Country Report

(2007)

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People’s Republic of China
1. Overview of Meteorological and Hydrological Conditions

1. Meteorological Assessment

From Oct. 1st 2006 to Sep. 30th 2007, altogether 23 tropical cyclones (including tropical storms, severe tropical storms, typhoons, severe typhoons and super typhoons) formed over the Western North Pacific and the South China Sea (Fig. 1.1). Among them, 8 TCs formed from Oct. 1st to Dec. 31st in 2006 and 4 of them affected China’s coastal waters but didn’t land on China’s coastal areas. They were super typhoon Cimaron (0619), super typhoon Chebi 0620), super typhoon Durian (0621) and severe typhoon Utor (0622).

In 2007, 15 tropical cyclones formed over the Western North Pacific and the South China Sea. The number was obviously less than the average (19.7) during the corresponding period from 1949 to 2006. And 9 of them developed into typhoons or beyond, which accounted for 60.0% of the total. The percentage was higher than the average (58.6%). During the same period, 4 TCs formed over the South China Sea. The number was slightly less than the average (4.7). Moreover, 6 TCs made landfalls over China coastal areas, all of them exceed tropical storm category. They were tropical storm Toraji (0703), severe tropical storm Pabuk 0706), tropical storm Wupit 0707), super typhoon Sepat (0708), super typhoon Wipha 0712) and tropical storm Francisco (0713). The total landed TC number was slightly less than the average (about 6.79), but the percentage of landed TCs (40.0%) was obviously above the average (30.8%). In addition, during the same period another 3 TCs affected China’s coastal region, despite of the fact that they did not land on China’s coastal areas. They were super typhoon Man-yi (0704), tropical storm nameless (07××) and severe typhoon Nari (0711). As above mentioned, in total there were 9 TCs landed over China’s coastal areas or affected its waters from Jan. 1st to Sep. 30th in 2007.

![Fig. 1.1 TC tracks over the WN Pacific and the South China Sea from Oct. 1st 2006 to Sep. 30th 2007](image)

a. The characteristics for the tropical cyclones activities

The characteristics for the tropical cyclones formed from Oct.1st in 2006 to Sep.30th in 2007 are described as follows:

- **TC number was less than normal**

  During report year, 23 tropical cyclones formed over the Western North Pacific and the South China Sea. The number was obviously less than the average (27.6). 14 of them reached the intensity of typhoon or above, which accounted for 60.9% of the total. The percentage was also less than the average (62.5%).
Few Forming Number with Partly high Intensity

In 2007, 15 tropical cyclones formed over the Western North Pacific and the South China Sea. The number was obviously less than the average (19.7). 9 of them developed into typhoons or above, which took 60.0% of the total. The percentage is higher than the average (58.6%).

TC Formation Tended to be More Eastward in Terms of Source Region

In 2007, 8 out of 15 TCs formed over the Western North Pacific between the eastern Philippines and the Marshall Islands. TC source regions located relatively eastward compared with the normal. 12 TCs formed at sea west of 150°E, which accounted for 80.0% of the total and the percentage was lower than the average (81.1%). 3 TCs developed at sea east of 150°E. Over the region, the number of TCs was slightly less than the average (3.6). In addition, 4 TCs formed over South China Sea, which was usually believed to be another source region with more frequent TC occurrence. The number was slightly less than the average (4.7)

The Concentrated Forming Time and Complicated Tracks

During this typhoon season, 13 TCs were formed from July to September 2007 and accounted for 86.7% of the total. The percentage was much higher than the average (76.6%). Moreover, during the first 10-day of August, severe tropical storm Pabuk (0706) and tropical storm Wutip (0707) formed one following the other over the Western North Pacific. Because of the Fujiwhara effect and the interactions among tropical cyclones, the tracks of these tropical cyclones became complicated. So it was found difficult to judge and forecast their tracks for issuing operational warning.

b. Factor analysis

SSTa in the equatorial Pacific

The SSTa turned quickly into such a pattern: “cold in the east and warm in the west” in the equatorial Pacific after a weak warm (El Niño) episode ended in February 2007. The negative SSTa in the mid-eastern equatorial Pacific has obviously been extending westward since July 2007. During August, the negative SSTa below -0.5°C extended westward to the vicinity of 140°W, and NINO Z index dropped to -0.6°C and reached the threshold for La Nina conditions (NINO Z index ≤-0.5°C), and during September and October the intensity of negative SSTa was increased obviously in the central and eastern equatorial Pacific.

![Fig 1.2 Monthly mean SST (top) and SSTA (bottom) in September 2007(unit:℃)](image)
Tropical convection activity indicated by OLRa in the North-western Pacific was suppressed with an exception of the period from July to September 2007.

Circulation

Generally, the NW Pacific Subtropical High was stronger and extended slightly more westward than normal. Its ridge line was positioned more southward than normal in June and July, but it tended to be more northward than normal in August and September.

2. Hydrological Assessment

In 2007, there were weather abnormality, uneven distribution of precipitation, frequent extreme weather events, like severe flood and drought in China. In the flood-prone period, severe flood took place in the Huaihe River Basin, which was just next to what happened in 1954. Under the influence of storms and typhoons, there were floods exceeding the warning levels in the upper- and middle-reaches of the Yangtze River and its tributaries, Taihu Lake Basin, middle reaches of the Yellow River and its tributaries, Pearl River Basin, and the provinces of Zhejiang, Fujian, Inner Mongolia, Liaoning, Yunnan, Xinjiang and Tibet. There were floods exceeding secure level or even historical records. The precipitation was obvious less in the regions of the Northeast China, south of the Yangtze River and the southern China. The inflow was obvious less. The same historically lowest levels were recorded in the lower-reaches of the Yangtze River, Boyanghu Lake, Songhuajiang River and some tributaries of Liaohe River. The low flows broke records in some medium- and small-sized rivers. There were prolonged droughts in some areas.

From Jan. to Sept., 2007, the accumulative inflow was smaller in the main rivers in China except the increase in the Huaihe River because of the floods in July. The inflow was decreased by 10% in the middle- and upper-streams of the Yangtze River, by more than 10% in the lower-stream of the Yangtze River, by approximately 20% in the Xiangjiang River, and by near 30% in the Ganjiang River. The inflow was decreased by about 30% in the middle reaches and near 30% in the lower reaches of the Yellow River. The inflow was increased by near 80% in upper reaches and by over 50% in the middle reach of the Huaihe River, and by more than 50% in the Songhuajiang River. However it was decreased by 70% in the Liaohe River and by near 30% in the Xijiang River of the Pearl River Basin. From Jan. to Sept., the accumulative inflow only reached 2,000,000 m$^3$; which was the minimum in the same period of the years.

3. Socio-economic Assessment

These typhoons or tropical storms brought abundant precipitation to China, and abated the agricultural droughts and impacts of hot weather in the most southern regions to the middle and lower reaches of the Yangtze River and southern China, and they increased the reservoir recharge. However, the violent gust, heavy rain and associated astronomical tides also brought about severe losses in the coastal areas during the year. The economic losses caused by typhoons during Jan. to Sep. 2007 were less severe compared with the last 10 years and the least severe one in the past 4 years. According to the preliminary statistics, more than 27 million people and 11800 km$^2$ farmland were affected. 61 people were killed and 18 people were missing. 57 thousands houses destroyed and 143 thousands houses were damaged. The direct economic losses were about 18 billion RMB Yuan.

There were totally 6 typhoons (including severe tropical storm) landed in China and brought precipitation in land from Jan. to Sep. 2007 (TORAJI, PABUK, WUTIP, SEPAT, WIPHA, FRANCISCO). With regard to impacted area, typhoon FRANCISCO was the most important one, with a total affected area being 1,427,000 km$^2$ and the total precipitation volume of 25.6 km$^3$. Meanwhile, with regard to precipitation volume, typhoon WIPHA was the most important case, during the period, with the precipitation amount being up to 59.1 km$^3$ and the total affected area reaching 1,284,000 km$^2$.
Fig. 1.3 The estimated precipitation volumes and impacted areas of typhoons or severe tropical storms which landed in China during Jan. to Sep. 2007
II. Meteorology

1. Progress in Member’s Regional Cooperation and Selected Strategic Plan Goals and Objectives

a. Hardware and/or Software Progress

   Satellite Observation System

The new geostationary satellite FY-2D was launched on Dec. 8, 2006. It consists of a twin satellite observation system with FY-2C. The observation coverage of the two satellites expands from 26.5°E to 165°E and the overlap region is at about 101.5°. The figure below gives the observation coverage of the FY-2C & FY-2D. During the flooding season of the year, according to the demands for making TCs analysis, the NSMC switched on the multi-temporal twin satellite observational-mode i.e. producing 96 pictures (once quarter an hour) everyday from the FY-2C and FY-2D satellites. Through the higher temporal resolution satellite data, the characteristic of TCs can be better derived, such as TC occurrences, developments and evolutions. The central meteorological office and each local meteorological bureau along the coastline highly commended the value of the twin satellite data in monitoring and forecasting TCs in the flood-prone season.

