) in coastal area of East China. It was found that the precipitation estimation based on GPS was consistent with the intensive observation.

#### ◆ Numerical Assimilation

Numerical assimilation products of various data were applied to investigate typhoon structure and precipitation. The cloud derived winds (CDW) data were assimilated by Global/Regional Assimilation and Prediction System of CMA with 3-D variation method. Analysis indicated that CDW data from different channels and levels had different standard deviation in numerical simulations. However, the assimilation of cloud-derived winds can improve the quality of TC wind and pressure field leading to the improvement of prediction in typhoon track and rainfall.

AMSU microwave data were also assimilated with three-dimensional variation method in order to explore the TC structure over the Northwest Pacific. It was found that the TC 3-D structure was revealed in a more reasonable way with data assimilation. For example, warm core structure of severe typhoon was strengthened, cyclonic circulations in the middle and lower layers of typhoon were more obvious and the strong anti-cyclonic circulation occurred in upper layer etc.

With severe tropical storm “Vongfong” as the target typhoon, nudging them into 4-D data assimilation process in meso-scale model MM5v3 assimilated the wind-profiler data. The influence of different intervals was detected in nudging-assimilation and nudging factor in the simulation. The results demonstrated that the assimilated initial fields were improved, and the rainfall simulation was improved compared with that with direct objective analysis field. With nudging factor  $4.0 \times 10^{-4} \text{ s}^{-1}$ , the simulated result was more realistic.

The impacts of the assimilated bogus vortex on numerical simulation using MM5 four-dimensional variational data assimilation system were studied. The results showed that assimilation of typhoon vortex variables was more effective than the conventional bogussing method that implants a synthetic vortex into background. Simultaneous assimilation of bogus wind, pressure, temperature and specific humidity together was less effective than that of bogus pressure or any one of other variables. It was found that an initial field with clearer structure and more consistent with environmental flow would be obtained by assimilating pressure and specific humidity together.

The NRL (US Naval Research Laboratory) rainfall assimilation was implemented with the idea of adjusting diabatic heating to improve the initial conditions of Tropical Cyclone Chris, which made landfall near Port Headland, Western Australia during 3-6th, Feb. 2002. The NRL rainfall data, classified as three types (i.e. stratiform, convective and composite rainfall), is used to define the vertical profiles of diabatic heating. During the period of initialization (assimilation), the diabatic heating from the cumulus scheme is replaced by the heating profile given by Johnson (1984). The BMRC (Bureau of Meteorology Research Center, Australia) tropical limited-area model is used for the experiments performed with the options of “rainfall assimilation” and “dynamic nudging”. For the experiments RA (with rainfall assimilation) and RAN (with rainfall assimilation and dynamic nudging), 6-h accumulated NRL rainfall data are ingested in the model within each of the 4\*6h initial (assimilation) periods, valid respectively at 24h, 18h, 12h, 6h prior to the base time of the simulation (23UTC 3 Feb 2002). To help make the momentum field more consistent with the mass field during the initialization, dynamic nudging (using conventional observations) is used in RAN. Inclusion of NRL rainfall data improves the track in all the experiments, with the RAN experiment giving the most significant improvement.

## **f. Other Cooperative/RCPIP Progress**

### **◆ The 3<sup>rd</sup> Regional Workshop on Storm Surge and Sea Wave Forecast**

The 3<sup>rd</sup> JCOMM Regional Workshop on Storm Surge and Sea Wave Forecast and the Training Course for the Forecast Model were held at Beijing National Marine Environment Forecast Center from the 25<sup>th</sup> to 29<sup>th</sup> of July 2005. 30 representatives from 20 countries participated in the meeting.

This training lasted for 5 days, divided into 2 parts: (1) workshop; (2) training. 5 experts from Norway, Japan, India, Thailand and China conducted the training on forecasting models for ocean storm surge and sea waves. The training enhanced the capacity building of the marine meteorological forecasts, and it facilitated the improvement of marine disaster prevention and mitigation. Hence, the training was highly appreciated by JCOMM and its Member countries.

## **3. Opportunities for Further Enhancement of Regional Cooperation**

The International Workshop on Tropical Cyclone Landfall Processes was organized by WMO Commission on Atmospheric Science (CAS) Tropical Meteorology Research Program (TMRP), and held in Macao during 22-25 March 2005. Four projects were recommended in the meeting, and they would further enhance regional cooperation. The following projects were recommended:

- ◆ Project 1: Model Inter-comparison for Prediction of TC Landfall.
- ◆ Project 2: Project on East Asian International Program for a Forecast Demonstration Project on TC Landfall.
- ◆ Project 3: East Asia TC Advanced Forecast Guidance Project.
- ◆ Project 4: Pacific THORPEX Regional Campaign linked with the International Polar Year in 2008.

### **III. Hydrology**

#### **1. Progress in Member's Regional Cooperation and Selected RCPIP Goals and Objectives**

##### **a. Progress in Hardware and Software Development and Applications**

Since the Workshop on Living with Risk: Dealing with Typhoon-related Disasters as part of the Integrated Water Resources Management held in Seoul, Korea, 20-24 September, 2004, China has been taken an active part in the Regional Cooperative Programme Implementation Plan (RCPIP) of hydrological and Disaster Prevention and Preparedness (DPP) components of Typhoon Committee. Now, China is actively pushing forward the two projects led by the Chinese side, namely the project on *the Extension of Flood Forecasting Systems to Selected River Basins*, and the project on the *Evaluation and Improvement of Hydrological Instruments and Telecommunication Equipment*.

##### **◆ The Projects on the Extension of Flood Forecasting Systems to Selected River Basins**

In accordance with the road map drawn at the Workshop on Living with Risk: Dealing with Typhoon-Related Disasters as Part of the Integrated Water Resources Management held in Seoul, Republic of Korea in September 2004, China made the following progresses in the Project on the Extension of Flood Forecasting Systems to Selected River Basins:

- Reviewed the situation of flood forecasting system establishment and application in members according to the reports provided by members at the Seoul Workshop;
- Prepared an English-version Demo of flood forecasting system of China;
- Drafted the Guidelines for Development of Flood Forecasting System to Selected River Basins. The draft of main contents has been determined.
- Summarized the hydrological forecasting techniques in China as a reference for TC members.

This project would be continued till 2006. At the next workshop, China would submit the final Guidelines on Development of Flood Forecasting Systems.

##### **◆ The Projects on the Evaluation and Improvement of Hydrological Instruments and Telecommunication Equipment**

Since 2002, this project has been implemented for 3 years. On the basis of the current status of the project and the road map drawn at the Workshop on Living with Risk: Dealing with Typhoon-related Disasters as Part of the Integrated Water Resources Management held in Seoul Korea in September 2004, a draft review report on the Evaluation and Improvement of Hydrological Instruments and Telecommunication Equipment was prepared.

This review was a glancing report because of the very limiting information taken from only three counties' (China, Japan and Malaysia). Nevertheless, it was obvious that Japan was most advanced in hydrological instruments and telecommunication equipments, China and Malaysia need to further promote the development of hydrological instruments and telecommunication equipments though they had their own experience in this aspect. In the connection, the other members all needed to enhance their hydrological instruments and telecommunication equipment.

The final report was submitted at the forthcoming TC session to be held in Viet Nam in November.

For reference, China prepared a report on Application of the Automatic Telemetry System for Hydrological Data Collection in Real-time Flood Forecasting for TC members.

China submitted the Review of report on *the Evaluation and Improvement of Hydrological Instruments and Telecommunication Equipment* and provided a case study entitled the Application of the Automatic Telemetry System for Hydrological Data Collection in Real-time Flood Forecasting in China as an example.

The draft review report was under revision according to the comments. According the suggestions and requirements by the Working Group on Hydrology at the Workshop held in Malaysia, this project would last for the next round of RCPIP.

## **b. Implications to Operational Progress**

Nil

## **c. Interaction with users, other Members, and/or other components**

China continued her sustained efforts in data exchange with neighboring countries and in undertaking the activities of hydrological and DPP components of Typhoon Committee.

### **◆ Project on the Evaluation and Improvement of Operational Flood Forecasting System Focusing on Model Performance**

As a partner of this project, China provided some papers about Chinese hydrological models for the Korea Institute of Construction Technology (KICT), and answered the questionnaire from KICT. At present, the sum and substance of flood forecasting are as following:

#### **• Flood Forecasting**

Mathematical hydrologic models used in operational flood forecasting in China:

- ✧ Watershed hydrological models such as Xinanjing model, Shaanbei model (runoff yield under excess infiltration), API model, Sacramento model, SCLS (Synthesized Constrained Liner System);
- ✧ Channel routing models such as Maskingum routing method, Lag/K routing method, Liner Diffusion Wave routing method, Dynamic Wave routing method;
- ✧ Empirical methods such as P+Pa~R, Relation curve of water level between upstream and downstream, and
- ✧ Commercial model package such as MIKE 11.

Application of GIS and DEM in hydrological forecasting includes:

- ✧ Delineating basin boundary and estimating basin area,
- ✧ Generating Thiessen polygons of rain-gage network,
- ✧ Calculating areal-mean rainfall,
- ✧ Computing watershed parameters like land slope & river, etc..

