



WMO

**WORLD METEOROLOGICAL ORGANIZATION
AND
ECONOMIC AND SOCIAL COMMISSION
FOR ASIA AND THE PACIFIC**



ESCAP

WMO/ESCAP PANEL ON TROPICAL CYCLONES

THIRTY-THIRD SESSION

Dhaka, Bangladesh

(30 January to 4 February 2006)

FINAL REPORT

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (Agenda 1)

The thirty-third session of the WMO/ESCAP Panel on Tropical Cyclones (PTC) hosted by the Bangladesh Meteorological Department (BMD) was held in Dhaka, Bangladesh from 30 January to 4 February 2006.

Attendance

The session was attended by 41 participants from seven (out of eight) Members of the Panel on Tropical Cyclones namely: Bangladesh, India, Maldives, Oman, Pakistan, Sri Lanka and Thailand. It was also attended by observers from China, the Indian Institute of Technology (IIT)-Kharagpur, Bangladesh Water Development Board, SAARC Meteorological Research Centre (SMRC), Cyclone Preparedness Programme (CPP), Bangladesh Inland Water Transport Authority (BIWTA), Disaster Management Bureau (DMB) of Bangladesh and representatives from WMO, UNESCAP and Technical Support Unit (TSU). The list of participants in the session as well as the capacities in which they attended is given in **Appendix I**.

Opening of the Session

1.1 The inaugural ceremony commenced at 12:15 p.m. on Monday, 30 January 2006 at the Dhaka Sheraton Hotel.

1.2 The Honorable Prime Minister Begum Khaleda Zia delivered the inaugural address (see para 1.5) and declared the session open.

1.3 Mr Mesbah Uddin Ahmed, Secretary, Ministry of Defence, in his welcome address, extended his thanks to all the participants, especially to those who have come a long way to share their expertise and experience for better utilization of the existing cooperation in the field of meteorology for proper disaster management. He mentioned that in Bangladesh frequent disasters like tropical cyclones, its associated storm surges, prolonged and widespread flooding make the losses and sufferings many times to a stage of non-recovery. Because of this, the Government of the People's Republic of Bangladesh has given much importance to disaster risk reduction and has given priority to strengthen the capability of the BMD towards its delivery of more accurate and timely forecasts and warnings for proper disaster preparedness and mitigation. The Government had also given maximum emphasis to incorporate the latest technology based meteorological science and its application to the capacity enhancement of BMD. He further stated that Bangladesh is now associated with many international and regional efforts to foster cooperation in the field of early warning system development. In closing, he expressed his hope that the participants would be more pro-active in formulating new ideas and recommendations for the meteorological sector to meet the scientific challenge of the 21st century and to meet the societal demands for their well-being.

1.4 Speaking on behalf of Mr Michel Jarraud, Secretary-General of WMO, Dr Tokiyoshi Toya, expressed his deep appreciation, and that of the World Meteorological Organization, to Mr Mesbah Uddin Ahmed, Secretary, Ministry of Defence, and to Mr Md Akram Hossain, Director of the Bangladesh Meteorological Department and his staff for the warm welcome and for the excellent arrangements made to ensure the success of the session. He stated that the "Theme" for this year's session "*Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards in the Panel Region*" was selected in recognition of the fact that the availability of a well functioning early warning system that could deliver accurate and useful information in a timely and dependable manner to decision-makers and the population at risk is a fundamental condition for disaster preparedness. In this regard, the interaction between the National Meteorological and Hydrological Services (NMHSs) and the

National Agencies concerned with disaster prevention and preparedness has to be further strengthened in order to increase the effectiveness of the warning system and national disaster mitigation measures. In this context, WMO is actively working with its partners at the international, regional and national levels to further improve early warning capabilities and ensure that these systems are available to all countries, particularly those with the least resources. In response to a call for WMO's core technical and scientific capabilities to be optimally integrated into disaster risk reduction strategies at all levels, WMO will carry out, within a "multi-hazard" framework, a comprehensive survey and mapping of regional and national capabilities, factoring in the requirements of the disaster risk-management community. Furthermore, WMO will work on strengthening contributions by NMHSs to hydrometeorological risk assessment at the national level. WMO is firmly committed to participate in key international endeavours on this subject. In closing, he expressed the hope that the session would come up with priority activities and related strategies to strengthen the existing systems and infrastructures and in the further development of a culture of prevention in the region.

1.5 The Executive Secretary of UNESCAP, in his message transmitted by Mr Ti Le-Huu as representative of UNESCAP, expressed his appreciation to the Government of Bangladesh for hosting the thirty-third session. He noted that the Government of Bangladesh had been playing an active role in efforts to achieve the objectives of the Panel, particularly in promoting and coordinating the planning and implementation of measures and research activities required to minimize the loss of life and damage caused by cyclones. He highlighted the impressive achievements of the Government of Bangladesh over the course of the past 35 years in drastically reducing the loss of lives caused by cyclones, since the tragic disaster of the 1970 cyclone, which had killed over 300,000 people in Bangladesh and led to the establishment of the Panel on Tropical Cyclones. He pointed out that, in recent years, the socio-economic impact of natural disasters had increased in the region as reflected in a 2005 UNESCAP study on the socio-economic impact of natural disasters in the region: the number of deaths from natural disasters increased to account for 91 per cent of the world total from 1900 to 2005, and economic loss now accounted for 54 per cent during the same period. He also pointed out that during the past five decades, from 1950 to 2005, the number of people killed by natural disasters totaled over 5.5 million, of which cyclones and floods accounted for 54 per cent, and the total economic loss during the same period was estimated at over US\$588 billion, of which cyclones and floods accounted for 57 per cent. He informed the Panel that UNESCAP would soon start implementation of regional projects as part of the UN's response to the Indian Ocean tsunami, using the US\$ 1 million contribution of Republic of Korea and that a regional trust fund had been established on 26 September 2005 to support capacity building of regional, subregional and national centres concerned with tsunami early warning arrangements in the Indian Ocean and South-East Asia. This trust fund is now totaled US\$12.5 million with a contribution of US\$10 million from Thailand and US\$2.5 million from Sweden. He expressed his sincere appreciation to the Government of Pakistan for its continuing support in hosting the Technical Support Unit of the Panel and to the Government of India for its continuing technical assistance in providing the services of the Regional Specialized Meteorological Centre -Tropical Cyclone New Delhi, which extended valuable support to all Members of the Panel.