![The observation coverage of the FY-2C & FY-2D](image)

FY-1D was launched on May 15, 2002 and it has a 10-Channels radiometer. It is now operating over the designed lifetime and still in a healthy operation, it plays an important role in the typhoon monitoring. Its horizontal resolution at the nadir is 1.1 km, and can provide more high space resolution images for typhoon monitoring. This facilitates the study on the fine structure of typhoon cloud, especially the mid and lower level cloud around the typhoon eyes. In the typhoon monitoring in 2007, FY-1D satellite data were used in estimating and precisely locating cloud systems, in making structure analysis, and in modifying the location and strength of typhoons based on the geostationary meteorological satellites. At the same time, other foreign polar orbiting meteorological satellites such as NOAA series (NOAA-16, NOAA-17, NOAA-18) and EOS series (TERRA and AQUA) of the USA are also used in daily typhoon monitoring, such that polar orbital meteorological satellites provide continuous monitoring imagery of typhoons and they become the important supplements to the geostationary meteorological satellites for making typhoon analysis.
Up to October 14, 2007, the National Satellite Meteorological Center (NSMC) has monitored and analyzed 19 Tropical Cyclones (TCs) with the meteorological satellites. The tasks not only include TC center locating, strength estimation, track monitoring, structure analysis, but also cover analysis on the distribution of the gale region, the heaviest rainfall area, etc. NSMC releases the real-time results of the TCs’ analysis, such as TCs’ locations, intensity, tracks, comprehensive analysis reports and multiple relevant data & products on the website. The website is http://dear.cma.gov.cn.

In 2007, TCs were formed later than other years, but there are many strong TCs influencing China after August. Not only ‘Pabuk’, ‘Wutip’, ‘Sepat’, but also ‘Wipha’, ‘Lekima’ and ‘Krosa’, binging about serious impacts to the Chinese mainland. NSMC actively attended the emergency services of TCs organized by the China Meteorological Administration (CMA) and carried out 24-hour continuous satellite monitoring and analysis of TCs which were approaching to land and causing potential severe damages. NSMC attended dozens of weather consultation teleconferences focusing on TCs, which were organized by CMA. During these TC weather discussion meetings, NSMC presented satellite TC observations, the atmospheric status from the remote sensing, physical quantity distributions, etc., and it provided advisory opinions about the possible change of the future weather. In the meantime, NSMC put forward 13 satellite monitoring reports on tropical cyclones to provide key satellite features for the decision-making and forecasters. In the TC services of this year, NSMC gave much attention to public serves. Based on the illustrative & vivid satellite data, NSMC produced 3-D satellite cloud imageries, TC cross-section charts, etc. These products are made available to the meteorological TV programs on a regular basis, so as to enable the viewers to better understand the motions and the possible impacts of TCs.

- **RADAR Observation System**

According to the latest plan, 158 new generation Doppler weather radars -- CINRAD will constitute the China New Generation Doppler Radars Network. 118 CINRAD radars have already deployed in China and used in observing hail, rainstorm and typhoon monitoring. It has provided encouraging contribution to the disastrous weather prevention & mitigation in a large number of provinces.

So far, 14 typhoons have affected China, i.e. super typhoons “Sepat”, “Wipha”, “Krosa”, especially the Chinese southeast foreland, causing great impacts.

In Southeast China, the radar at Zhoushan, Zhejiang province, and radars located at Fuzhou, Xiamen, Jianyang in Fujian province were successfully used to monitor “Sepat”, “Wipha”, “Krosa” and contributed to accurate forecasts. They have made due contribution to prevention and mitigation of disastrous weather events.
Up to end of this year, about 125 CINRAD radars will be setup in mainland, and 10 or so CINRAD radars will be built in next year.

- **Upper air sounding observation**

In order to strengthen the monitoring of the super typhoons “Sepat”, “Wipha”, “Krosa”, CMA intensified the upper-air observations during the alert period of the 3 approaching super typhoons. 26 upper-air stations of 9 provinces, during the landing period of “Sepat”, 40 upper-air stations in 13 provinces intensified their observations for “Wipha”, 15 upper-air sounding stations in 6 provinces increased their observations for “Krosa”.

- **Surface Observation**

About 2134 AWSs operated by CMA has become operational by now.

The other surface observations include:
- weather radar
- in-situ meteorological observations

**b. Implications to Operational Progress**

Based on the monitoring requirements when typhoon is over the ocean, NSMC developed the precipitation retrieval products of tropical cyclones by combining the precipitation from the infrared & microwave channels and provided more precise precipitation estimation over the ocean. In making the landing TC analyses and forecasts in 2007, the satellite precipitation products discovered the distribution pattern of typhoon rainfall and provided the useful information about typhoon-induced heavy rainfall & disasters. This strongly supported TC analysis & forecasting operations and thus made social contributions.

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**Fig. 2.3 precipitation retrieval products for tropical cyclone**

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

CMA’s satellite-based broadcasting system PCVSAT was running in a stable manner in 2007. There was a new remote station, Dhaka PCVSAT reception-only station, installed outside China in the year. Currently, PCVSAT
system totally has exceeded 2500 remote stations, and its average daily broadcasting data volume is over 2.8 GB, including surface observations, upper-air observations, aircraft observations, weather radar data & products, satellite data & products, as well as NWP products generated by numerical weather and climate models.

At RTH Beijing, the upgrading for GTS links made good progress in 2007. Beijing-Pyongyang link was upgraded from 75Bauds ASYNC circuit to 64kbps IP link in April, 2007. The GTS links to Offenbach, Tokyo, Moscow and New Delhi was upgraded from FR VPN to MPLS VPN in July, 2007, and the port speed for Beijing side was increased from 256 kbps to 2 Mbps. And, a new link, Beijing-EUMETSAT link, was also established over MPLS VPN in July, 2007 to exchange satellite data, including the observations and products of FY-2C, METEOSAT 7, METEOSAT 9, GOES 11 and 12, between CMA and EUMETSAT on real-time basis.

CMA’s Internet system was built in 1997. Nowadays it has established internet access to two different ISPs, which access internet through firewall with a bi-routing 100M-Bandwidth link. As the network-based platform provides the available meteorological information, the internet system offers WWW, E-mail and DNS services. Meanwhile, internet system also provides network access and data exchange service from the meteorological information service website, such as the official website of CMA (www.cma.gov.cn), international communications systems and for other international meteorological services, e.g. WIS.

d. Training Progress

The education & training infrastructure was improved, like new meeting halls, case study training rooms as well as other training facilities. Distance education & training platforms and the Internet based education training environment were also implemented. The preparation of training materials & course wares were continued, which were used and distributed in the training courses of both residence and distance events through multiple channels.

The typhoon forecast, warning, disaster prevention & mitigation were also applied to the international training seminars in CMA.

e. Research Progress

The researches on tropical cyclone mainly focused on the following aspects in the past year: tropical cyclone structure, intensity and its changes, precipitation mechanism, prediction techniques and tropical cyclone climatic characteristics, etc.
TC Structure

More attention was paid on the mesoscale wave activities in typhoon in order to better understand TC structures and their changes. Using the barotropic shallow water equations and baroclinic disturbance equations in the cylindrical coordinates, 2 kinds of vortex Rossby Wave (VRW) in a typhoon are separated. One (barotropic VRW) is generated with the second order radial horizontal shear of tangential base flow or the radial change of vertical vorticity in it. If a second order vertical shear in the tangential base flow is allowed for, the expression could be found for phase speed of second VRW (baroclinic VRW) in a typhoon. If wind speed of the tangential base flow experiences linear shear only, no VRW occurs at all, except the internal inertia gravity wave.

A numerical study shows that the mesoscale waves in typhoon possess the mixed features of inertia gravity waves and vortex Rossby waves. The mesoscale waves show the features of strong convergence, divergence and ageostrophic wind. And the maximum perturbation occurs near the maximum wind radius in typhoon. The formation of polygonal eye wall in typhoon is possibly related to the mesoscale waves.

In addition, based on the f-plane shallow water model, the interaction between the fast inertia gravity wave (FAGW) and balance vortex was studied. Results indicate that the vortex could intensify and the wind distribution of the vortex would become asymmetric when the FAGW is transmitted into the vortex area. However, the vortex would recover after the FAGW leaves.

Intensity and Intensity Change

Generally, tropical cyclones will decrease while some of them could intensify greatly when they are approaching to the land. Statistical analysis on the TC in the northern South China Sea from 1960-2002 has been made. It is found that there are 6.7 TCs on annual average and 4.9 of them may experience sudden intensity change. About 3% of the total strengthens abruptly, 72% decreases rapidly and 25% tend to intensify and decay suddenly. Typhoon Saomai (2006) intensified remarkably when it approached to the coastal zone of China. Recent studies indicate that its sudden intensification is closely related to the entrainment of vorticity belt into its circulation from the remnant of typhoon Bopha (2006), which was next to Saomai. In addition, Numerical experiment results showed that the sudden intensification of Saomai also was associated with the sea surface temperature (SST) change, Saomai would increase its minimum sea level pressure by 17hPa if the SST were reduced by 2 degrees Celsius.