China is planning to use the radar rainfall products in real time flood forecasting, and to use more DEM data in dynamic wave modeling and hydrological modeling.

#### **• Hydrological data collecting and transmission**

Currently, there are 7981 hydrometric stations providing real time hydrological information for flood forecasting in China, among which there are 4606 water level and discharge stations, 3275 rain gages. In general, the time interval of flood information provision is 6 hours, while the time interval is 1 hour in the case of major/great floods.

The telecommunication and computer network used in data transmission in China include: short-wave and ultra-short wave, microwave, PSTN, GPRS, satellite, CHINAPAC, and Wide Area Network (WAN) of real-time flood information.

- ***Hydrological model calibration***

The calibration of hydrological model parameters can be done manually or through automatic-calibration approach.

The manual calibration of model parameter is undertaken by a method of trial and error with the help of man-machine interactive interface, while the automatic calibration can be done by using an optimization method like Rosenbrock, simplex or genetic method.

◆ **The Project of Development of Guidelines for Reservoir Operation in Relation to Flood Forecasting**

As a partner of this project, China has completed the questionnaire from KOWACO (Korea Water Resources Corporation). The Main aspects of guidelines for reservoir operation in relation to flood forecasting are as following.

- ***Decision-making procedures of reservoir operation to reduce flood damage***

At present, the forecasting of reservoir inflow hydrographs is mainly based on the observed rainfall via hydrological models. In addition, China is continuing the efforts in improving the rainfall forecasts, and using rainfall forecasts into operational flood forecasting and prediction in order to increase the lead-time of flood forecasting.

In flood season every reservoir has their own flood control restricted level, the capacity above this level is flood control capacity, because flood situation is different in different months, so, for different months the level are different. The flood control restricted level is fixed on according to the design flood and the capacity of flood control need.

When floods occur, the reservoir management for flood control is done according to dynamic limiting level during flood season itself.

All the large-sized & medium-sized reservoirs have flood regulation schemes. According to the scale and importance, the flood regulation schemes of reservoirs are developed by the flood control agencies at various levels. The basic principle of the flood regulation scheme of a reservoir lies in fully using its function so as to protect the downstream area given the priority of ensuring the safety of dam. In addition, the flood regulation of a reservoir should be compatible with overall flood management the whole river basin. The scheme design for flood regulation is made out basing on the design flood and the need of flood control.

The design flood is derived on basis of probability theory. In the sake of ensuring the safety of dam, the probability of flood is designed from 1% to 0.01%, depending on the scale of reservoir. For the purpose of protecting the downstream area, the probability of flood is design from 10% to 1%.

In Aug. 2005, a very successful flood regulation of the Dahuofang reservoir was made on the Hunhe River. The Dahuofang reservoir is located in the upstream of the Hunhe River, which is located in Laoning province in Northeast China. When the flood occurred, the Dahuofang reservoir closed all the releasing gates, leading to the reduction of flood peak discharge by 3690m<sup>3</sup>/s at the Shenyang station, which is located on the outskirt of Shenyang city. If there were no such discharge control at the reservoir, the flood peak of Shenyang would have been 8000m<sup>3</sup>/s.

A general procedure of real time reservoir operation is shown in the following chart.

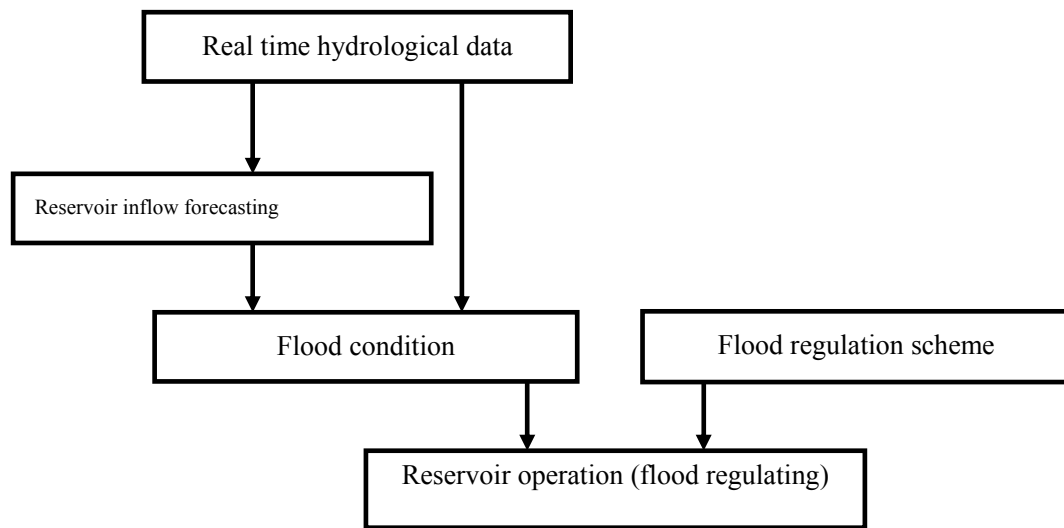


Fig.3.1 A general procedure of the real time reservoir operation

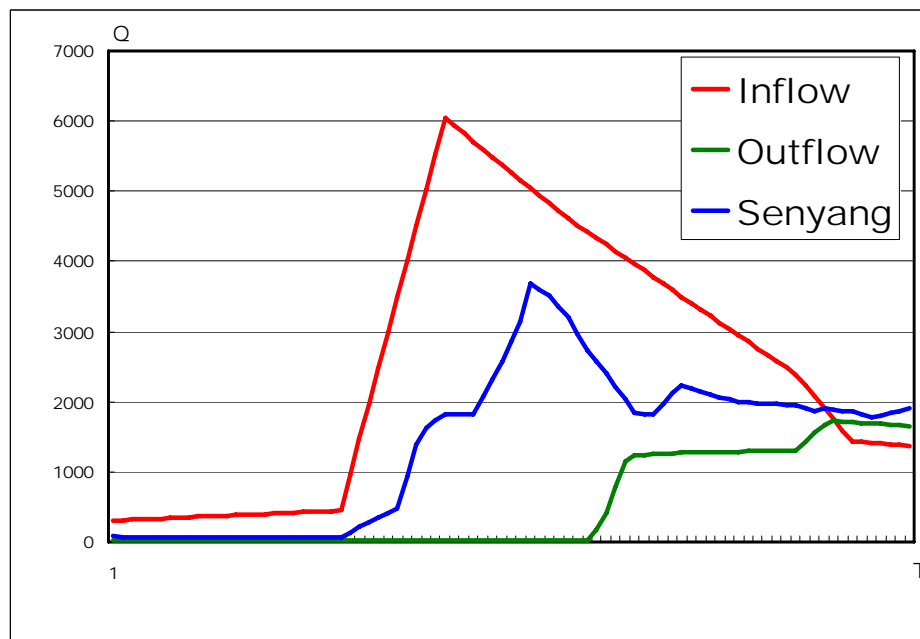


Fig. 3.2 Flood regulation of the Dahuofang reservoir in Aug. 2005

#### • *Flood regulation through spillway release and its evaluation*

As soon as the decision of flood release is made, the people and governmental agencies in dangerous area must be warned timely. Before the gates of spillway are opened, the people in the area to be affected by flood must be evacuated, when necessary the dikes and embankment should be reinforced.

When evaluating the flood control effect, the follows factors are taken into account:

- ✧ Reduction of the down stream discharge & water level as result of dam operation;
- ✧ Reduction of the flood affected area due to dam operation & dike reinforcement;
- ✧ Number of people saved or protected, and Reduction of the direct economic losses, etc.



- ***Countermeasure against extreme flood events exceeding design capacity***

Structural measure means that for dam, the safety height of dam is decided by check flood and plus safety height, for large reservoir, the probability of exceeding design criteria is 0.1%, the probability of check flood is 0.01%, the safety height is about 1m above the maximum level. If flood exceed the check flood, in order to release more water to avoid dam break, the spillway can be exploded.

Non-structural measure means that developing flood forecasting and warning system, for get more leading time to evacuate the people from dangerous area, to reinforce the down stream dike. Make emergent plan. In recent year non-structural measure become more and more important.

Moreover, hydrology in China is always positive for international cooperation with neighboring countries and TC members, and it is an active member in international hydrological and meteorological organizations. China has kept on exchanging and sharing data with neighboring countries and international/inter-governmental organizations, such as Russia, Korea, Vietnam, India, Kazakstine and Mekong River Committee.

#### **d. Training Progress**

In January, 2005, two Chinese participants attended the training courses on flood hazard mapping held in Tokyo, Japan, among whom, one was from the administrative department of flood hazard maps, the Office of State Flood Control and Drought Relief Headquarters, and the other one was from the Bureau of Hydrology, Ministry of Water Resources. This training event enabled them to further understand the significance of flood hazard mapping in the practice and to learn the technical methods for flood hazard mapping so as to promote the application of flood hazard maps in China.