1.6 In her inaugural address, the Honorable Prime Minister Begum Khaleda Zia, against the backdrop of recent pervasive natural calamities, called for international cooperation in global exchange of weather information for worldwide disaster mitigation as meteorological activities do not obey any political or geographical boundaries. The Prime Minister stressed the need for proper application of the latest technology for upgrading the existing early warning and mitigation arrangements for natural disasters. She observed that although it is not possible to prevent natural disasters, disaster mitigation is possible through accurate and timely forecasts and warnings and adequate preparations.

1.7 Mr Md. Akram Hossain, Director of BMD, offered words of thanks to the Honorable Prime Minister, Members of the Cabinet, Members of Parliament, Representatives of the

Various Diplomatic Missions in Bangladesh for their presence at the inaugural ceremony. He also acknowledged the valuable support extended by the Prime Minister and the Secretary of the Ministry of Defense to BMD, in particular to the organization of the session. He expressed his gratitude to all the participants whose presence symbolizes the need for cooperation to solve the recurring problems of tropical cyclones.

2 ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN (Agenda item 1.2)

Election of the Chairman and Vice-chairman of the Panel on Tropical Cyclones

2.1 Mr B. Lal (India), Chairman of the PTC for 2005, chaired the election for this year's Chairman and Vice-chairman. Mr Md. Akram Hossain (Bangladesh) and Mr Badar Al-Rumhi (Oman) were unanimously elected as Chairman and Vice-chairman of the Panel, respectively, to hold their posts until the next session.

Election of the chairman of the drafting committee

2.2 Mr S.K. Subramanian (India) was elected as Chairman of the drafting committee.

3. ADOPTION OF THE AGENDA (Agenda item 3)

The Panel adopted the agenda as given in **Appendix II**.

4. WORKING ARRANGEMENTS (Agenda item 4)

The Panel decided on its working hours and the arrangements for the session. All technical sessions were held at the SAARC Meteorological Research Centre (SMRC).

5. FOLLOW-UP ACTION ON PTC-32 (Agenda item 5)

5.1 A detailed review of the recommendations of the thirty-second session and their follow-up action taken was carried out based on the action sheet as shown in **Appendix III**.

5.2 The Panel was pleased to note that most of the items requiring action had been implemented while actions on ongoing activities were continuing satisfactorily.

6. REVIEW OF THE 2005 CYCLONE SEASON (Agenda item 6)

6.1 The Director of RSMC-tropical cyclones New Delhi presented a review of the 2005 cyclone season on the basis of the centres' comprehensive report entitled "REPORT ON CYCLONIC DISTURBANCES OVER NORTH INDIAN OCEAN DURING 2005" distributed during the session.

6.2 The Director of RSMC New Delhi informed the Panel that the year 2005 was a year of near normal activity over the north Indian Ocean. The basin witnessed the formation of twelve disturbances against a normal of fifteen cyclones. Out of the twelve, four (against a normal of six) intensified into cyclonic storms and three did not intensify beyond deep depression stage. There was one land depression during the year. The Arabian Sea was less active and was devoid of any cyclonic storms. Only two depressions formed over that basin. On the other hand, the Bay of Bengal was more active with the formation of four cyclonic storms, three deep depressions and two depressions during the year.

6.3 The representatives of the Panel Members reported to the session a review of the 2005 cyclone season of their respective countries, a summary of which is given in **Appendix IV**.

6.4 The Panel also noted with appreciation that during the year RSMC New Delhi had started the operational use of names for tropical cyclones occurring in the Bay of Bengal and the Arabian Sea areas.

6.5 The Panel was informed that the matter relating to the proposed change of the boundaries of RSMC New Delhi's forecast area of responsibility was discussed during the seventeenth session of the RA I Tropical Cyclone Committee for the South-West Indian Ocean (Gaborone, October 2005) and also at the fifth TC RSMC/TCWC Technical Coordination Meeting (Honolulu, December 2005). The Panel requested WMO to pursue the matter for approval with WMO's Regional Association I which will meet in Abuja tentatively in November 2006.

6.6 The Panel expressed its appreciation to the RSMC -tropical cyclones New Delhi for the continued valuable contribution it was making to its Members and further emphasized the importance of further strengthening the existing cooperation and collaboration between the national warning centres and RSMC New Delhi.

6.7 The Panel expressed its appreciation to Mr S.K. Subramanian for his devotion to his work as Director of RSMC New Delhi and for his untiring efforts to further improve the services of the RSMC to the Panel Members and wished him all the best in his retirement.

7. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME (Agenda item 7)

7.1 The Panel noted with appreciation the comprehensive information provided by the WMO Secretariat on the implementation of the WMO Tropical Cyclone Programme (TCP). It noted with satisfaction the developments and progress made in both the general component and the regional component of the TCP since the thirty-second session of the WMO/ESCAP Panel on Tropical Cyclones (New Delhi, India, 21 to 26 February 2005).

7.2 The Panel was pleased to note that to address the issue of sustainable development, the TCP had capacity building as its main priority in 2005. In accordance with this, a number of workshops, training courses and attachment of forecasters were organized as a means for national warning centers, especially those in developing countries, to achieve sustainability. This is also in accordance with the programme's objective to facilitate the transfer of knowledge and technology intended to improve the institutional efficiency of the NMHSs and lead to the provision of better tropical cyclone, associated flood and storm surge forecasts.

7.3 The Panel expressed its appreciation to WMO and IIT Kharagpur for arranging the attachment of two storm surge experts from Myanmar and Pakistan (8 to 19 August 2005) at the Indian Institute of Technology (Kharagpur) in the implementation and running of a PC-based high-resolution storm surge model. Unfortunately, due to visa problems the participant from Pakistan was not able to participate. The Panel expressed its gratitude to Prof. Shishir Kumar Dube and to IIT Kharagpur for this valuable contribution to the Panel's activities and requested that WMO make similar arrangements with the IIT for the year 2006 for the attachment of storm surge/wave experts from Pakistan and Bangladesh.

7.4 The Panel was informed that steps are underway to organize the Fourth Regional Workshop on Storm Surges and Wave Forecasting – A Hands on Training Laboratory in Manila, Philippines in September 2006. The Members were pleased to note that all the Panel Members will again be invited to participate at the said workshop.

7.5 The Panel noted with pleasure that the "Annual Summary of Global Tropical Cyclone Season 2004" (WMO/TD-No. 1194) (TCP-49) was published in CD-Rom format in December 2005 and that the next issue of the annual summary (2005) is under preparation and will be published in August 2006.