Intensification of northwardly typhoons is closely related to its extratropical transition (ET) process. The baroclinic potential energy can be converted into TC kinetic energy due to the interaction between TC and baroclinic systems. This is the way to intensify TC depression during its ET process. Typhoon Winnie (1997) underwent transformation and re-intensification process and caused a large scale heavy rainfall after its landfall. Mesoscale numerical model MM5v3 was used to testify and compare the effects of different troughs on Winnie ET process. The results indicate that ET process is sensitive to the intensity of upper trough, which throws its effects in terms of temperature advection, vorticity advection and upper divergence associated with the upper trough. The stronger the upper trough is, the faster the TC re-intensifies. Besides, the PV analysis of simulations results show that Winnie ET and re-intensification is related to the interactions of TC circulation with lower layer front and PV downward transportation from upper troposphere.

TC precipitation

The mechanism of TC periphery rainfall brought more attention in the past year. Based on intensive surface observation data, remotely sensed data and new-generation Doppler weather radar products, the heavy rainstorm process induced by the inverted trough of typhoon Haitang on July 22, 2005 was studied. The results indicate that the rainstorm is related to interaction between the northwardly inverted trough of typhoon Haitang and weak cold wave. Abundant heat and water vapor are transported by southeasterly jet on the eastern side of the inverted trough. Severe convection likely occurs on its left frontage area.

An analysis was made to investigate the structure features of the extensive heavy rainfall left by typhoon Matsa, after its landfall in mainland China in August 2005, based on a wide range of observational results, including surface intensive observation data, TBB data from China’s FY-2 satellite, and NCEP 1°×1° reanalysis data. Results show that Matsa rainbands, extending as far as 2000 km northwardly from the typhoon center, have the features of noticeable wave train distribution and long distance propagation with 500-1000 km in wavelength and 12-24 h in time period. The wave structure of Matsa rainbands is closely associated with the corresponding wave
variation of the ambient 3-D atmospheric structures, including disturbance vorticity, divergence field, vertical motion field, water vapor flux divergence field, etc. Moreover, both observational facts and theoretical analysis show that the northward extending typhoon rainbands are associated with the mixed effects of atmospheric inertia wave and internal gravity wave. It's found that only under proper atmospheric stratification and vertical wave number of gravity wave, can a typhoon stimulate such a wave reach such a distance, and lead to extending wavy rainbands.

TC forecasting

The technique of ensemble prediction still was a research focus in the past year. Ensemble Kalman Filter (EnKF) data assimilation was applied to tropical cyclone track prediction by using MM5 model. Various parameterization schemes were used to design 9 groups of model configurations, 45-, 60- and 75-minute forecasts were conducted for each situation. With the "mirror imaging method", 18 different initial conditions were obtained to provide the initial ensemble numbers. The initial fields were also obtained from different models. For example, using three numerical models, 16 different initial fields were produced. Based on the comparison of the results of numerical experiments on 9 TC cases in 2004, seven cases were selected as initial ensemble members for TC track forecast in the South China Sea or nearby areas. Besides, there were two main sources for estimating uncertainty in Numerical Weather Prediction (NWP), i.e., initial value-related uncertainty and model-related uncertainty. A 20-member mesoscale ensemble forecasting system including these two kinds of uncertainty was identified to simulate tropical cyclone Danny (1997). It was found the ensemble approach was the best compared with all 20 members after 12-h integration time.

In addition, TC intensity forecasting method was studied too. Using genetic algorithm and artificial neural network, an experiment for establishing a forecasting model was implemented to predict TC intensity based on TC data over the South China Sea area in July and August respectively from 1960 to 2001. The method of genetic algorithm combining with artificial neural network was compared with the Climatology and Persistence (CLIPER) method. It was found that the former was better than the latter.

TC climatic feature

The climatically characteristics of wind vectors on 100 hPa and 850 hPa level and the relationship between the tropical easterly current on the 100 hPa level and tropical cyclone frequency were analyzed using NCEP/NCAR reanalysis data and the tropical cyclone data from JTWC (Joint Typhoon Warning Center) over the Arabian Sea, the Bay of Bengal and the South China Sea during the period 1958-1998. The result showed a high positive correlation between tropical easterly current and the TC frequency over the Arabian Sea and the Bay of Bengal. However, the TC frequency in the South China Sea was closely related to the intensity change of meridional wind at 100hPa level.

An improved cumulus parameterization scheme for typhoon numerical prediction

As cumulus parameterization defines the sub-grid scale convective activities in a numerical model and it is crucial for typhoon numerical prediction. In a study, according to three typical typhoons made landfall at East China in 2006, 15 numerical experiments were implemented with three most popular cumulus parameterization schemes, namely, Kain-Fritsch, Betts-Miller and Grell, to evaluate their performance. It was concluded that Kain-Fritsch scheme was more stable and appreciable in heavy rainfall and track prediction. While admitting its advantages, it was also noted that Kain-Fritsch scheme was necessary to be improved in the case of weak environmental forcing. Particularly, the parameterization of convective parcel’s temperature perturbation with environmental vertical velocity in convective triggering function was not so robust, which may be applicable only when the prerequisite of moisture transportation was satisfied. To alleviate this deficiency, spatial temperature anomaly as well as the effect of moisture advection were taken into account in determine convective parcel’s temperature perturbation, where the contribution from boundary layer heat and moisture flux was treated explicitly. Contrast with the original scheme, this technique could eliminate the convective instability more effectively for the rainfall simulation.

Sheared-Super-Helicity and its application in rainfall prediction

Based on the vertical super-vorticity equation, the conception of Sheared-Super-Helicity is proposed, which means the interaction between vertical wind shear and mesoscale coupled vortex, or in other words, the tussling between vertical wind shear induced horizontal vortex tube and horizontal nonuniform vertical vorticity. Preliminary case studies show that the new idea of Sheared-Super-Helicity is valuable in nowcasting on
supercell-induced deep convection and heavy rainfall.

**Generation and merging of the meso-vortices in a landfall tropical depression**

A heavy rain event resulting from the interaction between a landed tropical depression (TD) and its adjacent mesoscale vortices was studied. Generation and merging processes of these mesoscale vortices around the TD were examined through observations and numerical simulations. The large-scale environment was quite favorable for convection to be organized. A diagnosis of the potential vorticity (PV) equation showed strong interaction between the TD and the newly-generated vortices. A newly-generated vortex finally replaced the TD due to horizontal PV advection. The PV advection and diabatic heating terms became primary sources of PV for the mesoscale vortices generation and development of the east. These newly-generated mesoscale vortices moved cyclonically and approached to each other under the effect of the cyclonic circulation associated with the remnants of the TD. Due to PV advection, two vortices finally merged and the weakened TD began to reintensify, which directly causes the heavy rain.

**Prognostics for quantitative precipitation forecast of landfall typhoon**

Through case study of Talim (2005), several parameters were compared on their prognostic capability in rainfall distribution and variation, including vorticity, potential vorticity, helicity, and so on. A synthetic parameter was proposed, which was found to be better than any single one in diagnosing rain distribution and enhancement with a lead time of 1-5 hours.

**Vertical wind shear and inner core asymmetric convection of typhoon**

Based on a high-resolution numerical simulation of Typhoon Rananim (2004), the shear-induced vortex tilt and storm-relative asymmetric winds were examined to investigate how vertical shear impacted the asymmetric convection in the inner core region. It was found that the inner core vertical shear was non-unidirectional, and induces a non-unidirectional vortex tilt. The distribution of asymmetric convection was inconsistent with the typical downshear-left pattern for considering a deep layer shear. Qualitative agreement was found between the divergence pattern and the storm-relative flow with convergence (divergence) generally connected with asymmetric inflow (outflow) in the eyewall. In conclusion, the collocation between the inflow-induced lower-level convergence in the boundary layer and in the lower troposphere and mid-level divergence led to shallow updrafts in eyewall, while the deep and strong upward motion in the eyewall was in conjunction with the corresponding collocation between the net convergence associated with the strong asymmetric flow in the mid troposphere and the inflow near 400 hPa and the divergence in the outflow layer.