#### **e. Research Progress**

Nil

#### **f. Other Cooperative/RCPIP Progress**

In September 2005, China sent 3 persons to participate in the Workshop on Risk Management towards Millennium Development Goals and Socio-Economic Impact Assessment of Typhoon-related Disasters, which was held in Kuala Lumpur, Malaysia.

## **2. Progress in Member's Important, High-Priority Goals and Objectives**

### **a. Hardware and Software Progress**

#### **◆ Pilot Project on the Establishment of Flash Flood Warning and Forecasting System**

In 2005, China continued undertaking the work under the project on sediment disaster forecasting and warning system.

Mudslide disaster forecasting and warning continued in the pilot area of Xuanhan in Sichuan province. By using the sediment forecasting technique provided by the Japanese colleagues, an event of mudflow and landslide was well detected, which occurred in the Huangjin town in early July of 2005.

Due to its complex topography and vulnerable geology, China is highly susceptible to the sediment-related disasters such as debris/mud flow and landslide caused by torrential rainfalls. With economic growth, urbanization and the subsequent concentration of population and property, the damage caused by sediment-related disaster is becoming more and more remarkable.

Chinese Government has attached great importance to sediment disasters in recent years. The Ministry of Water Resources in liaison with the China Meteorology Administration, the Ministry of Land Resources, the Ministry of Construction and the China State Environmental Protection Administration has developed a plan for technical research on monitoring the debris/mud flow and landslide induced by mountainous floods. The plan was approved by the National Development and Reform Commission in May 2005, and will be implemented soon. The objective of the plan is to establish a national-wide monitoring system of the mudflow, flash flood and landslide, to develop the static model and dynamic model for sediment disaster prediction and to develop a mechanism for reduction of both life and property losses in disaster-prone areas.

The main components of the sediment disaster monitoring system include:

- ✧ Establishment of the monitoring system at five levels such as the state, provinces, counties, townships/villages and sediment sites under the leadership of the State Flood Control and Drought Relief Headquarters;
- ✧ Classification of the sediment disasters into 3 severity levels: extremely dangerous, dangerous and generally dangerous according to the scale and extent of mudflow and landslide;
- ✧ Combination of the national-wide monitoring network with regional monitoring system, and the routine monitoring with hi-tech monitoring such as on-line fully automatic satellite- microwave transmission system;
- ✧ Establishment of a database of sediment disaster; and development an analysis and prediction platform based on GIS.

#### ◆ **Pilot Project on Flood Hazard Mapping**

In recent years, China made continued efforts in fulfilling the tasks scheduled in the implementation plan on the flood hazard mapping, and the satisfactory achievements have been made. Especially, China has finished the revising of the Flood Control Plans for seven major river basins, which established the foundation for the basin-wide flood hazard mapping.

The Office of State Flood Control and Drought Relief Headquarters requested each water resources commission to choose 2~3 conditional provinces (cities or districts) as pilot areas for flood hazard mapping every year, focusing on making flood hazard maps for the key flood-prone/flood-control areas, large-sized reservoirs and flood diversion basins. Up to now, 8 provinces within 7 river basins have started this pilot project.

At present, the *Guide to Flood Hazard Mapping* is under preparation. The guide will include description of the functions and applications of the flood hazard map and the definitions of risks. Various analysis methods and technical approaches will be incorporated to facilitate the preparations of flood hazard maps in accordance to different purposes and applications. Preparation of the flood hazard maps for all major rivers in China has been included in the *Eleventh Five-Year Development Plan of Water Conservancy of China*. It is expected to start the work in China from 2006.

#### **b. Implications to Operational Progress**

##### ◆ **Standard Development**

The new '*Standard for Hydrological Information Code (SHIC)*' has been put into application in some pilot areas for flood season. Based on this document, the Standard for Structure and Identifier in Real-time Hydrological Information Database is put into use in September 2005. To adapt to the development of automatic hydrological measurement and reporting system and data transmission technique, the Data Transfer Protocol has been revised and applied.

#### **c. Interaction with users, other Members, and/or other components**

Nil.

**d. Training Progress**

Nil.

**e. Research Progress**

Nil.

**f. Other Cooperative/RCPIP Progress**

Nil.

**3. Opportunities for Further Enhancement of Regional Cooperation**

◆ As discussed with Malaysia at the Seoul Workshop in September 2004 and Malaysia workshop in September in 2005, China would like to cooperate with Malaysia to combine the project on the Extension of Flood Forecasting Systems to Selected River Basins with the project on on-job training by Malaysia. China hoped that some achievement in combined projects could be made. China would like to provide experts involved in the project with on-job training.

◆ China will continue to participate in the RCPIP projects on Hydrology and DPP and continue to cooperate with TC members. More cooperative activities will be done with TC members advanced in the field of hydrological instruments and telecommunication equipments and flood forecasting system.

◆ TC members are encouraged to conduct further cooperation at regional level, not only in the form of short-term Workshop or TC Session, but also through long-term training and expert exchanges.

## **IV. Disaster Prevention and Preparedness (DPP)**

### **1. Progress in Member's Regional Cooperation and Selected RCPIP Goals and Objectives**

#### **a. Hardware and/or Software Progress**

Currently, the software about impact assessment of typhoon on society and economic are developing in National Climate Center (NCC). In order to provide more useful information to relative departments for disaster mitigating and preventing, Meteorological services strengthen the report system at real time on the impact assessment of typhoon this year.

#### **b. Implications to Operational Progress**

Nil

#### **c. Interaction with users, other Members, and/or other components**

The Asian Conference on Disaster Reduction (ACDR) was convened in Beijing, China on 27-29 September 2005 at the invitation of the Government of the People's Republic of China. A total of 385 participants attended the conference, which includes delegations from 42 Asian and South Pacific countries, of which 33 were represented at the ministerial level, and 13 UN agencies and the international organizations. The meeting was organized to facilitate the implementation of the World Conference on Disaster Reduction (WCDR) outcomes (the Hyogo Framework for Action 2005-2015): Building the Resilience of Nations and Communities to Disasters. The participants developed and presented the Beijing Action for Disaster Risk Reduction in Asia to enhance regional cooperation in the implantation of the Hyogo Framework for Action.

#### **d. Training Progress**

Nil

#### **e. Research Progress**

Nil

#### **f. Other Cooperative/RCPIP Progress**

Nil

### **2. Progress in Member's Important, High-Priority Goals and Objectives**

#### **a. Hardware and/or Software Progress**

The China Meteorological Administration issued, subject to the approval of the national government, a *Contingency Plan for Significant Meteorological Disaster*, *Procedure for Issuing Unexpected Meteorological Disaster Early Warning Signals* (trial) and the *Guidance on Meteorological Disaster Early Warning Signaling and Preventative Actions*; *Provisional Rules on News Release of Major Meteorological Information*; and *Rules on Collection, Survey and Evaluation of Meteorological Disasters*. It also worked out a 4-level warning signals and associated rules for issuing, set up regular (monthly) new release system for meteorological information and for disasters, and directly reporting system and evaluating system for meteorological disasters. CMA has prepared *Regulations on Meteorological Disaster Prevention*, which was now going through a legislative procedure.

#### **b. Implications to Operational Progress**

From October 1 2004 to 10 October 2005, 10 typhoons landed over China, among which

Typhoon Haitang (0505), Metsa (0509), Talim (0513) and Khanun (0515) were most severe, affecting large areas. Typhoon Haitang was the most severe one hitting China's Taiwan over the past 5 years, and it also affected the Fujian and Zhejiang provinces. Due to strong wind at the time of landfall, Metsa caused serious damages and huge losses. It was one of the most severe typhoons affecting east costal areas and East China areas since the No.9711 typhoon 8 years ago. Typhoon Khanun was the most powerful one landed over Mainland China up to now in 2005. The maximum wind speed in the central part of the typhoon reached 50m/s, and its central air pressure was 945 hPa. Typhoon Talim among the typhoons in 2005 caused largest death toll. Typhoon Talim moved steadily towards west and northwest, bringing about 300-400mm rainfall in central part of Anhui and northern part of Jiangxi, even 500mm in some regions. It brought about heavy rainfall to Fujian, Zhejiang, Anhui, Jiangxi and Jiangsu, which led to floods and associated geological disasters, causing serious economic losses and casualties.

Before their landfalls, the Central Meteorological Observatory, CMA had kept the Central Government, including the State Council and the National Headquarters for Flood Control and Drought Relief informed about movements of typhoons in an updated manner. CMA also intensified the technical guidance to local meteorological bureaus. The governments at various levels took preventative measures based on the meteorological forecasts and typhoon-related information, including population evacuations. The meteorological bureaus of the provinces under potential impacts of typhoons kept tracking the approaching typhoons around clock and delivering timely weather information to local governments and customers. In Zhejiang Province alone, 1.158 million people were evacuated from the risky areas, and vessels at sea were managed to call back to seaports, all aimed at minimizing the losses of possible casualties and potential damages.