8. REVIEW OF THE COORDINATED TECHNICAL PLAN AND CONSIDERATION OF THE WORK PROGRAMME FOR THE NEXT FIVE YEARS (Agenda item 6)

- (a) The Panel was informed that Mr Ahmed Hamoud Mohamed Al-Harthy (Oman), Chairman of the Working Group tasked to carry out a detailed review of the Coordinated Technical Plan (CTP) had requested that, due to his heavy work load, the Panel choose another Chairman. The Panel expressed its appreciation on the work done by Mr Al-Harthy during the intersessional period. It decided to request Mr Al-Harthy to reconsider his decision to relinquish the chairmanship. If, however, Mr Al-Harthy cannot do so, the Panel requested that Mr Badar Al-Rumhi assume the chairmanship of the working group.
- (b) The Panel established a working group during the session to identify the priority issues (**Appendix V**) for possible implementation during the next two years (2006-2007) on the basis of the overall framework of the CTP which was adopted during the 32nd session and whenever possible not necessitate high capital expenditure.
- (c) The Panel noted with thanks the survey form submitted by Mr Al-Harthy and urged the Members to duly fill up the said survey for subsequent submission before 30 April 2006 to the TSU. The Panel requested TSU to make a consolidated report of the said survey which will be presented to the Members in its session in 2007.

8.1 Meteorological Component (agenda item 8.1)

8.1.1 Under this item, matters relating to the basic observational network, the telecommunication links and data-processing systems established in the region to fulfill the requirements of WMO's World Weather Watch Programme were given priority. The Panel Members were invited to present reports on the current progress in dealing with problems encountered and on programmes for the modernization of observing and telecommunication networks and forecasting systems, aiming at further improvements in tropical cyclone monitoring, forecasting and warning services. The Panel reviewed the activities under the meteorological component of the Members during the past year, details of which are presented in **Appendix VI**.

8.1.2 The Panel was informed that according to the results of the WWW Annual Global Monitoring (AGM) October 2005, the availability of SYNOP reports expected to be received from the Regional Basic Synoptic Network (RBSN) of Members ranged from 68 to 100 per cent. The percentage of the reports received from India and Oman remained stable constituting 93 per cent each respectively whilst Thailand remained the highest in the region, constituting 100 per cent of expected reports. The availability of data from rest of the Member countries showed an increase with Bangladesh 94 per cent (74% in 2004), Sri Lanka 89 per cent (83% in 2004), Pakistan 87 per cent (47% in 2004), Maldives 80 per cent (39% in 2004) and Myanmar 68 per cent (51% in 2004) of reports expected being registered.

8.1.3 The availability of TEMP reports during the same AGM period in October 2005 ranged from 0 to 90 per cent. India continued to provide the highest coverage of data from its 35 upper-air stations (90 per cent), while the 5 upper-air stations in Myanmar continued to be silent similar to previous years. Availability of reports from Oman, Thailand and Bangladesh remained stable producing 53, 50 and 30 per cent of expected reports respectively while Pakistan showed a significant increase in the availability of reports 48 per cent compared to 8 per cent in 2004. Maldives joined the RBSN in 2005 establishing one upper-air station and produced 50 per cent of expected reports. Sri Lanka did not have any upper-air stations listed in the RBSN during the monitoring period.

8.1.4 The Panel noted that as before, deficiencies in surface and especially upper-air data coverage over certain areas in the region continued to be caused mainly due to financial difficulties in countries concerned to rehabilitate and operate both observational and telecommunication equipment. It should be also stressed that some observing stations destroyed during natural disasters in South-East Asia region during 2004-2005 are yet to be rehabilitated.

8.1.5 The Panel requested WMO for the urgent implementation of the GTS upgrade in Panel Members such as Bangladesh, Maldives, Sri Lanka and Thailand so as to address requirements for tsunami-related information exchange in the Indian Ocean Rim.

8.1.6 The Panel noted with appreciation that the Coordination Group for Meteorological Satellites (CGMS) during its' 33rd session (Tokyo, Japan, 1-4 November 2005), had taken actions in response to the requirements of the PTC forwarded to the group by TCP. The TCP expressed in particular three requirements: geostationary satellite coverage of the Indian Ocean, availability of TRMM data and ocean surface winds from scatterometer data. The Panel noted with appreciation that the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) plans to relocate Meteosat-7 over the Indian Ocean which would allow continued coverage until 2008. It however recalled the need for long-term coverage of the Indian Ocean area whereupon it was pleased to learn that Russia intended to ensure long-term coverage of the Indian Ocean Region, with its Electro L-N1 and N2 satellites, currently scheduled for launch in 2007 and 2009 respectively.

8.1.7 The Panel noted the opening of the Centre of Excellence in Oman for Satellite Application Courses. The Centre was established with the kind cooperation between the Sultanate of Oman and EUMETSAT. The Panel Members were requested to participate in the courses offered by the Centre.

8.1.8 The Panel was informed that TCP had requested the National Aeronautics and Space Administration (NASA) of the USA through the CGMS to continue the Tropical Rainfall Measuring Mission (TRMM) as long as the satellite is still in a functional status. In response to this request, NASA, as noted in the recent CGMS report, agreed to extend the operation until 30 September 2009. The Panel was further informed that TCP recommended that CGMS develop future plans for the deployment of scatterometer sensors and other satellite surface wind vector retrievals.

8.1.9 The Panel noted that automated meteorological observation reporting systems from aircraft collectively known as Aircraft Meteorological Data Relay (AMDAR) continued to represent a prime source of good quality, high resolution and timely upper air data increasingly used to supplement conventional upper air observations from the World Weather Watch (WWW) Global Observing System (GOS). Globally, 14 national operational AMDAR programmes are currently producing up to 200,000 observations per day compared to only 3 operational national programmes producing around 30,000 observations per day in 1998 when the AMDAR Programme started.

8.1.10 The Panel was pleased to note that India and Pakistan have expressed interest in developing AMDAR programmes and that the AMDAR Panel has provided relevant AMDAR information to a number of airlines of these countries.

8.1.11 The Panel was informed that the AMDAR Panel has offered to assist countries in the Panel Region to develop national AMDAR programmes and is also encouraging cooperation in developing a regional AMDAR programme. The AMDAR Panel is facilitating the development of stand-alone AMDAR application software for the visualization of AMDAR data. When completed, this visualization software will enable users, in particular those in developing countries, to receive, decode, archive and display AMDAR data and minimize development costs.