**Climatic variation of tropical cyclone activity**

The interannual, interdecadal and intercential variation of typhoon affecting East China during AD1450 - AD1949 was analyzed and 50-yr trend analyses were performed on the frequency and intensity of typhoons making landfall in China, as well as the precipitation and high winds brought by typhoons to China.

f. **Other Cooperative/Strategic Plan Progress**

Nil

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

(towards the goals and objectives of the Typhoon Committee)

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

◆ **IBM HP Computer System**

CMA imported IBM CLUSTER 1600 parallel computer system in July 2004. It consists of 376 nodes, 3152 CPUs, 8224GB memory, 8 I/O nodes and 128TB capacity of disks. Its theoretical peak performance can reach 21 TFLOPS, and serves as the platform of running 7*24 short-term climate forecast, ensemble forecast and some other high-resolution regional weather forecast models.
b. Implications to Operational Progress

CMA is building a new satellite-based broadcasting system, DVB-S system, for replacing the current PCVSAT system. The new system has run in parallel with PCVSAT since April, 2006. It supports the services of priorities-based data broadcasting, which disseminates warning messages and information to users with highest priority, and multimedia program broadcasting. Comparing with the current PCVSAT system, the new system has the main advantages in terms of higher data transmission rates and lower costs for remote stations due to standard DVB technology.

At present, the total broadcasting rate for the new system is 8.5 Mbps, and the daily broadcasting data volume is over 25GB, including the traffic of FY satellite observations and products at 30 minutes intervals. Currently, it has a hub station installed at National Meteorological Information Center and about 350 receiving stations deployed at all provincial centers and city level centers. And its services will be extended to all level stations gradually.

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

d. Training Progress

- Training Course on Application of the New-generation Doppler Weather Radar

From October 2006 to September 2007, China Meteorological Administration Training Centre (CMATC) has held 4 training courses on application of the new-generation Doppler weather radar and 2 seminars on application of the subject with about 300 participants. The training mainly included the principles of the new-generation Doppler weather radar, locating the typhoon center with the Radar, estimation of wind intensity, the echo characteristics of the radar in convective weather and the cases studies, estimation of typhoon precipitation as well as warnings of the severe convective weather related to typhoon spiral rain band, etc.

- Training Course on Application of Meteorological Satellite Data

From January 6 to 16, 2007, CMATC held one training course on application of meteorological satellite data with 86 participants. The main training content covered the basic principles of meteorological satellites and satellite imagery interpretation, making weather forecast with satellite data, the production and application of SST data, the production and application of TOVS data, location and intensity estimation of Typhoon with satellite images, the interaction of typhoon and the mid-latitude weather system, methods of estimating precipitation with satellite data, analysis and application of water vapor images, etc.

- Advanced Training Course for Senior Forecasters

From October to December, 2006, CMATC held one Advanced Training Course for Senior Forecasters, 37
forecasters took part in the training. They studied the radar detection and warning of severe convective weather, analysis of satellite image, estimation of typhoon precipitation, forecasts of torrential rains and severe convective weather systems, calculation of severe convection parameters, forecast of tropical cyclones, the small systems of torrential rains and severe convective weather, the echo characteristics of the Radar in convective weather and the case studies, etc.

- **Training Course for Fresh Forecasters**

From September to December, 2006, CMATC held a Training Course for Fresh Forecasters with 38 participants. The training contents included locating the center of Typhoon by use of Radar echo and satellite image, estimating the intensity of winds, analysis of satellite image, estimating typhoon precipitation, the interaction of typhoon and the mid-latitude weather system, forecasting torrential rains and severe convective weather, forecasting tropical cyclones, the small systems of torrential rains and severe convective weather, the echo characteristics of the radar in convective weather and case studies, etc.

- **The Training Course on Typhoon Forecasting Techniques**

From August 11 to 15, Shanghai Typhoon Institute held a Training Course on Typhoon Forecasting Techniques for army meteorologists. More than 10 army meteorologists attended this training course. The training included the forecast of typhoon track and intensity, typhoon climate and short-range climate prediction, typhoon numerical forecast, typhoon data, marine meteorology, typhoon monitoring and forecasting techniques, the landfall process of typhoon, etc.

- **The Training Course in Typhoon Season**

On July 23, 2007, China Southern Airlines Shantou Company held one training course focusing on the typhoon season. Engineers of Shantou Air Control Agency and Weather Stations illustrated the typhoon weather features and track changing situations and other related themes such as the safety precautions against typhoon. Participants of the training are staffs of the Airlines.

e. **Research Progress**

- **An improved vortex initialization scheme for GRAPES-TCM**

The original vortex relocation technique of GRAPES-TCM encounters difficulty in the case of strong storm prediction for the deficiency in upgrading the intensity of the initial vortex. An improved vortex initialization scheme was proposed for picking up the TC vortex from the prediction at a previous time, which represents better the observed one in terms of intensity, scale and asymmetry. This vortex was then assimilated into the model with 3-DVAR to ensure the harmony between vortex and environmental field. Integrations for typhoons making landfall on East China in 2006 showed positive performance as compared to the old vortex initialization technique.

- **An improved BDA scheme for STI-TCM**

Treated in Shanghai Typhoon Numerical Model symmetrically, the structure of bogus vortex in BDA may be quite different with the real situation in some occasions. Thus a new bogus vortex scheme was designed to improve the depiction of the initial vortex. In this new scheme, a model constrained vortex from model integration was used to replace the original statistical vortex defined by symmetric sea level pressure. While performing the new scheme, the NCAR-AFWA method, which proved to be more efficient than its counterpart in GFDL model in keeping consistency among vortex variables, was used to pick up the original vortex from the background field. Case study on typhoon numbered 0701 showed the improvement of the new scheme, by which the average track prediction errors were 120 km/24h, 161 km/48h and 148 km/60h respectively, better than the original BDA scheme with 160 km/24h, 213 km/48h and 212 km/60h. This study also showed the particular role of asymmetric vortex in typhoon initialization.

- **Operational experiments on bogus vortex and satellite data assimilation**

Operational experiments on vortex initialization were conducted with satellite-derived and bogus vortex data and 3DVAR technique based on the understanding of the observational error of Satellite-derived wind, QuikSCAT sea wind and AMSU-retrieved temperature. Statistics on a number of simulations identified particular effects of
various types of datasets. Experiment for typhoons making landfall on East China in 2006 showed the benefit of joint assimilation of satellite datasets and bogus vortex, as compared with that of BDA.

**An ensemble prediction system for typhoon tracks**

An ensemble prediction system was set up for typhoon track prediction based on GRAPES-TCM model. 21 prediction members constituted the system. Each of the members had a horizontal resolution of 0.5 degree, in which the Breeding Method was employed for initial perturbation. In addition, vortex relocation and bogus vortex were also implemented during the quasi-operational experiments. Presently, 0-72h prediction on typhoon track’s probability was made twice a day on 00UTC and 12 UTC.

**Evaluation on the performance of typhoon numerical model in QPF**

The performance of GRAPES-TCM in Quantitative Precipitation Forecast (QPF) was evaluated for cases making landfall on East China in 2006. The results were also compared with those of Shanghai Regional Numerical Prediction Model and TRaP (Tropical Rainfall Potential Technique). It showed that GRAPES-TCM could represent generally well the coverage of rainfall and outperformed the other two methods, due mainly to the consistency between the vortex structure and environmental field with the updated relocation technique.

**An updated model output statistical tropical cyclone intensity prediction scheme for the western North Pacific**

An updated model output statistical tropical cyclone intensity prediction scheme for the western North Pacific (MSTIP) was developed based on samples stronger than 17.2m/s from 1996 to 2002. All the samples were divided into 3 sub-groups according to the initial position: the region near the coast of East China (ECR), the South China Sea region (SCR), and the far ocean region (FOR). Regression equations were developed respectively for each region, with major predictors different for different regions. 5 versions of MSTIP were developed using different operational model output. Independent test and operational experiment in 2006 showed that the version based on T213 model operating at National Meteorological Center and the one based on GFS had positive skills.

**An updated consensus scheme for tropical cyclone track forecast**

The consensus scheme for typhoon track prediction was updated by replacing 3 statistical sub-methods with 3 numerical prediction models, Shanghai Typhoon model, GRAPES-TCM, and the Typhoon model operating at National Meteorological Center. The forecast leading time was extended from 48 hour to 72 hour. Mean errors of the updated scheme for 2006 were 74.8, 116.9, 158.9, 208.3, 239.1, and 311km for 12, 24, 36, 48, 60, and 72 h forecast, respectively. It was put into operation in May 2007.

**Operational system**

No changes in the operational system

**Research and development on TC track prediction**

1) A new vortex initialization scheme was developed and used in the new experimental TC track prediction system based on the SSI data assimilation system. The mean track errors are greatly reduced. The differences between the operational system and the new TC track prediction system are as table 1.

**Table 1.** The difference between the operational system and the experimental system

<table>
<thead>
<tr>
<th></th>
<th>Dada assimilation</th>
<th>Vortex initialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation TC System</td>
<td>OI</td>
<td>BOGUS vortex</td>
</tr>
<tr>
<td>New TC System</td>
<td>SSI</td>
<td>New vortex scheme</td>
</tr>
</tbody>
</table>

The results from the operational system and the new experimental system for 2007 are shown as figure 1.
2) The TC track numerical ensemble prediction system was developed and put into real time running in July 2007. The TC track numerical ensemble prediction system was developed based on the global medium range numerical ensemble prediction system and the BOGUS vortex technique used in the operation TC track prediction system in 2006 and put into real time run in 2007. The ensemble tracks and the strike probability (shown as figure 2 and figure 3) are provided to the forecasting office in NMC.