### **c. Interaction with users, other Members, and/or other components**

#### **◆ Improvement in Warning Service System**

Meteorological services at various levels worked closer with various sectors, such as media, communication and urban construction in order to inform wider general public of the tracks and landing information of typhoons as well as relevant warning messages and preventive measures and advices through diversified media including radio, TV, SMS, websites, mobile WAP, hot-line telephone (96121), electronic display screens, and newspaper, etc. Accordingly, the general public would get prepared to protect themselves and other people from possible disasters in a more consciously manner and the casualties were greatly reduced. CMA arranged two groups headed by a Deputy Administrator to visit the affected regions for understanding the situation, showing concern and care about local people, providing guidance for disaster relief and conducting evaluation on typhoons Haitang and Metsa respectively.

#### **◆ Disaster Prevention and Preparedness Exercise**

A joint nautical exercise was held in the seawater off the Yangshan Port in Shanghai on July 7, 2005. The exercise involves approximately 1,000 people, 30 ships and five aircraft to showcase China's capabilities to cope with any possible emergency situation at sea, search for people missing in mishap on the sea, put out a fire on ship, clear away oil spills and remove explosive devices on ships. Dr. Xu Xiaofeng, Deputy Administrator of CMA, was invited to view the exercise on the spot. Mr. Tang Xu, Director of Shanghai Meteorology Bureau, was in command of the meteorological service for the exercise. As every component of the exercise was closely related to meteorological conditions, it provides a good opportunity to test the ability in providing marine meteorology service in an emergency situation with many precious experiences having been obtained.

### **d. Training Progress**

Nil

#### **e. Research Progress**

◆ The researches on TC disaster prevention and preparedness were focused on analysis of disaster characteristic, disaster assessment and the development of warning system for potential TC disasters etc. The evolution of genesis and landfall of typhoon over the Northwest Pacific was studied with 50-year meteorological data. In the same time, the effects of TC disaster were analyzed and estimated quantitatively based on the social and economical data and the possible severity of TC disasters. The risk of a typhoon originated over the Northwest Pacific could be calculated based on typhoon center position and wind speeds. According to the risk evaluations, the distribution pattern and occurrence of excessively strong wind in 10-, 20- and 50-years were given respectively.

◆ Based on intensity, maximum wind speed and maximum rainfall data of 42 TC cases that made landfalls over Guangdong Province from 1950 to 2000, TC disasters were analyzed, based on which an evaluation model was developed. Moreover, TC disaster characteristics were analyzed and the relationship between TC disaster distributions and TC tracks was studied using the disaster data available. Furthermore, a high-resolution numerical storm surge model (ECOM Si) dedicated to the estuary of Yangtze River was developed. The 8 storm surges caused induced by typhoons passing through the estuary of Yangtze River were simulated. It was found that the average error was less than 10 centimeter, comparing the simulated output with observations.

#### **f. Other Cooperative/RCPIP Progress**

◆ An academic Seminar on Meteorological Disaster Prevention Science between Taiwan, China and Mainland China in 18-23 February 2005. The Atmospheric Science Department of Taiwan University hosted the Academic Seminar on Meteorological Disaster Prevention between the two sides. Some researchers from Shanghai Typhoon Institute attended the Seminar and delivered presentations.

### **3. Opportunities for Further Enhancement of Regional Cooperation**

Nil

## V. Typhoon that Impacted TC Members

### 1. Operational Forecast

From January 1 to October 10 2005, 19 tropical cyclones formed over NW Pacific and the South China Sea. The table 5.1 gives the mean distance errors of prediction of these tropical cyclones. It shows that the 24h, 48h and 72h mean errors of NMC forecasts are about 101, 171 and 248km respectively.

Table.5.1 Mean distance errors of prediction of tropical cyclone landed over China (km)  
Jan. 1 to Sept. 30 2005, unit: km.

Forecast time	24h	48h	72h
Mean distance errors	101	171	248

### 2. Narrative Accounts of Tropical Cyclones

#### a. Characteristics of Landing Tropical Cyclones

As mentioned above, from Oct. 1 2004 to Oct.10 2005, 27 tropical storms in total were formed over the Northwest Pacific and the South China Sea. 10 made their landfalls over China during this period (see table5.2).

Table.5.2. List of Tropical cyclone landing over China (Oct.1 2004. -Oct.10, 2005)

TC Name/Number	Landing location	Time/Date	Maximum wind speed when landing (m/s)	Minimum SLP When landing (hPa)
Nock-ten (0424)	Yilan, Taiwan province	02:30UTC, Oct.25	40	960
Nanmadol (0427)	Pingdong, Taiwan province	23:40UTC, Dec.03	28	980
Haitang (0505)	Yilan, Taiwan province	06:50UTC, Jul.18	45	945
	Lianjiang, Fujian	09:10UTC, Jul.19	33	975
Washi (0508)	Qionghai, Hainan	21:25UTC, Jul.29	25	984
Matsa (0509)	Yuhuan, Zhejiang	19:40UTC, Aug.05	45	950
	Dalian, Liaoning	23:10UTC, Aug.08	12	995
Sanvu (0510)	Shantou, Guangdong	04:45UTC, Aug.13	28	982
Talim (0513)	Hualian, Taiwan province	22:00UTC, Aug. 31	50	930
	Putian, Fujian	06:30UTC, Sept.01	35	970
Khanun (0515)	Taizhou, Zhejiang	06:50UTC, Sept.11	50	945
Damrey(0518)	Wanning, Hainan	20:00UTC, Sept. 25	45	950
Longwang(0519)	Hualian, Taiwan province	21:30UTC, Oct.01	50	940
	Jinjiang, Fujian	13:35UTC, Oct.02	33	975

Table 5.2 showed that the intensity of 10 landed tropical cyclones was relatively intense when they landed. Seven of them were in typhoon category, three were severe tropical storms, Typhoon Talim(0513), Typhoon Khanun(0515) and Typhoon Longwang(0519) were the most severe tropical cyclones landed in 2005, their maximum wind speeds near center reached 50m/s.

#### b. Narrative on Tropical Cyclones

##### ◆ Nock-ten (0424)

Tropical storm Nock-ten (0424) formed before dawn on Oct. 17 in 2004 over Northwest Pacific, southeast of Guam. Afterwards it moved westwards with its intensity upgrading to severe tropical storm and typhoon in the next day afternoon and evening respectively. From the evening Oct.19, Nock-ten moved northwestwards and approached east coast of Taiwan. It made landfall on 02:30UTC Oct. 25 at Yilan, Taiwan province with the maximum winds at 40m/s near center. After landing, Nock-ten turned to move northwards with its intensity being reduced quickly. It reentered into East China Sea in the afternoon and changed to northeastward direction in the nighttime. At last, Nock-ten became an extratropical cyclone over the sea southwest of Japan in the afternoon Oct. 26.

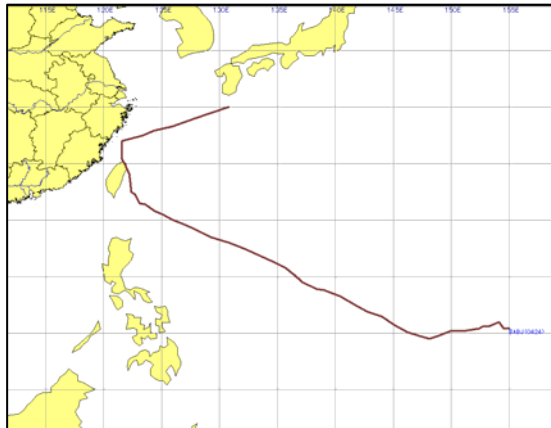


Fig. 5.1a Track of Typhoon Nock-Ten (0424)

Fig. 5.1b FY-1D VIS Image at 0003UTC on Oct. 24 2004 when Typhoon Nock-ten(0424) was approaching to Eastern Taiwan province, China

#### ◆ Nanmadol (0427)

Tropical storm Nanmadol (0427) was formed in the morning of Nov. 29 over Northwest Pacific moving northwestwards steadily with its intensity intensified gradually. It became a severe tropical storm and later a typhoon in the afternoon and evening the next day. Typhoon Nanmadol landed on the southeastern part of Luzon Island at 12:00UTC Dec. 2 with the max winds of 45m/s near center. After the first landing, it continued to move northwestwards and its intensity reduced badly. Nanmadol passed through southern part of Luzon Island and entered into the northeastern part of South China Sea in the morning Dec. 3. Quickly it turned northeastwards and made its second landfall at Pingdong Taiwan, China on 23:40UTC Dec. 3 with the max winds of 28m/s near center. Thereafter Nanmadol passed through southern part of Taiwan and it was weakened into an extratropical cyclone over the sea east of Taiwan in the afternoon Dec. 4.