8.1.12 The Panel noted that buoy reports from the region continue to increase primarily due to the activities of the International Buoy Programme for the Indian Ocean (IBPIO) and the National Data Buoy Programme (NDBP) of India.

8.1.13 The Panel appreciated the efforts of India to digitize the cyclone track atlas which will be completed soon.

8.2 Hydrological Component (agenda item 8.2)

8.2.1 Under the hydrological component, the Panel reviewed the activities of its Members, WMO and UNESCAP. The representatives of the Members reported the activities of their respective countries as reflected in **Appendix VII**. In 2005, several important improvements in the hydrological component had been made by Panel Members, including flood forecasting techniques and modelling, real-time monitoring of water level and rainfall, risk mapping and participation of stakeholders in flood warning systems.

8.2.2 The Panel expressed its appreciation to the strong spirit of cooperation among the concerned Members of international river basins in the region on the exchange of hydrological data, especially for flood forecasting. The Panel noted the important increase in the lead-time as a result of exchange of real time data as emphasized by hydrology experts from Bangladesh. The Panel urged that these Members continue this kind of cooperation to further improve flood forecasting services for better protection of lives of the people and hoped that this spirit of cooperation for humanitarian cause be highlighted at various international forums to reflect the enhanced spirit of cooperation among the Panel Members.

8.2.3 The Panel recognized that several Members had been using the Mike11 system for flood forecasting and detailed exchange of experiences would be beneficial to all. It therefore decided to establish a task force on Mike-11 to encourage sharing of experiences and called on international organizations to assist in facilitating the exchange of experiences, including organization of a regional workshop.

8.2.4 The Panel expressed its interest on the efforts of India to strengthen the flood forecasting system, to digitize the inundation areas and to revise its guidelines on flood forecasting. It urged India to share the results of these studies.

Activities of UNESCAP

8.2.5 In 2005, UNESCAP continued its efforts to build on the achievement of the project on "Capacity-building in strategic planning and management of natural resources in Asia and the Pacific" to support regional efforts in the development of integrated water resources management (IWRM) plans by 2005 as recommended in the Johannesburg Plan of Implementation of the World Summit on Sustainable Development. The activities included:

- (i) preparation and printing a special publication on "Good Practices on Strategic Planning and Management of Water Resources in Asia and the Pacific" at the end of 2005;
- (ii) launching a web site on SPM jointly by FAO Regional Office for Asia and the Pacific and UNESCAP, and
- (iii) preparation for a special session on this subject at the Fourth World Water Forum to be held in Mexico in March 2006.

8.2.6 The Panel Members were urged to make use of the advisory services which could be made available by UNESCAP to developing countries in the region on various aspects of water resources planning and management and to contribute their experiences, especially best practices, and research results related to water resources management to be published

in the *Water Resources Journal* of UNESCAP for dissemination to developing countries in the region.

8.2.7 The Panel was informed of ongoing activities of UNESCAP related to flood hazard mapping, flash flood and sediment disasters, including land slide forecasting and warnings and encouraged participation of interested members in these activities.

Activities of WMO

8.2.8 WMO launched a flood forecasting initiative based on the recommendations of a start-up expert meeting held in April 2003 in the WMO Secretariat. The principal objective of the initiative was to improve flood forecasting by making use of advanced weather forecasting products through the enhanced cooperation between NMSs and NHSs. So far, regional workshops had been held in South Africa in December 2003 and for RA III (South America) and RA IV (Central America) in Valencia, Spain, in March 2004 and in Bangkok in December 2005.

8.2.9 The meeting in Bangkok had been co-organized with ESCAP and was attended by 13 experts from meteorological and hydrological services of 8 countries. In particular, participants urged the Panel to revive its Storm Surge Project in the light of the 2004 Tsunami including the need to prevent coastal flood disasters as a result of storm surges in the PTC region. In particular, participants had recommended that storm surge risk management supporting technology and forecasting techniques and associated activities should be renewed in the context of the PTC and also the Typhoon Committee (TC). In this regard, a closer cooperation between the PTC and the TC was encouraged in particular with regard to strengthening the hydrological component of the PTC. Likewise, the participants recommended that efforts should be undertaken to improve and utilize ensemble-forecasting techniques in hydrology based on relevant meteorological information. They also recognized that the outreach to risk and disaster management activities is essential and therefore, risk-based flood hazards maps should be prepared for areas exposed to hydrometeorological hazards and therefore invited Panel Members to consider whether such issues should be addressed in the work programme of the PTC's hydrological component.

8.2.10 Further, regional workshops are planned for West Africa and for WMO Region V (Australia and the Pacific) in 2006. The initiative is closely related to projects of WMO's Commission for Hydrology (CHy) namely the "Global/Regional Short-term Hydrological Forecasting System Project" and the "Flash Flood Threshold Pilot Project".

8.2.11 In this respect an international workshop on flash flood forecasting in Costa Rica will be held in Costa Rica from 13 to 17 March 2006. This workshop is co-organized by WMO and NOAA. Two flash flood related workshops had been held in Tsukuba, Japan in February 2005 in close collaboration between the Public Works Research Institute of Japan and WMO and another one in Lhasa, Autonomous Region of Tibet, China in November 2005 that was organized jointly by the International Centre for Integrated Mountain Development (ICIMOD), Nepal and WMO.

8.2.12 As flash floods are a serious problem in the PTC region and in the context of tropical cyclones, Panel Members were urged to consider activities related to flash flood forecasting jointly in the meteorological and hydrological components of the PTC.

8.2.13 Another CHy project under implementation is with the objective to assist National Hydrological Services (NHSs) in implementing risk management practices to mitigate social, economic and environmental losses resulting from flooding including aspects of climate variability and change. A Web-based study on "Risk Management" that had been undertaken as a CHy activity in the previous reporting period is currently being revised and can be obtained from the WMO Secretariat. The study provides a first survey on approaches,

methodologies and techniques currently used in risk management related to flooding and climate variability.

8.2.14 It is recalled that XIII RA II (Asia) had appreciated the development of a Strategic Plan for the Enhancement of NHSs in RA II for the period 2006–2008 as an overall, region-wide effort to enhance capabilities of National Hydrological Services (NHSs) to adequately plan and respond to requirements regarding issues including improved early warning, flood forecasting and disaster preparedness on national and regional levels. The President of RA II in May 2005 has endorsed the Strategic Plan on behalf of Members of RA II. The Strategic Plan has since been distributed to all Members of WMO Region II (Asia). In particular, the Strategic Plan aims to strengthen the capabilities of NHSs in the Asia Region to a world standard; to meet the growing demands for improved hydrological services and products; to ensure safety and well being of people; to contribute to achieving sustainable development; and, to fulfill countries commitments under regional and international agreements and conventions. The PTC is invited to consult the strategy with a view to its implementation in the framework of current and planned PTC activities.