◆ Field experiments for landfall typhoon

Special field experiments were conducted with two landfall typhoons, Sepat (2007) and Wipha (2007), by using GPS sonde, mobile wind profiler, sonic anemometer/thermometer, and AWSs. Real time data were provided consecutively to weather forecast centers during each experiment. The collected data were processed and analyzed.

f. Other Cooperative/Strategic Plan Progress
Nil.

3. Opportunities for Further Enhancement of Regional Cooperation
Nil.
III. Hydrology

1. Progress in Member’s Regional Cooperation and Selected Strategic Plan Goals and Objectives

   a. Hardware and Software Progress

   b. Project of Flood Risk Mapping and System of Mud-Rock Flow Warning and Forecasting

   China took active part in all the 11 cooperative projects, especially took part in the local experiments of Flood Risk Mapping and System of Mud-Rock Flow Warning and Forecasting, of which Japan was in charge. Chinese representative introduced their task in flood risk maps and mountain heavy rain disaster prevention. As for the local experiments of Manual of Reservoir Operation and Evaluation of Flood Forecasting Model, of which the Public of Korea was in charge, China made its contribution.

   In recent years, China has continuously has worked on flood risk maps and has achieved some success. In 2005, the State Headquarters of Flood Control and Drought Relief requested various river basin authorities to select 2-3 provinces as experimental areas to prepare flood risk maps. The graphic information is important for managements of rivers, reservoirs and flooding plains. The Guidance of Flood Risk Mapping was issued and the project for developing Flood Risk Mapping & Management Platform Software was initiated by the State Headquarters of Flood Control and Drought Relief. Meanwhile, a specific website has been set up as a platform for studying, discussing and exchanging experience in flood risk mapping. Based on the experience from this pilot project, the Guidance on Flood Risk Mapping was revised. Now, the universal flood risk mapping & management software, the platform and the technical standards & methods for flood risk mapping are still under research and preparation.

   China continuously made progress in monitoring mud-rock flow. Ministry of Water Resources, China Meteorological Administration, Ministry of Land and Resources, Ministry of Construction and State Environmental Protection Administration have together prepared the plan and design for the study on mud-rock flow & landslide monitoring techniques, with the main objectives include creation of a monitoring system with high and new technologies, development of both hydrostatic & dynamic models for detecting mud-rock flows & landslides, their forecasting, and offering preventive measures to avoid or reduce the losses from these events. The plan is involved with the mountainous and hilly areas in the 29 provinces, focusing on smaller basins of less than 200 km² as the main targets, involving 32753 small river basins. The investment is about 25 billion USD. Now, the plan of disaster prevention has been approved by the Chinese government.

   c. Implications to Operational Progress

   Nil.

   d. Interaction with users, other Members, and/or other components

   Since the workshop on “Living with Risk: Dealing with Typhoon-related Disasters as Part of the Integrated Water Resources Management”, held in Seoul, the Public of Korea in September 2004, China has taken active part in such projects as RCPIP (Regional Cooperative Programme Implementation Plan) and DPP (Disaster Prevention and Preparedness).

   In 2007, China sent 7 representatives to Bangkok, Thailand attending the Integrated Workshop on Social-economic Impacts of Extreme Typhoon-related Events, and 4 representatives actively joined in the discussions of working group on hydrology and work group on disaster prevention and mitigation.

   e. Training Progress

   • International Training Class on the Flood Forecasting System and Application
In order to quicken the project of application of flood forecasting system to the selected river basins, to promote Chinese flood forecasting system, and to increase technical exchanges and cooperation between the members of Typhoon Committee, Bureau of Hydrology, Ministry of Water Resources, PRC, would hold an international training class of the flood forecasting system and application in Beijing. Typhoon Committee will sponsor 5000 Dollars as the international traveling expenses for the trainees, while China will sponsor 25000 US Dollars as the training and board/dodging expenses for the foreign trainees in Beijing.

After discussing with Secretariat of Typhoon Committee, Bureau of Hydrology, Ministry of Water Resources, PRC, decided to hold the international training class of the flood forecasting system and application in Beijing from 15 to 21 October 2007, where the trainees would study the basic theory and knowledge in flood forecasting, especially the technology and experience of flood forecasting system. Through lectures and exchanging experience, the trainees would learn some theoretical and practical knowledge of the flood forecasting systems, which could be put in their future operational forecasting.

The 10 foreign trainees are from 7 countries of Korea, Laos, Malaysia, Philippines, Thailand, Vietnam and Singapore while the Chinese trainees were from the Yellow River Water Resources Commission and the provinces of Sichuan, Shaanxi, Shandong and Guangdong. Mr. Olavo Rasquinho, Secretary of Typhoon Committee, Mr. Liu Jinping, Vice Chair of the Working Group on Hydrology and the leaders from China Meteorological Administration, Bureau of Hydrology and the Department of International Cooperation and Science Technology of Ministry of Water Resources of China would attend the opening ceremony.

In the training, there would be 1-2 day lectures, and 3-day hand-on practices and summaries. The foreign trainees would study the Xianjiang flood forecasting model and application software of flood forecasting system of China, set up the flood forecasting schemes of their test basins with the Chinese flood forecasting system, and simulate operational flood forecasting.

The teaching materials were prepared for the trainees, including CD of China’s flood forecasting system, the technical report and manual of the Chinese National Flood Forecasting System (in English). The experts and professors from IWHR, Qinghua University and Bureau of Hydrology were invited to give lectures and tutorship.

f. Research Progress
Nil.

g. Other Cooperative/RCPIP Progress
Nil.

2. Progress in Member’s Important, High-Priority Goals and Objectives

(Towards the goals and objectives of the Typhoon Committee)

a. Hardware and Software Progress

- National Flood Control Commanding System (NFCCS)

After substantial efforts made in the past 50 years, general floods for large rivers could be controlled. In order to ensure the sustainable development of China's national economy, a nationwide flood control & management as well as flood disaster reduction system need to be established. Therefore, the Chinese government decided to develop the National Flood Control Commanding System (NFCCS).

The system is divided into 4 sub-systems: information collecting, telecommunication, computer network and decision-making support. The target and strategy of the NFCCS are to be:

- A capacity of monitoring observed maximum historic floods shall be built for the hydrological stations that are mandated to report/release hydrological information to the State Flood Control and Drought Relief Headquarters (SFCDRH).

- Hydrological information shall be transmitted from local stations to the SFCDRH within 30 minutes.
Information collection for flood, drought and flood-control water projects shall be carried out on the basis of standardization, normalization, and digitization.

Real-time or near real-time monitoring hydrological, engineering and disaster information on the key river stretches of 7 major rivers and for the key flood control areas, shall improve the accuracy in predicting floods or droughts, which provides scientific basis and technical support for decision-making and flood commanding.

In the first stage, NFCCS will be completed by 2008. China is planning to construct 224 sub-centers of hydrological information. 125 sub-centers will have been set up under the National Flood Control Commanding System by the end of 2007.

Wide Band Network

By 2005, a wide band network of 2 Mbps connecting the Ministry of Water Resources, river basins authorities and provincial hydrological departments has been constructed and put into operation, which significantly improved the time efficiency of information transmission. At present, about 40% of the 3200 central flood-reporting stations measure and report information in an automatic way, over 80% of the hydrological information from the 3200 central flood reporting stations can be transmitted to Bureau of Hydrology, MWR, within 30 minutes on the WRN of real time flood information.

Developments of Operational Systems

Currently, 1,134 hydrometric stations are involved for hydrological forecasting. Flood forecasting schemes are made for major flood control stations along the mainstream and tributaries of the 7 major rivers, reservoirs and flood storage and detention areas. Operational systems developed by the Bureau of Hydrology such as Comprehensive Hydrolo-Meteorological System for Flood Control and Drought Relief, WEB-based Hydrological Information Inquiry System for Flood Control and Drought Relief, China National Flood Forecasting System, Hydrological Consultation System for Flood Control and Drought Relief, Information Release System have been put into full use, achieving noticeable benefits in terms of flood control and drought relief over the years.

b. Implications to Operational Progress
Nil.

c. Training Progress
Nil.

d. Research Progress
Nil.

e. Other Cooperative/RCPIP Progress
Nil.

3. Opportunities for Further Enhancement of Regional Cooperation

China sponsored Typhoon Committee’s international training class on the flood forecasting system and application in October, 2007. If the members of Typhoon Committee want to use the flood forecasting system of China, technical support could be provided. China would send experts to assist Malaysia in the training class in Jan., 2008.