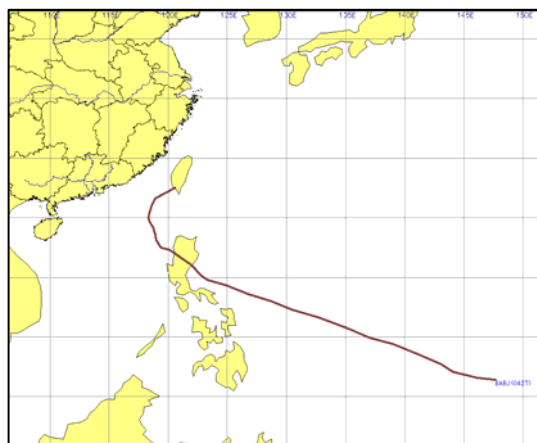


Fig. 5.2a Track of Typhoon Nanmadol (0427)

Fig. 5.2b NOAA-16 VIS Image at 1836UTC on Dec. 2 2004 when Typhoon Nanmadol (0427) passed through the Philippines into the South China Sea



### ◆ Haitang (0505)

Tropical storm Haitang (0505) was formed in the morning on June 12 in 2005 over Northwest Pacific, and then it moved westward in 15 km per hour .It became intensified to be a severe tropical storm and a typhoon on 12UTC June 13 and on 06UTC the next day respectively. Start from 06UTC June 15, Haitang turned northwestward with relatively quicker motion at 25 km per hour. As it was gradually approaching to Taiwan China, its intensity reached the climax with 65m/s and 910hpa on 12UTC June 16. Haitang was less than 50 km distance from Taiwan China on 21UTC June 17. From then on Haitang suddenly began to move southwestward and rotated anticlockwise slowly following a circle with radius of about 25 km. Until 06UTC June 18, Haitang rotated without much movement and then resumed moving northwestward. Because of its interactions with Taiwan coast, its intensity had been greatly reduced during the rotation. Less than one hour later it made landfall at Yilan, Taiwan province at 06:50UTC on July 18, on which the maximum wind at 45m/s near center. It took almost 7 hours for Haitang to pass through Taiwan from east to west. Haitang entered Taiwan Strait on 14UTC June 18 and turned from northwestward to westward. But beginning from 21UTC June 18, it suddenly turned northeastward for 3 hours. Haitang started to move north-northwest with 10 km per hour approaching Fujian province. It landed again on Lianjiang, Fujian on 9:10UTC July 19, with its maximum speed at 33m/s near center at the time of landing. After its second landing, Haitang moved northwestward with its intensity weakened quickly. It reduced to a severe tropical storm and a tropical storm on 12UTC and 18UTC July 19 respectively in Fujian province. At last Haitang faded away in Jiangxi province on 12UTC July 20 (Fig. 5.1a, 5.1b). It could be seen from the above description, the typhoon Haitang firstly had a long lifespan as it survived 204 hours. Next, its path is rather complex. 6 people died. The economic loss was estimated about 119.2 million Yuan RMB.

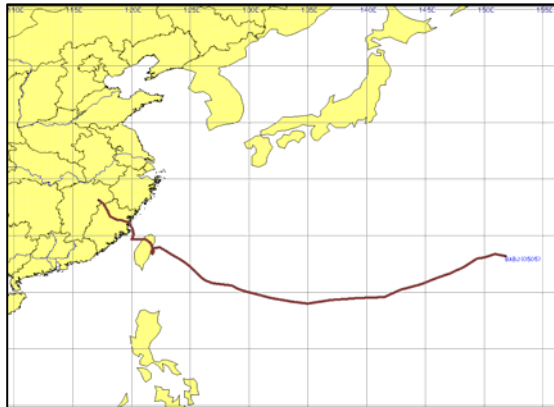


Fig. 5.3a Track of Typhoon Haitang (0505)

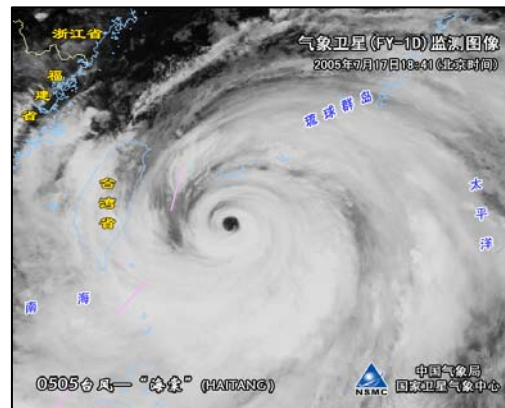


Fig. 5.3b FY-1D IR Image at 1041UTC on July 17 2005 when Typhoon Haitang (0505) was approaching to Taiwan province, China

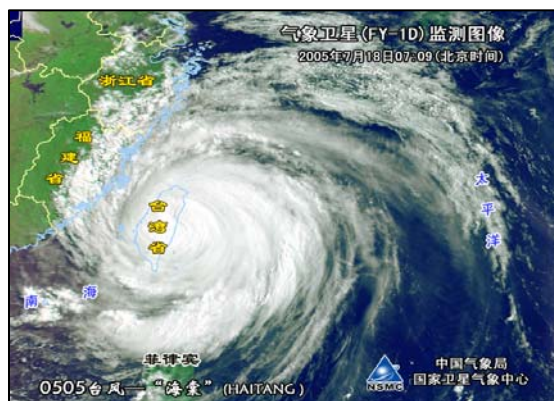


Fig. 5.3c FY-1D VIS Image at 2309UTC on July 17 2005 when Typhoon Haitang (0505) was landing over Taiwan province, China

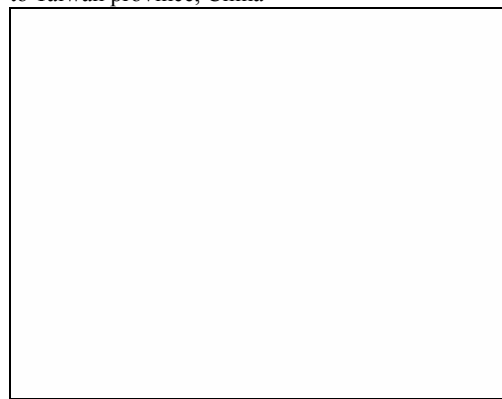


Fig. 5.3d Changle Radar echo at 0707UTC on Jul. 19, 2005 before Haitang made landfall over Fujian province, China

### ◆ Washi (0508)

Tropical storm Washi (0508) was generated in the morning on July 29 in 2005 over northern part of the South China Sea. Afterwards it moved northwestwards with a speed of 10 km per hour and intensified to a severe tropical storm in the sea near eastern coast of HAINAN province. At 21:25UTC July 29, Washi landed over Qionghai, Hainan province with the maximum winds of 25m/s near center. After landing, it was reduced into a tropical storm quickly. Later it went through Hainan Island and entered into Beibu Gulf at 4PM. At last tropical storm Washi landed again over Nanning to Qinghua Vietnam at 05:10UTC July 31 and it became a tropical depression in northern Vietnam on the morning August 1. One people died during its landfall in China. The economic loss was estimated about 1.4 million Yuan RMB.

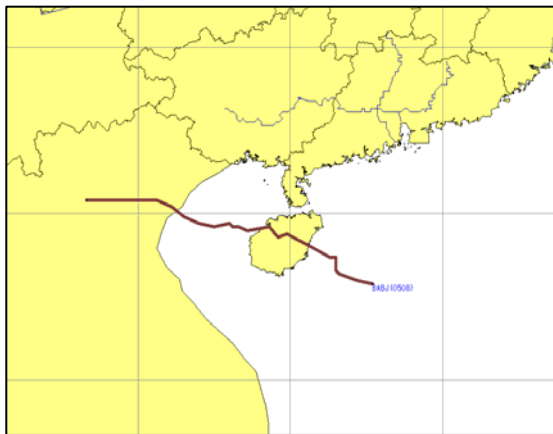


Fig. 5.4a Track of Severe Tropical Storm Washi (0508)

Fig.5.4b NOAA-17 VIS Image at 0242UTC on July. 30 2005 after Severe Tropical Storm Washi (0508) made landfall over Hainan province, China

### ◆ Matsa (0509)

Tropical storm Matsa was developed in the evening of July 31, 2005 over Northwest Pacific Ocean. After its generation, Matsa moved northwest at a speed of 20km per hour and it was intensified into a severe tropical storm and then a typhoon in the morning August 2 and before dawn the next day respectively. Typhoon Matsa entered the southern part of East China Sea in the morning August 5 and it gradually approached to the coast of Zhejiang province. It made landfall over Yuhuan of Zhejiang province at 19:40UTC August 5 with the max winds of 45m/s near center. After landfall it continued to move northwestward with its intensity being reduced gradually. It became a severe tropical storm in northwestern part of Zhejiang province in the evening August 6. Afterwards it changed to move northward and weakened into a tropical storm in southeastern part of Anhui province. And then Matsa entered into Jiangsu province in the afternoon August 7 and went into Shandong province in the morning August 8. At last it entered into Bohai Sea and made landfall at Dalian Liaoning province in the morning August 9 becoming an extratropical cyclone at the same time. Typhoon Matsa was well known for its intensive wind, the long lifespan and the large coverage. It was one of the typhoons that had severe impacts on East China in the recent 8 years since typhoon 9711. 20 people died as result of its landfall. The economic loss was estimated about 177.22 million Yuan RMB.