8.2.15 The Members of the Panel were requested to explore more efficient communication and cooperation mechanisms that would allow an enhanced collaboration between relevant programmes of WMO including the Hydrology and Water Resources Programme (HWRP) and the Disaster Management Programme (DPM) as well as the CHy and the regional Working Group on Hydrology and national focal points related to the DPM. Through such improved interaction it is expected that results-based activities could be identified for the benefit of all participating partners.

8.2.16 As part of the effort to enhance cooperation between WMO and UNESCAP as stipulated in the Memorandum of Understanding signed by the Secretary General of WMO and the Executive Secretary of UNESCAP in 2003, a “Regional Expert Meeting on Improved Meteorological and Hydrological Forecasting of the WMO Flood Initiative” (see para 8.2.9) was jointly organized by WMO and UNESCAP in December 2005 at the United Nations Conference Centre of Bangkok. Aiming at strengthening services of NMHS's on flood forecasting, the meeting attended by both meteorologists and hydrologists recommended a list of priority activities for WMO and UNESCAP to consider for further action.

8.3 Disaster Prevention and Preparedness (DPP) Component (agenda item 8.3)

8.3.1 Under this agenda item, the Panel reviewed the activities of its Members and discussed the related activities of WMO, UNESCAP and the International Strategy for Disaster Prevention (ISDR). The representatives of the Members reported the situations on disaster mitigation and related disaster management activities of their respective countries in the past year and their future plans. The Panel noted with appreciation the participation of the DPP experts from the host country, Bangladesh. In view of the importance of DPP activities, the Panel urged Members to send their DPP experts to take part in future sessions.

8.3.2 In most of the Panel Members, efforts have continued to provide much needed training to stakeholders to enhance awareness and participation in DPP activities. Summary of DPP activities of Panel Members is given in **Appendix VIII**.

8.3.3 The Panel noted the importance of involvement of communities in disaster management and disaster risk management. In view of the extensive experiences of Bangladesh, the Panel welcomed the offer of Bangladesh to lead a working group aimed at facilitating exchange of experiences on disaster management among the Panel Members and decided to appoint Mr Md. M. Rahman of Disaster Management Bureau to chair this working group and requested him to report to the next session of progress of work.

Activities of WMO

8.3.4 WMO is working to strengthen its strategic partnerships with other organizations at the regional and international levels. WMO is working closely with the Secretariat of the International Strategy for Disaster Reduction, through its Interagency Task Force (ISDR/IATF) in several areas:

- a) WMO had actively participated in all the four Working Groups of ISDR's Inter-Agency Task Force (IATF) and encouraged Members to contribute to the work of ISDR;
- b) WMO continues to co-chair Working Group 1 on Climate and Disasters; and
- c) WMO is co-chairing a new advisory group, guiding the implementation of the Global Survey of the Early Warning Systems requested by the UN Secretary General.

8.3.5 WMO is also working to develop new partnerships based on the complementary roles and activities of the organizations, their value, added towards advancing DPM goals as well as contributions to the area of disaster risk reduction as a whole. The DPM programme office in close collaboration with WMO programmes is carrying out a systematic evaluation of potential partners through the ISDR/Interagency Task Force (IATF) for Disaster Reduction, conferences, and bilateral and multilateral meetings and discussions are underway with several international and regional agencies (e.g., the World Bank, United Nations Development Programme (UNDP), International Federation of Red Cross and Red Crescent Societies (IFRC), UN Office for the Coordination of Humanitarian Affairs (OCHA), and the Asian Disaster Reduction Center (ADRC). It is urging National Meteorological and Hydrological Services (NMHSs) to seek targeted partnerships at the national level and through participation in the emerging National Disaster Reduction Platforms. Particularly, the Secretariat will be assisting NMHSs in the developing countries and least developed countries and Small Island Developing States (SIDS), in their efforts to establish their partnerships at the national level.

8.3.6 The Meeting noted that the WMO/ESCAP partnership has been very effective and can be used to further strengthen the linkages between the NMHSs and the disaster risk management community at the regional and national levels in this region.

WMO's Contributions to the Development of Tsunami Early Warning System

8.3.7 WMO is working together with UN Educational, Scientific and Cultural Organization-Intergovernmental Oceanographic Commission (UNESCO-IOC), ISDR and other key partners at the international, regional, and national levels to contribute its relevant capabilities to the development of end-to-end tsunami early warning systems in the Indian Ocean and other regions at risk. WMO is also committed to developing the capabilities of the NMHSs of the Indian Ocean Rim countries to establish an effective tsunami early warning system within a multi-hazard framework, particularly related to national multi-hazards alert and response mechanisms. However, the value of this effort applies not only to all the Indian Ocean Rim countries, but also to all regions at risk. WMO has developed and initiated several concrete projects and is working towards raising resources to assist its Members in the region. These projects are outlined in the following paragraphs.

8.3.8 The WMO Global Telecommunication System (GTS) is being upgraded, where needed, to address requirements for tsunami-related information exchange in the Ocean Indian Rim. The GTS already provides for the exchange of warnings related to cyclones and severe weather, including in the Indian Ocean region, and supports the current Pacific Tsunami Warning System in the Pacific basin. The GTS, including its satellite-based telecommunications sub-systems and the data-collection and data-distribution components of meteorological satellites, will support the exchange of tsunami warnings and related information in the Indian Ocean Rim. The WMO GTS is being upgraded, where needed, to address requirements for tsunami-related information exchange for the interim period and

longer term. WMO held a multi-disciplinary workshop from 14 to 18 March, 2005 in Jakarta, Indonesia, during which it developed a detailed plan for upgrading the GTS and identified twelve countries in need of equipment upgrades, including:

Asia: Bangladesh, Maldives, Myanmar, and Sri Lanka
Arab Region: Yemen
Africa: Comoros, Djibouti, Kenya, Madagascar, Seychelles, Somalia, and Tanzania

8.3.9 Furthermore, Indonesia, Pakistan and Thailand indicated their need for GTS upgrades. GTS Expert Teams visited the NMHSs of these countries in July through September of 2005 and identified specific GTS equipment needs of each country. A meeting of experts was held in October 2005 at the WMO Secretariat to review and consolidate the experts visits reports and other relevant information to develop concrete upgrade plans for the GTS in these countries. The United States has indicated its support for GTS upgrades for Sri Lanka, Indonesia, Maldives and Thailand, with further details to be provided at a later date.