China will continue to take active part in the regional cooperation under the plan of the Typhoon Committee, such as regional pilot projects on flood risk mapping, heavy rain & mud-rock flow forecasting, reservoir forecasting & regulation, flood forecasting model verification & improvement and disaster information system. China will provide the available information both at home and abroad. Meanwhile, China will exchange relevant information on typhoon prevention with other countries to improve the database.

The urban typhoon disaster risk management project led by China has been endorsed by the Typhoon Committee as the cooperative project with its various working groups. The results of the project will be submitted to the Water Conference and Water Forum of Asia and Pacific Region.
IV. Disaster Prevention and Preparedness

1. Progress in Member’s Regional Cooperation and Selected Strategic Plan Goals and Objectives

a. Hardware and/or Software Progress

b. Implications to Operational Progress
Nil.

d. Interaction with users, other Members, and/or other components

On September 25, 2007, the participants who took part in Administrator Seminar of Emerge Disasters over Developing Countries visited CMA. They listened to the report of CMA’s work on meteorological disaster prevention & mitigation system and got an overview of observations, forecasts for preventing meteorological disaster in China.

![Fig. 4.1 The participants of Seminar on Emerge Disasters for Directors from the Developing Countries visited CMA](image)

e. Training Progress

- **The international training workshop on tropical cyclone disaster reduction**

The international training workshop on tropical cyclone disaster reduction was held in Guangzhou, China in 26-31 March 2007. It was organized by WMO and CMA and hosted by Chinese Academy of Meteorological Science and Guangdong Meteorological Bureau. 60 participants coming from 11 countries attended the workshop, and 45 were operational forecasters from the five tropical cyclone regional bodies while the workshop lecturers were leading experts in the field of tropical cyclone research and forecasting which included Russell Elsberry, Peter Black, Chen Lianshou, and Charles Guard, et al.

This research-oriented international training workshop provided training and experience on new knowledge gained from recent advances on tropical cyclone research and how best to apply these to operational prediction activities in order to enhance the accuracy and usefulness of tropical cyclone forecasts and warnings. It also enabled participants to be aware of the issues associated with disaster mitigation, such as factors contributing to human and economic losses, conveying forecasting and warning information to stakeholders, users and the general public, evaluating the effectiveness of warning systems, mitigation strategies and community capacity-building for disaster reduction. The abstracts of the nine lectures were printed in a booklet and...
The meeting will provide opportunities for further enhancement of regional cooperation in future.

- **The Training Seminar on Meteorological Disasters Forecast, Prevention and Mitigation**

  From May 21 to June 8, 2007, CMATC held Training Seminar on Meteorological Disasters Forecast, Prevention and Mitigation with 45 foreign participants from 25 counties. Professor Chen Lianshou from the Chinese Academy of Meteorological Sciences, an Academician of the Chinese Academy of Engineering Sciences, was invited to give a lecture to the participants. The main theme of his lecture was the prediction and prevention of typhoon which covered the typhoon types, analysis of typhoon tracks, its moving speed, destructiveness and some effective measures for the prediction and prevention.

- **The International Training Course on Coastal Zone Natural Disaster Prevention and Warning**

  From July 25 to August 8, 2007, CMATC sponsored another International Training Course on Coastal Zone Natural Disaster Prevention and Warning with 10 participants from 8 countries in the class. Professor Chen Lianshou, one Academician of CEA, gave the participants a lecture on the Natural Disaster and Scientific Issues for Landfall Tropical Cyclones, which includes scientific issues of track turns with the abrupt change of structure and intensity, storm surge, heavy rainfall, dissipating and sustaining as well as the monitoring, forecasting and warning Systems. Professor Jiang Jixi, Senior researcher of National Satellite Meteorological Centre, also was invited to give a lecture on the monitoring, analysis, and techniques for the tropical weather systems based on satellite observation, which included tropical cyclogenesis, locating tropical cyclone centre, tropical cyclone intensity analysis, tropical cyclone thermal structure, tropical cyclone motion forecasting, Intertropical Convergence Zone (ITCZ), upper tropospheric cold vortex, easterly wave, an operational auto-monitoring for the El Nino episodes and a primary study for summer monsoon index over the South China Sea and East Asia based on satellite observation.

e. Research Progress

f. Other Cooperative/RCPIP Progress

Nil.

2. Progress in Member’s Important, High-Priority Goals and Objectives

(Towards the goals and objectives of the Typhoon Committee)

a. Hardware and/or Software Progress

- **Reference Standard for Severity of Tropical Cyclone**

  On June 2007, CMA set the reference standards for severity of tropical cyclones. This standard gives different severities of tropical cyclones, including the potential impacts & damages on vessels and building, etc. The new standard serves as a platform for providing effective meteorological services for prevention of tropical cyclone-induced disasters. It provides for government and relevant agencies to take effective measure.

- **Warning Signal of Meteorological Disasters**

  On June 2007, in order to make a unified system for issuing warning signal of the meteorological disasters, CMA amended and published the Methods for Issuing and Broadcasting the Warning Signals of Meteorological Disaster. The warning signals on potential disasters will be broadcasted on a timely basis according to the new methods. By so doing, the warning signals of potential disasters such as typhoon can reach to public more quickly and effectively.

- **Atlas of China Disastrous Weather and Climate**

  Atlas of China Disastrous Weather and Climate was published at September 2007. The content includes typhoon and temporal and spatial varieties of its disasters. The book provides an important reference for government decision and academic research, and offers a textbook for occasional people to know the disaster of typhoon and timely prevent the disasters.
b. Implications to Operational Progress

- **Investigations on landing typhoon-induced disasters**

There are several typhoons that choose to land on China each year. Investigations on landing typhoon-induced disasters may help to better understand variations of typhoon strength, impact area, associated disasters and losses, etc. The investigations may also give reference information for preventing and mitigating typhoon-induced disasters. This year, before the landing of some strong tropical storms, CMA had sent teams to coastal provinces. They arranged preparatory work in advance and carried out post event investigations.

- **Meteorological Disasters Yearbook of China**

In 2007, CMA also continued to publish Meteorological Disasters Yearbook of China. It compiles the main meteorological disasters that took place in China in the year. The Yearbook also includes the information about severe meteorological disastrous events in the world during the previous year.

- **Disseminations of Messages of Typhoon Warning**

Technological methods were used to issue messages of typhoon warnings. The public may get warning messages in time and take relevant prevent measure. The systems to issue message includes mobile phone message, TV, radio, newspaper, websites, electronic display screen, serving station of messages at villages, 96121 phone line. People can get warning messages from different message sending systems. All levels of meteorological bureaus had sent 48,000 pieces of free warning messages from January 2007 to August 2007. There were about 1,200,000,000 times and persons who had got these messages.

During the typhoon season, more than 900 pieces of news on typhoon have been published by new website (http://www.nmc.gov.cn/typhoon.php?code=722) for typhoon and service; symbols on the topic of typhoon changed for 17 times, the satellite cloud pictures, the radar echoes composite maps, the latest forecast of typhoon and other relevant information were issued in real time. 7 experts-online and 2 specialized websites on typhoon were created. Some information on typhoon and as how to prevent typhoon was sent out.

![Fig. 4.2](image-url) In 2007, mobile telephone short messages were added to routine typhoon forecast and service.
c. Interaction with users, other Members, and/or other components

Chinese government attaches great importance to prevention and reduction of typhoon disasters. Governments at all levels request the relevant agencies to take the preventive measures when they received warning message of typhoon. When information is received, the relevant agencies shall monitor typhoon’s motions and coordinate their actions in preventing typhoon disasters. These preparations reduce casualties of people as result of typhoon landing. During the invasion of Typhoon SEPAT and VIPA, authorities in the coastal provinces timely organized evacuations of 4.65 million people into some safety area against strong wind. These measures effectively reduced casualties and loss of properties.

In September 2007, the National Meteorological Disaster Prevention and Mitigation Conference was held at Beijing. Its’ main topic is to prevent and mitigate meteorological disasters. At the conference, Vice Premier Hui Liangyu pointed out that it was a top priority to prevent and mitigate meteorological disasters in this new period. The leaders of some relevant provinces and major agencies and meteorologists discussed the topic and exchanged the experiences in meteorological disasters prevention at the conference. The national program for preventing meteorological disasters from 2007 to 2010 was revised at the conference. This event increased governmental and public awareness of meteorological disasters in China.
CMA cooperates with a wide range of agencies in the certification of national comprehensive disaster prevention projects for the 11th 5-year National Development Plan period and revision of the National Emergency Response to Natural Disasters. This work is an important part of the national disaster prevention & mitigation work.

**d. Training Progress**

Nil.