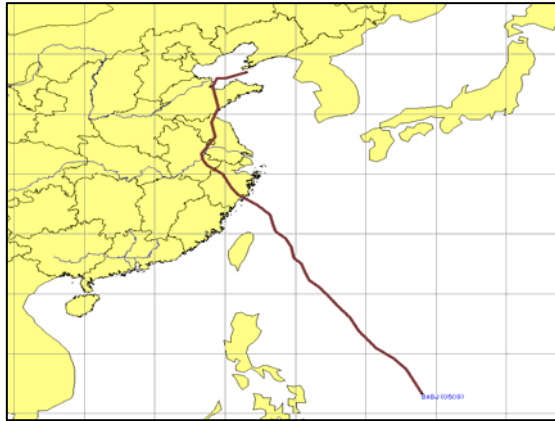


Fig. 5.5a Track of Typhoon Matsa (0509)

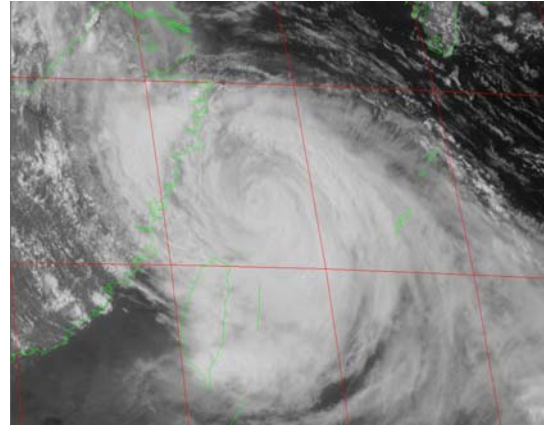


Fig. 5.4b FY-2C VIS Image at 0600UTC, Aug. 5 2005 when Matsa (0509) was approaching to Zhejiang, China

Fig. 5.4c NOAA-16 VIS Image at 1822UTC on Aug. 5 2005 when Typhoon Matsa (0509) was landing over Zhejiang province, China

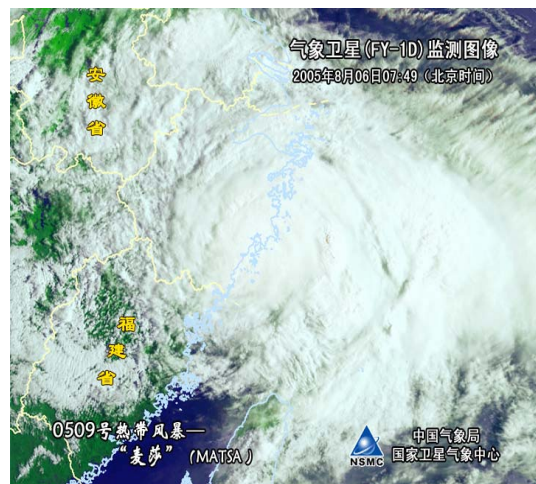


Fig. 5.4d FY-ID VIS Image at 2349UTC on Aug. 5 2005 after Typhoon Matsa (0509) made landfall over Zhejiang province, China

Fig. 5.5d Wenzhou Radar echo at 1940UTC on Aug. 5, 2005 when Matsa was landing over Zhejiang province

Fig. 5.5d Wenzhou Radar Velocity at 1940UTC on Aug. 5, 2005 when Matsa was landing over Zhejiang province

#### ◆ Sanvu (0510)

The tropical storm Sanvu was generated in shape in the afternoon August 11 in 2005 over Northwest Pacific, east of Luzon Island of the Philippines. It moved northwestwards with its intensifying .After passing through Bashi channel in the evening August 11, Sanvu entered

into south China sea and upgraded to severe tropical storm in the afternoon the next day. It landed at Shantou, Guangdong province on 04:45UTC August 13 with the max winds of 28m/s near center. Sanvu continued to move northwestwards after landing and reduced to tropical storm in the afternoon intraday. Then it entered into southern part of Jiangxi province and reduced to tropical depression before dawn August 14. 16 people died as result of it. The economic loss was estimated about 26.7 million Yuan RMB.



Fig. 5.6a Track of Severe Tropical Storm Sanvu(0510)

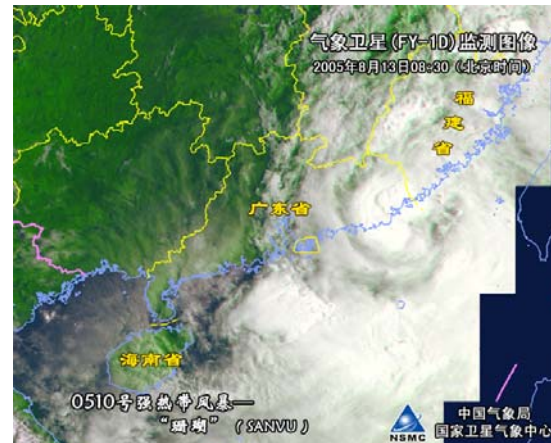


Fig. 5.6b FY-ID VIS Image at 0030UTC on Aug. 13 2005 before Severe Tropical Storm Sanvu (0510) made landfall over Guangdong province, China

#### ◆ Talim (0513)

The tropical storm Talim was formed in the morning of August 27 in 2005 over Northwest Pacific moving northwestwards at a speed of 20 km per hour, it grew into a typhoon in the afternoon the next day quickly. Its intensity reached the climax with 65m/s and 910hpa on 09UTC August 30 and was retained until 01UTC August 31. Typhoon Talim landed on Hualian, Taiwan province at 22:00UTC August 31 with the max winds of 50m/s near center. After landing its intensity was severely reduced. It passed over Taiwan Strait and made landfall again at Putian, Fujian province at 06:30UTC September 1 with the max winds of 35m/s near center. After the second landing Typhoon Talim still moved northwestwards and reduced to severe tropical storm and tropical storm in the afternoon and in the evening intraday .Tropical storm moved into Jiangxi province in the morning September 2 and reduced to a tropical depression. 96 people died. The economic loss was estimated about 120.6 million Yuan RMB.

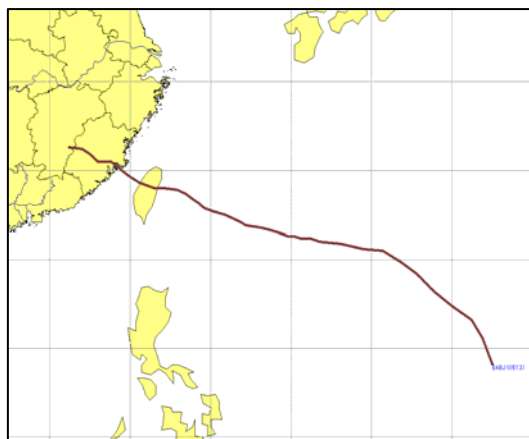


Fig. 5.7a Track of Typhoon Talim (0513)

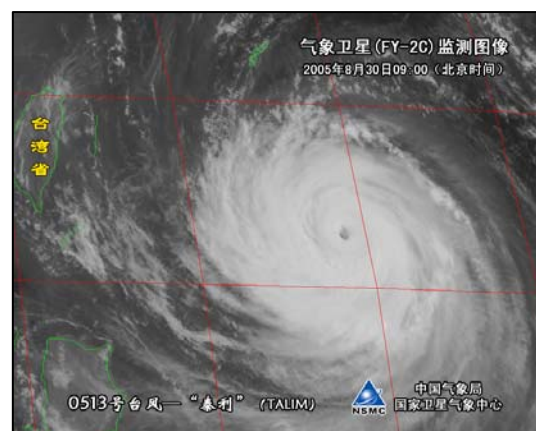


Fig. 5.7b FY-2C VIS Image at 0100UTC on Aug. 30 2005 when Typhoon Talim (0513) was over the sea of Taiwan province , China



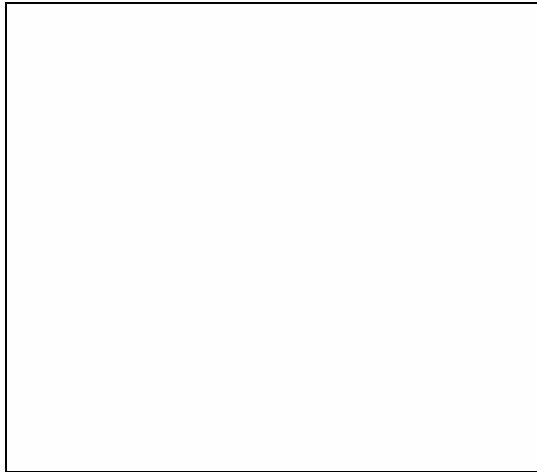


Fig. 5.7c FY-1D VIS Image at 1100UTC on Aug. 31 2005 when Typhoon Talim (0513) was approaching to Taiwan province, China



Fig. 5.7d FY-1D VIS Image at 2329UTC on Aug. 31 2005 when Typhoon Talim (0513) was approaching to Fujian province, China

### ◆ Khanun (0515)

The 15th tropical storm Khanun was formed over in the morning September 7 in 2005 over Northwest Pacific, east of Luzon Island of the Philippines. Then it moved northwestward by north with a speed of 15 km per hour and it was intensified into a severe tropical storm and a typhoon in the morning Sept. 8 and in the morning Sept.9 respectively. Starting from Sept. 9, typhoon Khanun turned northwestwards with a quicker pace, and it approached the coast of Zhejiang province. Its intensity reached 50m/s with 945hpa on 06:00UTC Sept. 10, and it maintained the same intensity until its landfall over Taizhou, Zhejiang province the next day in the afternoon. After its landing, Khanun continued to move northwestwards with intensity reduced quickly and it became a severe tropical storm on 15:00UTC Sept.11 over Zhejiang. Khanun entered Jiangsu province before dawn Sept.12, and reduced to tropical storm in the morning, turning northwards. Starting from the afternoon Sept.12, Khanun moved northeastwards and entered into Yellow Sea in the evening. Finally Khanun was weakened into an extratropical cyclone in the mid Yellow Sea at 09:00UTC Sept. 13. Typhoon Khanun was the strongest typhoon landing in Zhejiang province since the twelfth typhoon in 1956.16 people died. The economic loss was estimated about 92.5 million Yuan RMB.