8.3.10 The Meeting noted that the WMO's workshop on operational concepts of Early Warning Centres (Singapore, 21-23 November 2005) proved very valuable as it provided a sound platform for the discussion on the regional tsunami warning centres. During this meeting, WMO experience with operational World Meteorological Centers (WMC) and Regional Specialized Meteorological Centers (RSMCs) were discussed particularly related to operational procedures, requirements and accreditation process. The outcome of this meeting was presented at the second Intergovernmental Coordination Group for Indian Ocean Tsunami Warning System (ICG-IOTWS) in Hyderabad, India (14-16 December 2005). Several elements of WMO's WMC/RSMC systems were taken on board by the ICG-IOTWS.

8.3.11 WMO is assisting in the enhancement of multi-hazard national warning alert mechanisms of the NMHSs to support 24/7 dissemination of tsunami warnings, and to raise public awareness through development of their educational and public outreach programmes in support of the round-the-clock dissemination of tsunami warnings to authorities, general public and the mariners. Currently, most Indian Ocean Rim Countries have designated their NMHSs as their tsunami focal point. Under the coordination of UNESCO-IOC, expert teams including tsunami expert and representatives from IOC, WMO, ISDR and other agencies have completed national assessment visits to 16 countries of which nine are in the southwestern Indian Ocean. As the first step, WMO has carried out a preliminary survey of NMHSs to identify their needs related to enhancing warning dissemination and their education and outreach programmes. As part of the expert visits, WMO investigated the needs and requirements of the NMHSs, for dissemination of tsunami warnings as part of the multi-hazard approach.

8.3.12 WMO, through its Space Programme, is uniquely qualified as the sole intergovernmental organization responsible for the coordination of the complete global set of environmental satellites. Not only are satellite systems the only truly global observing system but they also provide a global capability for data collection from remote sites including ocean areas as well as the ability to disseminate information immediately to users at the local, regional and global levels. Disaster prevention and mitigation for all hazards represent an area where satellite system capabilities are a fundamental tool to increase capacity building in all countries, especially in developing countries.

8.3.13 WMO has developed a plan of action to identify specific observing capabilities presently available from existing satellite systems but not yet utilized in alert mechanisms, data-collection needs as well as contribution to dissemination systems made possible through environmental satellite systems. The improved satellite system capabilities will directly support NMHSs and other agencies. A consolidated statement of needs to which space agencies can respond will be developed through a series of regional workshop with participation of experts from Indian Ocean Rim countries and space agencies to identify local, regional and global requirements as well as to increase awareness of existing and planned

improvements though enhanced satellite system utilization. Longer-term improvements to satellite systems will also be identified in the development of the consolidated plan.

8.3.14 WMO, together with its partners, will also ensure that the tsunami and other hazard observation and monitoring requirements are incorporated in the implementation plan for the Global Earth Observing System of Systems (GEOSS) to ensure that this critical aspect is part of the GEOSS Work Programme.

8.3.15 The Meeting noted that there is need for a multi-hazard approach to the development of the tsunami early warning system in the Indian Ocean. However, all efforts on the regional level are solely focused on tsunami related issues. WMO continues to promote the benefits of a multi-hazard approach to the tsunami early warning system and significantly contribute to its implementation. WMO has initiated an effort to define and develop a "multi-hazard" approach to early-warning capabilities by defining synergies among the grouping of hazards.

8.3.16 The Meeting agreed that it is critical to ensure that the tsunami early warning system in the Indian ocean is linked with the existing tropical cyclone, floods and storm surge early warning systems to maximize the benefits of these capabilities for saving of life and property in the coastal regions.

8.3.17 WMO participated in the activities of all the working groups established under the ISDR framework, including the ad hoc group on drought. Regular El Niño monitoring, El Niño outlooks and the establishment of the International Research Centre for El Niño in collaboration with the Government of Ecuador were tangible results of those activities. Projects to establish a climate alert system and to link climate and disaster databases on floods were developed.

8.3.18 WMO participated actively in the Second International Conference on Early Warning that aimed to achieve better integration of early warning into public policy. It also collaborated in the review of the Yokohama strategy.

8.3.19 WMO is a member of the ProVention Consortium and is represented in the Consortium Steering Committee. The Consortium aims at helping developing countries to cope with disasters. WMO is also a Special Supporting Organization of the International Consortium on Landslides, which aims to promote related research and capacity building.

8.3.20 WMO initiated the Programme on Natural Disaster Prevention and Mitigation, one of the main objectives of which is to develop a mechanism to respond to the requirements of Members and to ensure that WMO participates fully in the ISDR.

Activities of UNESCAP

8.3.21 UNESCAP continued the implementation of the project on enhanced national capacity on assessing socio-economic impacts of natural disasters in Asia in cooperation with UNDP and the United Nations Economic Commission for Latin America and Caribbean (ECLAC), with special emphasis on the methodology developed by ECLAC for this purpose. Further to the regional workshop, held in May 2004 to review existing methodologies in the region and examine the ECLAC methodology, a series of case studies were carried out in seven countries, including three Members of the Panel, namely Pakistan, Sri Lanka and Thailand. The tsunami disaster in the Indian Ocean, which led to the adoption of the ECLAC methodology by the World Bank, Asian Development Bank (ADB), Japan Bank for International Cooperation (JBIC) and the United Nations for assessing impacts of the Tsunami disaster in all the major tsunami-affected countries, has boosted the commitment of all seven participating countries to adopt the ECLAC methodology. This commitment had encouraged UNESCAP to invest further efforts towards standardize the methodology using experiences in the region. The concluding workshop of this project was held in Bangkok in October 2005 to

synthesize the experiences of the seven countries and identify priority activities for further action. The Panel Members are encouraged to use the methodology for better integration of disaster reduction activities into the development process.

8.3.22 In parallel, UNESCAP has established a trust fund with the contribution of US\$ 1 million by the Government of Republic of Korea to implement three pilot community-based projects in three tsunami-affected countries, including India and Sri Lanka. The pilot projects are expected to start in March 2006. UNESCAP has also established a regional trust fund to assist in regional tsunami early warning arrangements for the Indian Ocean and South-East Asia in September 2005 with a contribution of US\$ 10 million from Thailand and US\$2.5 million from Sweden. Detailed guidelines on application on the use of the regional trust fund are expected to be available soon.