**e. Research Progress**

The causes of typhoon-induced disasters and their assessment methods were studied in the past year. A set of disaster economic loss indices (DELI), including disaster loss degree (DLD) and environmental instability (EI) was identified to analyze the trend of economic loss as result of typhoon disasters. The result shows that DELI is a reasonable element in making economic loss assessment, which is not limited by temporal and special factors and it is easy for comparisons. Based on disaster system theory, in combination of wind, rain, water and tide conditions, typhoon disaster chain model in Fujian was built up, including 3 continuous and simultaneous disaster chains, i.e. typhoon-winds, typhoon-storm-floods and storm surges. Analysis on typhoon Longwang showed that disaster was mostly due to the heavy precipitation induced by topographic effects and weak cold-air intrusion from the north.

**f. Other Cooperative/RCPIP Progress**

Nil.

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

Nil
V. Typhoon that Impacted TC Members

1. Operational Forecast

From January to September in 2007, the 24h, 48h and 72h mean distance errors of subjective forecasts for tropical cyclones, which formed over the Western North Pacific and the South China Sea in the National Meteorological Center (NMC) of CMA are about 114.0, 173.8 and 250.1km respectively (table 5.1). In the course of testing, real-time positioning was used by NMC as the basis of testing.

<table>
<thead>
<tr>
<th>Forecast time</th>
<th>24h</th>
<th>48h</th>
<th>72h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean distance errors</td>
<td>114.0</td>
<td>173.8</td>
<td>250.1</td>
</tr>
</tbody>
</table>

2. Narrative Accounts of Tropical Cyclones

a. Characteristics of Landing Tropical Cyclones

As mentioned above, from Jan. 1st to Sep. 30th 2007, 15 tropical cyclones in total formed over the Western North Pacific and the South China Sea. 6 TCs whose landing intensities exceeding the current tropical storm categories made their landfalls on China during the period (table 5.2).

<table>
<thead>
<tr>
<th>TC Name/Number</th>
<th>Landing location</th>
<th>Time/Date</th>
<th>Maximum wind speed at landing (m/s)</th>
<th>Minimum SLP at landing (hPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toraji (0703)</td>
<td>Dongxing, Guangxi</td>
<td>08:50UTC, Jul.05</td>
<td>23</td>
<td>986</td>
</tr>
<tr>
<td>Pabuk (0706)</td>
<td>Hengchun, Taiwan</td>
<td>17:00UTC, Aug.07</td>
<td>30</td>
<td>980</td>
</tr>
<tr>
<td></td>
<td>Xingjie, Hongkong</td>
<td>08:00UTC, Aug.10</td>
<td>20</td>
<td>991</td>
</tr>
<tr>
<td></td>
<td>Zhongshan, Guangdong</td>
<td>10:30UTC, Aug.10</td>
<td>18</td>
<td>996</td>
</tr>
<tr>
<td>Wutip (0707)</td>
<td>Hualian-Taidong</td>
<td>01:00UTC, Aug.09</td>
<td>20</td>
<td>990</td>
</tr>
<tr>
<td>Sepat (0708)</td>
<td>Hualian, Taiwan province</td>
<td>21:40UTC, Aug.17</td>
<td>50</td>
<td>930</td>
</tr>
<tr>
<td></td>
<td>Huian, Fujian</td>
<td>18:00UTC, Aug.18</td>
<td>33</td>
<td>975</td>
</tr>
<tr>
<td>Wipha (0712)</td>
<td>Cangnan, Zhejiang</td>
<td>18:30UTC, Sep.18</td>
<td>45</td>
<td>950</td>
</tr>
<tr>
<td>Francisco (0713)</td>
<td>Wengchang, Hainan</td>
<td>04:30UTC, Sep.24</td>
<td>20</td>
<td>987</td>
</tr>
</tbody>
</table>

Table 5.2 showed that the intensities of 6 TCs were relatively intense when they landed. 2 of them were in a severe typhoon category, 1 was severe tropical storm and 3 were tropical storms. Super Typhoon Sepat (0708) was the most severe one that landed from Jan. to Sept. in 2007, its maximum velocity near the center reached 50m/s.

The following lists the characteristics for landing tropical cyclones.

- **Landing TCs with a higher intensity**

Out of 6 landing TCs, 2 reached severe typhoon categories. The strongest one was super typhoon Sepat (0708) with the maximum winds of 50m/s near its center when landing over Taiwan Province.
Landing time concentrated in midsummer

From August 8th to 19th and from September 19th to 24th, there were 3 TCs and 2 TCs, respectively, landed over China Coastal Areas. The fact was that there was a TC landfall every 3 or 4 days during this period, the landing frequency was comparatively higher.

Landing location concentrated in Taiwan Province

From August 8th to 18th, there were 3 TCs landed over eastern part of Taiwan Province, the location was concentrated than the normal (the average number was 0.48). From 1949 to 2006, only in August of 1960, the same number TCs hit Taiwan eastern coastal areas.

The retard landing time

Tropical storm Toraji (0703) was the first tropical cyclone that landed on China in 2007. It landed over Dongxing, Guangxi Province at 08:50 UTC on July 5. Its landing time was about 9 days late than the average.

b. Narrative on Tropical Cyclones

TORAJI (0703)

Tropical storm Toraji (0703) formed over the Beibu Gulf at 00 UTC on Jul. 5, 2007. Afterwards it moved northward and approached to Guangxi coastal area. It made landfall over Dongxing, Guangxi province with the max winds of 23m/s near its center at 08:50 UTC Jul. 5. After landing, Toraji moved westward and moved into Vietnam at 12 UTC Jul. 5. Finally, it became a tropical depression and disappeared in the area of Vietnam. The heavy rain took place over southern Guangxi, southeastern Yunnan and eastern Hainan. The direct economic loss was estimated about 10 million US dollars.

PABUK (0706)

Tropical storm Pabuk (0706) formed at 06 UTC Aug. 5, 2007 over the Northwest Pacific. Afterwards it moved westward and gradually intensified. It became a severe tropical storm at 06 UTC Aug. 6 while approaching to the south coastal area of Taiwan. Pabuk made landfall over the Hengchun Ridge, Taiwan province with the max winds of 30 m/s near center at 17 UTC Aug. 7. After landing, Pabuk moved near westwards and it entered into Taiwan Strait at 18 UTC Aug. 7. It became a tropical depression at 08 UTC and intensified a tropical storm at 15 UTC Aug. 8 again over northeast of South Sea. It became a tropical depression again at 12 UTC Aug. 9 in the offshore area west of Guangdong. Pabuk intensified a tropical storm at 06 UTC Aug. 10 and made landfall on Tumeng, Hongkong with the max winds of 18 m/s near center at 08:30 UTC. Finally, it downgraded a tropical depression at 12 UTC Aug. 10 in the area of Zhongshan, Guangdong province and disappeared there.

Torrential rain took place over Leizhou Peninsula. The maximum total precipitation of 606 mm is recorded in 24 hours which broke historical records. The direct economic loss was estimated about 220 million US dollars.
WUTIP(0707)

Tropical storm Wutip (0707) was in shape at 00UTC Aug. 8 2007 over north of Philippines in the Northwest Pacific. Afterwards it moved northwestward and approached to the east coastal area of Taiwan with little change of intensity. Wutip made its landfall over the area between Taidong and Hua-lie, Taiwan province witnessed the max winds of 20m/s near center at 01UTC Aug. 9. After landing, Wutip crossed the middle of Taiwan and entered onto Taiwan Strait at 06UTC Aug. 9. Finally, it became a tropical depression over the south of the Taiwan Strait. Under the influence of Pabuk, Wutip and Southwest Monsoon, precipitation brought by them alleviated high temperature weather and the drought in Fujian, Guangdong and Guangxi provinces respectively.

Wutip(0707)
**SEPAT(0708)**

Tropical storm Sepat (0708) formed over sea east of Philippines at 18UTC on Aug. 12 2007. Afterwards it moved westward with its intensity increasing quickly. It upgraded to a typhoon at 00UTC Aug.14. Sepat turned to move northward from westward after it became a sever typhoon at 21UTC Aug.14. It upgraded to a super typhoon at 09UTC Aug.15 and was approaching to Taiwan Eastern Coastal Area. Sepat downgraded a sever typhoon at 20UTC Aug. 17 and made landfall over hualien, Taiwan province with the max winds of 50m/s near center at 21:40UTC. After landing, Sepat moved westwards and it entered into Taiwan Strait at about 04UTC Aug. 18. It gradually approached to mid-eastern part of Fujian province and became a typhoon at 07UTC Aug. 18. At 18UTC Aug. 18, Sepat landed on Huian, Fujian province with the max winds of 33m/s near center. After landing on Fujian, Sepat became a sever storm and moved continually northwestwards with its intensity weakening gradually. It downgraded to a tropical storm at 00UTC Aug. 19 in Nanan and then became a tropical depression again at 12UTC Aug. 19 in Yongan, Fujian province. Sepat turned to move west-southwestwards after it moved into Jianxi province at 19UTC Aug.19. Finally Sepat disappeared in Hunan province.