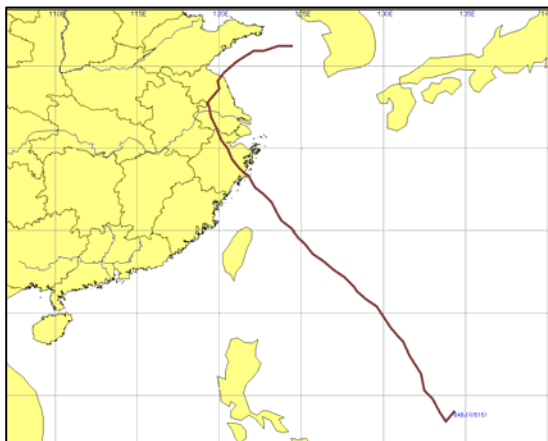


Fig. 5.8a Track of Typhoon Khanun (0515)

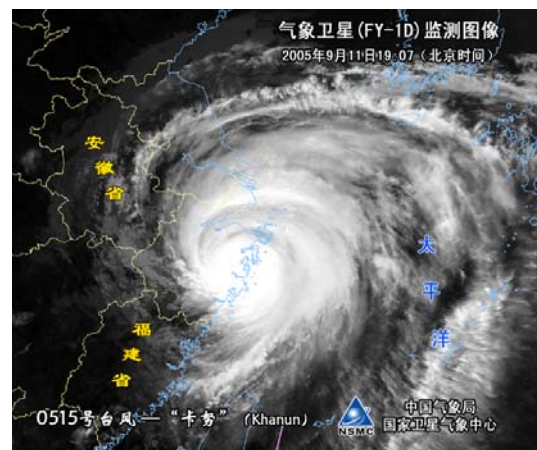


Fig.5.8b FY-1D VIS Image at 1107UTC on Sept. 11 2005 after Typhoon Khanun (0515) landed over Zhejiang province

Fig. 5.8c Wenzhou Radar echo at 0652UTC on Sept. 11, 2005 when Khanun was landing over Zhejiang province

Fig. 5.8d Zhoushan Radar echo at 0653UTC on Sept. 11, 2005 when Khanun was landing over Zhejiang province

### ◆ Damrey (0518)

Tropical storm Damrey (0518) was generated in the morning on Sep. 21 in 2005 over sea near northeastern part of Luzon Island. Afterwards it moved northwestwards with a speed of 10 km per hour and intensified gradually. In the evening Sep. 22, the center of storm entered into northeastern part of South China Sea and intensified to severe tropical storm and typhoon before dawn and in the afternoon Sep. 24 respectively. Its intensity reached climax with the max winds of 55m/s near center at 09:00UTC Sep. 25. 23 hours later, Damray landed at Wanning Hainan province with the max winds of 45m/s near center. After landing, it went westwards and passed through Hainan province with a speed 15 to 20 km per hour. Damray entered into Beibu Gulf twilight Sep. 26 and it was weakened into a severe tropical storm in the next morning over western part of Beibu Gulf. Later it landed again at Qinghua Vietnam around noon Sep. 27 with the max winds of 30m/s near center and reduced to a tropical storm in Yian Vietnam in the afternoon intraday. At last it turned to tropical depression before dawn the next day. According to statistics of the past 50 years, Damray's intensity while landing were only next to Typhoon Marge (7314) and stronger than Typhoon Kelly (8105) a little. But precipitation intensity with Damray was much more than the two previous 2 typhoons. 16 people died. The economic loss was estimated about 95.9 million Yuan RMB.



Fig. 5.9a Track of Typhoon Damrey (0518)

Fig. 5.9b NOAA-18 VIS Image at 1854UTC on Sept. 25 2005 when Typhoon Damrey (0518) was landing over Hainan provinces

### ◆ Longwang (0519)

Tropical storm Longwang (0519) was formed in the morning on Sep. 26 in 2005 over Northwest Pacific, about 690 kilometre northwest of Guam. Firstly, it moved northwestward about 10 km per hour and became intensified to be a typhoon in the morning Sep.27. Then it turned to move northwestwards by north with quicker speed and continued to strengthen. Up to before dawn Sep. 31, Longwang's intensity reached climax with the max winds of 60m/s near center. It retained the intensity for 19 hours, and then it was reduced slightly. Longwang made landfall at Hualian, Taiwan province at 21:30UTC on Oct.1 with max winds of 50m/s near center. Then it went through Taiwan quickly and entered into Taiwan Strait around noon Oct. 2. After it entered into Taiwan Strait its moving speed slowed down and the moving direction changed from west to northwest. Several hours later, It landed again on Jinjiang, Fujian province on 13:35UTC with its max speed of 33m/s near center and reduced to severe tropical storm whereat. And then it continued to move northwestward and eventually it was weakened into a tropical storm before dawn Oct. 3. At last Longwang faded away in Longyan, Fujian province in the morning. Consequently, 15 people died. The economic loss was estimated about 32.78 million Yuan RMB.

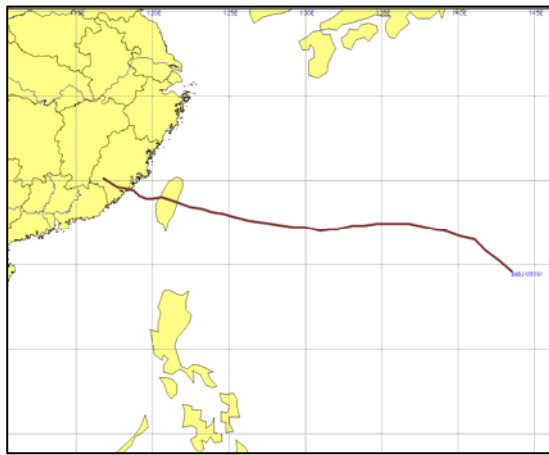


Fig. 5.10a Track of Typhoon Longwang (0519)

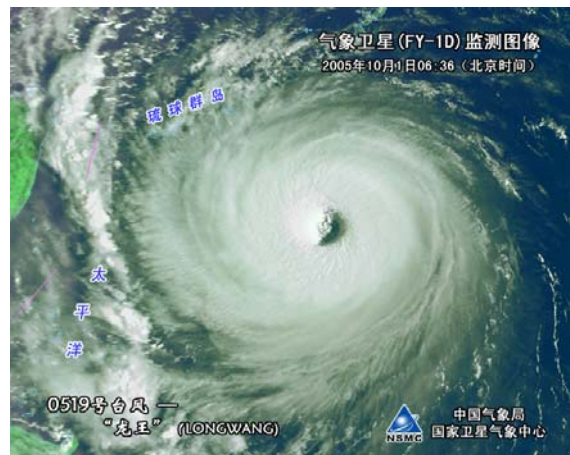


Fig. 5.10b FY-1D VIS Image at 2236UTC on Sept. 30 2005 when Typhoon Longwang (0519) was at sea east of Taiwan provinces, China

## VI. Resource Mobilization Activities

Nil.

## VII. Report on Damage Caused By Cyclones, Floods and Drought

COUNTRY : China

### PERIOD COVERED BY THIS REPORT

from : 1 Jan. 2005 to : 15 Oct. 2005  
(date, month, year) (date, month, year)

### PREPARED AND SUBMITTED BY:

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DATE PREPARED : 15 Oct. 2005  
(date, month, year)

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### INTRODUCTION

1. It was decided at the fourteenth session of the Typhoon Committee (Manila, November 1981) that information on damage caused by typhoons and floods should be compiled and sent to the Typhoon Committee Secretariat (TCS) before each annual session of the Typhoon Committee. This information shall consist of statistics on loss of human life, damage to houses, public facilities, agricultural products, etc.
2. At the fifth session of Management Board of the Typhoon Operational Experiment (TOPEX) (Tokyo, February 1982) UNDRO and LRCS were asked to co-operate in the preparation of a simple standard format for the region and make proposals for consideration by the Board at its sixth session.
3. The Board considered the proposed format at its sixth session (Bangkok, November 1982) and requested ESCAP and WMO in consultation with UNDRO and LRCS to revise the format with a view to incorporating more elaborately ESCAP long experience in flood statistics and to avoiding duplication with the ongoing efforts of ESCAP to improve disaster statistics.
4. Accordingly, this format was prepared for consideration at the third Planning Meeting for TOPEX (Tokyo, February 1993). The revised format was considered and adopted by the Meeting after some minor editorial amendments.

### REPORT

1. This report should cover the total damage caused by typhoons and heavy rainfall, and associated storm-surges, floods, landslides, etc.
  2. This report should be prepared by an official of the agency responsible for the disaster preparedness and relief in consultation with other agencies concerned.
- \* Such official should be designated by each member and reported to TCS beforehand.

### FORMAT

1. This format is designed to aid compilation of data and information which are already collected in each country. In other words, it does not propose any change in the existing systems of disaster damage survey in the various countries.
2. If final official figures for the reporting period are not available, it is recommended that tentative data be reported with appropriate notations.
3. Although this format covers broad aspects of disasters and detailed data, if the country is not prepared to provide data on some of the items, those may be left blank. However, it is recommended that the country report provides data at least on vital items marked with an asterisk and enclosed thick lines which are regarded as basic elements in disaster statistics on typhoon damage.
4. Data processing involved in the estimation of damage costs require much time, therefore, if the data are still being processed at the time of reporting, it should be noted when such data will become available.

\* = Applicable for the members of Typhoon Committee.



Noted

For consistency, please use the following necessary:

... data are not available or not separately reported

... amount is negligible or nil

N/A item is not applicable

I. GENERAL	Sequence No.	1	2	3	4	5	6	7	8	9
1. Type of disasters Sequence number/code name of the typhoon and or type of disaster caused by it or by a combination of weather disturbances such as rainfall, strong winds, storm-surges, floods and landslides.		0505 Haitang	0508 Wahsi	0509 Matsa	0510 Sanvu	0513 Taltm	0515 Khanun	0516 Vicente	0518 Damrey	0519 Longwang
2. Date or period of occurrence		18, JUL. 19, JUL.	30, JUL	6, AUG	13, AUG	1, SEP 1, SEP	11, SEP		26, SEP	2, Oct
3. Name of regions/areas seriously affected*		Fujian Zhejiang Jiangxi Hubei Henan Anhui	Hainan Guangdong	Zhejiang Shanghai Jiangsu Anhui Shandong Hebei Liaoning Fujian	Guangdong Fujian Jiangxi Hubei	Fujian Zhejiang Hubei Henan Jiangsu Jiangxi Anhui Guangdong	Zhejiang Jiangsu Anhui	Hainan Guangdong	Hainan Guangdong Gguangxi	Fujian Jiangxi Zhejiang

II. HUMAN DAMAGE	Unit									
4. Dead and missing*	persons	14		25	36	167	25	1	29	133
5. Injured	persons	356		303	81	871	24			
6. Homeless*	families	339600	5000	461000	109200	371400	226600		108400	129400
7. Affected	persons	11753000	131000	31575000	4576100	20088500	12715500	282000	8907000	4591900
8. Total	persons									

1) Please specify other categories of disaster victims covered here e.g. assisted by emergency relief, activities, those whose normal activities are seriously disrupted.

Remarks:

III. MATERIAL DAMAGE IN PHYSICAL TERMS	Sequence No.	1	2	3	4	5	6	7	8	9
<b>A. Houses and buildings</b>	Unit									
9. Destroyed*	Units	20900		59600	25700	116400	23800	100	33900	9400
10. Damaged*	Units	154800		191300	43900	292100	40600		109400	
11. Affected*	Units									
12. Total*	Units									
<b>B. Farmland</b>										
13. Farmland	hectares	478750		2140200	265140	1316490	895020	2350	1133000	1561900
<b>C. Agricultural Products</b>										
14. Crops	tons									
15. Livestock	heads	10100		200	1300	67000			31900	40900
16. Fruit plants	number hectares									
17. Others										

2) Houses and buildings include public buildings and are classified into three groups: Those not able to be used without reconstruction enter into destroyed”, those which can be required enter into damaged” and others which were inundated, damaged in minor parts or those fixtures and furniture were damaged enter into affected”.

3) Please specify other types of damage e.g. inundated marooned, evacuated.

4) Farmland affected are those buried, washed away, inundated and/or whose products were damaged.

5) If data are available for other products such as vegetables, marine products, forest products, please use this column.

Remarks:

	Sequence No.	1	2	3	4	5	6	7	8	9
<b>D. Public works facilities</b>	Unit									
18. Road	km	1489		726	283	1	809		518	417
19. Bridge	sites			301	17					
20. River embankment	km	251		447	35	80	647	2	4	103
21. Irrigation facilities	hectares sites	10124		4472	964	5641	3540	57	4492	4559
22. Reservoir and dam	number									
23. Harbor and port	number sites									
24. Other please specify										
<b>B. Public Utilities</b>										
25. Railway	km sites									
26. Electric Supply	affected families sites (km)	926		559	130	1	970	0	395	428
27. Water Supply	affected families sites									
28. Telecommunication	circuits sites (km)	508		479	18		711		712	133
29. Other please specify										

6) There are two types of classification methods in the public works facilities:

a) Classification in accordance with the nature of the service provided;

b) Classification in accordance with the administrative structure of the government. Although the format was prepared according to the former classification, if necessary appropriate changes might be allowed.

7) Public utilities include both private owned and state owned facilities. Column of Other can be used for the damage in airport, gas supply, etc.

	Sequence No.	1	2	3	4	5	6	7	8	9
<b>F. Others</b>	Unit									
30. Ships lost or damaged	number			53	388					
31. Landslide and collapse of slope	Sites									

<b>IV. MATERIAL DAMAGE IN MONETARY TERMS</b>	Sequence	1	2	3	4	5	6	7	8	9
32. Damage of houses and loss of private property* includes: * houses and buildings for residential use, * household furniture, appliances and possession, * stored good and other assets of farmers and fisherman 担 households * Other										
33. Loss of agricultural production includes: * crops, vegetables, fruits, etc. * livestock * Other: Fisheries	ten thousand dollars	33339		34863	7136	51675	55380		102484	22635

8) Damage of houses and loss of private property includes damage to a) houses and buildings for residential use; b) household furniture, appliances and possessions; c) stored goods and other assets of farmers' and fishermen's households. Damage to shops and manufactures could be classified under item 34. Loss of industry, however, if such separation was not possible for small shops and home-industries, such damage could be included in this item with an appropriate note.

Damage costs can be estimated by means of surveys listing the number of houses and buildings, their floor area and extend of damage, priced according to the value of the building or per unit area of floor space. Damage to household articles and personal effects such as clothing, furniture, electric appliances, cars, etc. are included in this category. If information on the household articles of an average family is available; loss may be calculated by multiplying the number of affected families by their total properties and an assessed percentage of damage.

Damage to stored goods and other assets of farmers' and fishermen's household can be assessed in a similar manner.

9) Loss of agricultural production includes damage to a) crops, vegetables, fruits, etc., b) livestock, c) marine products, d) forest products. Damage to agricultural products which had been stored in farmers' houses or warehouses should be counted under item 32. Damage of houses and loss of private properties.

Crop damage can be estimated by multiplying the damaged crop area by the average loss per hectare and unit price of the crop, after considering the extent of damage to crops inundated and buried under debris. Loss of livestock can be estimated in the same manner by multiplying the head of stock lost by unit market price.

	Sequence No.	1	2	3	4	5	6	7	8	9
34. Loss of industry	ten thousand dollars				272		38530		10357	43585
35. Loss of public work facilities includes items under III. MATERIAL DAMAGE IN PHYSICAL TERMS * road bridge, river embankment, etc., irrigation facility * reservoir and dam, harbor and port, and public bridges * rehabilitation cost of farmland at government expense * Other	ten thousand dollars	3671		12361	20665	6070	8300		7929	26996
36. Loss of public utilities includes items under III. MATERIAL DAMAGE IN PHYSICAL TERMS * railway, electric supply, water supply, telecommunication * Other										
37. Total estimated/counted damage cost, sum of items 32, 33, 34, 35, 36	ten thousand dollars	158669	2886	223279	54215	205661	117871	692	152028	94468

10) Loss of industry includes damage to buildings, factories, warehouses, machinery, stored good and other assets in factories and wholesale, retail and other service industries, but excludes agriculture, fishing and public utilities. Indirect losses due to suspension of routine activities are excluded here and if such data is available, please use column V. OTHER ADDITIONAL INFORMATION AND DATA AVAILABLE.

Estimates of the damage incurred can be sought from the industries concerned.

11) Loss of public works facilities is the cost required for the following facilities at Government expense: a) road and bridges, b) flood control installations, c) agricultural land, d) irrigation and drainage installations, e) reservoirs and dams, f) harbor, fishing port and airport installations, g) erosion control and landslide structures, h) streets, urban sewerage system and other public works facilities.

12) Public utilities include both private owned and state owned facilities.