From 00UTC Aug. 18 to 22, the heavy rain took place over Southern Zhejiang, Fujian, Northern Guangdong, Jianxi, Hunan and Southeastern Jiangxi. The maximum total precipitation of 514mm is recorded at Zixin, Hunan province. Force 9 to 11 wind in Beaufort scale hit coastal areas between Zhejiang and Fujian. 25 people died and 13 people missing. The direct economic loss was estimated about 740 million dollars.

**WIPHA(0712)**

Tropical storm Wipha (0712) formed at 00UTC Sep. 16 2007 over the Northwest Pacific. Afterwards it moved northwestern and gradually intensified. It became a typhoon at 18UTC Sep. 16 and intensified into a severe typhoon at 10UTC Sep. 17. Wipha upgraded as a super typhoon at 21UTC Sep. 17 with the max winds of 55m/s
over the east sea of Taiwan. It downgraded to a sever typhoon at 12UTC Sep. 18 while approaching to Zhejiang Coastal Area. Finally Wipha made landfall over the most southern Cangnan, Zhejiang province with the max winds of 45m/s near center at 18:30UTC Sep. 18. After landing, Wipha turned to move northwestward and became a typhoon at 21UTC Sep. 18 in Fuding, Fujian province. It upgraded as a sever tropical storm quickly soon after. At morning Sep. 19, Wipha moved into Zhejiang province and downgraded as a tropical storm at 03UTC. It stayed in Zhejiang province for about 15.5 hours. Then Wipha turned to move northeastward and crossed Anhui, Jiangsu province successively. After it moved into the Yellow Sea at about 23UTC Sep. 19, Wipha went through the east of Shandong Peninsula and finally became an extratropical cyclone over the north of the Yellow Sea.

From 06UTC Sep. 19 to 06UTC Sep. 20, force 7 to 8 wind in Beaufort scale hit the areas of Anhui, Jiangsu and Shandong Peninsula. Wind scale in east coastal regions of Fujian, Zhejiang and Shanghai also reached Force 8 to 11. Heavy rain took place over east of Liaoning, mid-east of Shandong, mid-north of Jiangsu, mid-east of Anhui, northeast of Jiangxi and so on, and the maximum total precipitation of 191mm was recorded in Rizhao, Shangdong province.

Many places over East China were plagued with heavy flood for torrential rain caused by Wipha and cold air from north. 8 people died, 3 people missing and 2539 thousands people transfer in this period. The direct economic loss was estimated about 1010 million dollars

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**FRANCISCO (0713)**

Tropical storm Francisco (0713) formed over South China Sea at 03UTC Sep. 23 2007. Then it moved westward and made landfall over Wenchang, Hainan province with the max winds of 20m/s near center at 04:30UTC Sep. 23. After landing, Francisco continually moved westward and became a tropical depression when it was on Beibu Bay. Francisco gradually disappeared after it landed over Vietnam.
During Francisco landing or later, force 6 to 8 wind in Beaufort scale hit coastal areas of South China. The maximum winds of 32.7m/s was observed during landing in the area of Cangjiang, Hainan province. From Sep. 23 to 25, Heavy rain took place over Hainan province and coastal area of South China, and the maximum total precipitation of 239.4mm was recorded in Qiongzhong, Hainan province. The precipitation brought by Francisco was favorable to the water storage of Hainan province and the disaster it brought was slight.
VI. Resource Mobilization Activities
Nil.
VII. REPORT ON DAMAGE CAUSED BY CYCLONES, FLOODS AND DROUGHT

COUNTRY: People’s Republic of China

PERIOD COVERED BY THIS REPORT

From: 1 Oct. 2006 to: 30 Sep. 2007
(date, month, year) (date, month, year)

PREPARED AND SUBMITTED BY:

DATE PREPARED : 15 Oct. 2007
(date, month, year)

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.

Notes:
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

<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type of disasters</td>
<td>0703 TORAJI</td>
<td>0707 PABUK</td>
<td>0708 WUTIP</td>
<td>0709 SEPAT</td>
<td>0713 WIPHA</td>
<td>0714 FRANCISCO</td>
</tr>
<tr>
<td>2. Date or period of occurrence</td>
<td>5, JUL</td>
<td>8, AUG 10, AUG 10, AUG</td>
<td>9, AUG 18, AUG 19, AUG</td>
<td>19, SEP 24, SEP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Name of regions/areas seriously affected*</td>
<td>Guangxi</td>
<td>Guangdong</td>
<td>Fujian</td>
<td>Fujian Zhejiang Jiangxi Hunan Guangdong Hubei Anhui Huain</td>
<td>Zhejiang Fujian Shanghai Jiangsu Anhui Shandong</td>
<td>Hainan Guangdong</td>
</tr>
</tbody>
</table>

### II. HUMAN DAMAGE

<table>
<thead>
<tr>
<th>Unit</th>
<th>1</th>
<th>3</th>
<th>62</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Dead and missing*</td>
<td>29400</td>
<td>64200</td>
<td>354120</td>
<td>563980</td>
</tr>
<tr>
<td>5. Injured</td>
<td>1113000</td>
<td>1131000</td>
<td>11423300</td>
<td>13933900</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Houses and buildings</strong></td>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Destroyed*</td>
<td>rooms</td>
<td>4000</td>
<td>4200</td>
<td>900</td>
<td>35200</td>
<td>16100</td>
</tr>
<tr>
<td>10. Damaged*</td>
<td>rooms</td>
<td>900</td>
<td>2700</td>
<td>75500</td>
<td>64200</td>
<td></td>
</tr>
<tr>
<td>11. Affected*</td>
<td>rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Total*</td>
<td>rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>B. Farmland</strong></th>
<th>hectares</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Farmland</td>
<td>hectares</td>
<td>6750</td>
<td></td>
<td>523360</td>
<td></td>
<td>652660</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>C. Agricultural Products</strong></th>
<th>tons</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Livestock</td>
<td>heads</td>
<td></td>
<td></td>
<td>900</td>
<td>29300</td>
<td></td>
</tr>
<tr>
<td>16. Fruit plants</td>
<td>number hectares</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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:
<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Public works facilities</td>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Road</td>
<td>km</td>
<td></td>
<td></td>
<td>42</td>
<td>779</td>
<td></td>
</tr>
<tr>
<td>19. Bridge</td>
<td>sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. River embankment</td>
<td>km</td>
<td></td>
<td></td>
<td>6</td>
<td>314</td>
<td></td>
</tr>
<tr>
<td>21. Irrigation facilities</td>
<td>hectares sites</td>
<td></td>
<td></td>
<td>622</td>
<td>4573</td>
<td></td>
</tr>
<tr>
<td>22. Reservoir and dam</td>
<td>number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Harbour and port</td>
<td>number sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Other please specify</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Public Utilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Railway</td>
<td>km sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Electric Supply</td>
<td>affected families sites (km)</td>
<td></td>
<td></td>
<td>33</td>
<td>761</td>
<td></td>
</tr>
<tr>
<td>27. Water Supply</td>
<td>affected families sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Telecommunication</td>
<td>circuits sites (km)</td>
<td></td>
<td></td>
<td>40</td>
<td>354</td>
<td></td>
</tr>
<tr>
<td>29. Other please specify</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F. Others</strong></td>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Ships lost or damaged</td>
<td>number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Landslide and collapse of slope</td>
<td>sites</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### IV. MATERIAL DAMAGE IN MONETARY TERMS

<table>
<thead>
<tr>
<th>Sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. Damage of houses and loss of private property* includes:</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* houses and buildings for residential use,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* household furniture, appliances and possession,</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* stored good and other assets of farmers’ and fishermen抯 households</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Other</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>33. Loss of agricultural production includes:</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* crops, vegetables, fruits, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* livestocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Other: Fisheries</td>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ten thousand dollars</td>
<td>62150</td>
<td>1750</td>
<td>3625</td>
<td>56425</td>
<td>44075</td>
</tr>
</tbody>
</table>

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抯 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抯 households 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 debrises. Loss of livestock can be estimated in the same manner by multiplying the head of stock lost by unit market price.
<table>
<thead>
<tr>
<th>Sequence No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>34. Loss of industry</td>
<td>ten thousand dollars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>140437</td>
</tr>
<tr>
<td>35. Loss of public work facilities includes items under III. MATERIAL DAMAGE IN PHYSICAL TERMS</td>
<td>ten thousand dollars</td>
<td></td>
<td></td>
<td>33870</td>
<td>505423</td>
<td></td>
</tr>
<tr>
<td>* road bridge, river embankment, etc., irrigation facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* reservoir and dam, harbour and port, and public bridges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* rehabilitation cost of farmland at government expense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. Loss of public utilities includes items under III. MATERIAL DAMAGE IN PHYSICAL TERMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* railway, electric supply, water supply, telecommunication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Other</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>37. Total estimated/counted damage cost, sum of items 32, 33, 34, 35, 36</td>
<td>ten thousand dollars</td>
<td>58578</td>
<td>121662</td>
<td>624681</td>
<td>625883</td>
<td>2628</td>
</tr>
</tbody>
</table>

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) harbour, 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.