8.3.23 In 2005, UNESCAP in cooperation with the Asian Disaster Preparedness Centre (ADPC) launched Phase III of the project on Partnership for Disaster Reduction – South-East Asia, which was funded by the Humanitarian Aid Office of European Commission (ECHO). The project provided opportunities to assist the target countries in their efforts to integrate community-based disaster risk management into the respective national socio-economic development processes.

8.3.24 UNESCAP in cooperation with ADPC and the ISDR Asia Partnership organized the Annual Forum on Natural Disaster Reduction on 12 October 2005 to commemorate the International Day for Natural Disaster Reduction at the United Nations Conference Centre in Bangkok. The event included also the presentation of the United Nations Sasakawa Award for 2005, which was held in Asia for the first time in the history of the Award.

Activities of other international organizations

Secretariat of the United Nations International Strategy for Disaster Reduction (ISDR)

8.3.25 The representative of ISDR, Dr Yuichi Ono, briefed the Panel of its activities relevant to the work of the Panel on DPP, including the assessment of capacity of various countries affected by the December 2005 Tsunami on early warning, and the Third Early Warning Conference (EWC-3) to be held in Germany in March 2006. He briefed in some detail the organization of ISDR Secretariat and the Hyogo Framework for Action (HFA), which was adopted at the World Conference on Disaster Reduction, held in Kobe in January 2005. He encouraged the Panel Members to link its programme of work to HFA to benefit from the increased commitment to disaster reduction by all countries and donor communities within HFA. He also informed the Panel of the establishment of the ISDR Asia Partnership, consisting of ISDR, Asian Disaster Preparedness Center (ADPC), ADRC, UNDP, UNESCAP and OCHA to support the implementation of the HFA.

8.3.26 On behalf of the Asian Disaster Reduction Center (ADRC), Dr Ono informed the Panel of the Asian Conference on Disaster Reduction (ACDR) to be held in Seoul, Republic of Korea from 15 to 17 March 2006. On behalf of ISDR Asia Partnership, he encouraged Panel Members to share their experiences on the implementation of the HFA at the Seoul ACDR.

8.4 Training (agenda item 8.4)

8.4.1 The Panel reviewed the involvement of its Members in various education and training activities supported under WMO Voluntary Cooperation Programme (VCP), regular budget (RB), UNDP and Technical Cooperation Among Developing Countries (ACDC) arrangements.

8.4.2 The Panel noted the number of training events and workshops, which were organized in 2005 for the benefit of its Members. Since its last session, the Panel had

benefited from WMO's education and training activities, relating to the award of fellowships, relevant training courses, workshops, seminars, the preparation of training publications, and the provision of advice and assistance to Members.

8.4.3 The Panel noted that WMO fellowships for long-term and short-term training continued to be granted to the Member countries of the Panel under the various WMO programmes.

8.4.4 The Panel expressed appreciation to Panel Member countries which offered their national training facilities to other Members under bilateral arrangements. These cooperative efforts by the Panel Members have been found by the recipient countries to be very useful, and the Panel strongly recommended that such endeavours should continue in the future and be strengthened. The Panel urged its Members to make maximum use of such training facilities.

8.4.5 The Panel was pleased to note the successful two week attachment of three tropical cyclone forecasters (from Maldives, Oman and Thailand) at the RSMC New Delhi in October 2005. The Panel requested that RSMC New Delhi continue to provide for the attachment of forecasters from the Members and that TSU, WMO and UNESCAP to support this activity.

8.4.6 The Panel expressed appreciation to IIT Kharagpur and Prof. Dube for indicating that the Institute will organize in 2006, attachment of storm surge forecasters from Bangladesh and Pakistan (see para 7.3). It also expressed its gratitude to Prof. Dube for accepting the Panel's request for him to chair the project on institutionalizing the storm surge training module.

8.4.7 The Panel was also pleased that operational tropical cyclone forecasters from Bangladesh, Oman and Sri Lanka participated at the 2005 Miami hurricane workshop.

8.4.8 A summary report on the 2005 training activities and future training plans of Members is given in **Appendix IX**.

8.5 Research (agenda item 8.5)

8.5.1 The Panel was informed that the International Workshop on Tropical/Extra-tropical Interaction, incorporating IWET-III was held in Perth, Australia in December 2005 to develop a scientific plan, which focused on extra-tropical transition of tropical cyclones in conjunction with the THORPEX Pacific Asian Regional Campaign and the International Polar Year during 2008. This project would contribute to improving further safety and to reducing the economic losses of land-falling tropical cyclone affected countries.

8.5.2 The Panel was pleased to note that steps are underway to organize the Sixth International Workshop on Tropical Cyclones (IWTC-VI), which will be held in San José, Costa Rica from 21-30 November 2006 with the theme "Quantitative Forecast Guidance for Tropical Cyclone Landfall in Relation to an Effective Warning System", which was considered by the Panel to be a timely topic given the devastation caused by tropical cyclones in both the Atlantic and the Pacific in 2005. The Panel is represented by Mr Subramanian (India) in the International Committee for IWTC-VI, which is responsible for the preparation and organization of the workshop. Members of the Panel are urged to actively participate in the said Workshop.

8.5.3 A summary report on the 2005 research activities and the future research activities of the Panel Members is given in **Appendix X**.

8.6 Storm surge project (agenda item 8.6)

8.6.1 The Panel noted with pleasure the submission of Bangladesh and Sri Lanka of their National Storm Surge Project Proposals.

8.6.2 The Panel was informed that Thailand had received government approval of their storm surge project under the integrated storm surge – tsunami early warning project.

8.7 Publications (agenda item 8.7)

Publications issued under the programmes of the Panel fall into two categories (a) Panel News, and (b) the Annual Review of the Tropical Cyclones affecting the Bay of Bengal and the Arabian Sea. Information on the current status of each is presented below:

(a) Panel News

Panel News No.22 is under preparation and will be published soon by TSU and subsequently distributed to the Members.

(b) Annual Review

The Panel on Tropical Cyclones Annual Review for the year 2004 which was consolidated and finalized by the Chief Editor, Mr S.R. Kalsi (India), with contributions from the National Editors will be submitted to WMO in March 2006 for publication as soon as possible. In this regard, the Panel expressed its appreciation to the Chief Editor and the National Editors of the Review. The Editorial Board for the 2005 annual review is given in **Appendix XI**.

9. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN (Agenda item 9)

9.1 The basic purpose of the operational plan is to facilitate the most effective tropical cyclone warning system for the region with existing facilities. In doing so the plan defines the sharing of responsibilities among Panel countries for the various segments of the system and records the coordination and cooperation achieved. The plan contains the agreed arrangements for standardization of operational procedures, efficient exchange of various data related to tropical cyclone warnings, archival of data and issue of a tropical weather outlook for the benefit of the region, from a central location having the required facilities for this purpose, that is RSMC -tropical cyclones New Delhi, as agreed upon by the Panel.

9.2 The operational plan contains an explicit formulation of the procedures adopted in the Bay of Bengal and the Arabian Sea region for the preparation, distribution and exchange of information and warnings pertaining to tropical cyclones. Experience has shown that it is a great advantage to have an explicit statement of the regional procedures to be followed in the event of a cyclone and this document is designed to serve as a valuable source of information to be readily available for reference by the forecaster and other users, particularly under operational conditions.

9.3 The Panel noted that a lot of changes have to be incorporated to the text of the Operational Plan (2005 Edition). The Acting Director General of the Indian Meteorological Department (IMD) suggested that Mr S.K. Subramanian (India) continue serving as a focal point for the editorial changes or minor amendments necessary with a view to issuing an updated Edition of the Operational Plan as early as possible. To this effect, the Panel urged the Members to communicate their amendments, if any, by 28 February 2006 to Mr Subramanian who kindly agreed to finalize the 2006 edition of the Operational Plan.

9.4 The Panel proposed changes to some of the tropical cyclone names in the current list. However, as Myanmar was not represented in the session it was agreed that WMO will coordinate with Myanmar on the needed changes in names and that the updated list be

finalized before the end of February 2006. The Panel also requested Pakistan to propose two names to the current list.

9.5 In recognition of the need to further harmonize the warning system within the region, the Panel discussed at length the different practices used for the classification of cyclonic disturbances by the Members. It finally agreed on a common classification of tropical cyclones for the Panel Region, which will be included in the updated TCP-21.

9.6 The Panel requested WMO to issue the 2006 Edition of TCP-21 as soon as possible.

10. Technical Support Unit (Agenda item 10)

10.1 The Panel expressed its gratitude to the Government of Pakistan for hosting the Technical Support Unit (TSU) and appreciated the services being rendered by Dr Qamar-uz-Zaman Chaudhry, Director-General of Pakistan Meteorological Department (PMD) in his capacity as TSU Coordinator. It also thanked Mr Umar Hayat Ghalib who had served as the TSU Meteorologist for the past five years and wished him all the best in his retirement. The Panel welcomed Ms Asma Younas as the new TSU Meteorologist and wished her success in her assignment.

10.2 The Panel was briefed by the new TSU Meteorologist on the activities of TSU during the intersessional period. The Panel expressed its satisfaction with the work of the TSU.

10.3 The Panel was informed that, on account of belated receipt of contributions/materials from the Panel News correspondents, the 22nd issue of the Panel News is still under preparation but will soon be published for subsequent distribution to the Members.

10.4 TSU provided the Panel with a detailed breakdown of its expenses incurred by the TSU during the Inter-sessional period (see **Appendix XII**).

11. SUPPORT FOR THE PANEL'S PROGRAMME (Agenda item 11)

11.1 The Panel was briefed on the activities of the WMO's Technical Cooperation Programme (TCO). The Panel expressed its appreciation to the WMO Secretariat for its continued support to its Members by providing support through Voluntary Cooperation Programme (VCP) and implementing projects. It urged its Members to increase their support and give priority to the WMO/VCP and TCDC.

11.2 The Panel encouraged its Members to approach the various national economic sectors in the effort to mobilize resources for the Panel's activities.

11.3 The Panel noted with appreciation that WMO and UNESCAP would continue to undertake activities in support of the Panel on Tropical Cyclones.

Panel on Tropical Cyclones Trust Fund (PTCTF)

11.4 The establishment of the Panel on Tropical Cyclones Trust Fund (PTCTF) indicated a step towards achieving self-reliance of the Panel. At the moment, the Fund is being used not only for the provision of institutional support but also as funding support to representatives of Panel Members attending training events and conferences.

11.5 Members were urged to continue to enhance their contributions to the Trust Fund as a substantial support for the Panel's activities.

11.6 The Panel endorsed the use of the Trust Fund for 2006 for the following specific purposes:

- (i) Supplemental support for the attendance of storm surge experts from Members of the Panel to the Fourth Regional Workshop on Storm Surge and Wave Forecasting- A Hands-on Forecast Laboratory to be held in Manila, Philippines in September 2006 (US\$ 2,000);
- (ii) Supplemental support for the attendance of tropical cyclone experts from Members of the Panel to the Sixth International Workshop on Tropical Cyclones to be held in San Jose, Costa Rica in November 2006 (US\$ 4,000);

(Total: US\$ 6,000)

- (iii) Any other emergency expenditure that can be justified for the use of the PTCTF requires the concurrence of both the TSU Coordinator and the Panel on Tropical Cyclones Chairman.

11.7 A detailed financial report on the Trust Fund as of 31 December 2005 was submitted to the Thirty-third session of the Panel (see **Appendix XIII**).

12. SCIENTIFIC LECTURES (Agenda item 12)

12.1 The Panel devoted part of the time at the session to the presentation of lectures and technical discussions. The list of presentations is as follows:

- (a) Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards in the Panel Region and Early Warning of Tsunami Arrivals – Prof Shishir Kumar Dube (Indian Institute of Technology);
- (b) Early Warning System for Major Natural Disasters in India – Mr Bhukan Lal (India);
- (c) The Behaviour of Cyclones (May 1991 and September 1997) in the Bay of Bengal and their influence on the thermodynamic property of troposphere over Bangladesh – Mr Abdul Mannan (Bangladesh);
- (d) Recent Experiences in assessing socio-economic impacts of hydro-meteorological disasters in Asia - Mr Le Huu Ti (UNESCAP);
- (e) Early Warning Systems and Disaster Management of all Meteorological and Hydrological Hazards – Sri Lanka scenario – Mr. G.B. Samarasinghe (Sri Lanka);
- (f) Disaster Management in China - Mr Ye Xiaodong (China).

12.2 The Panel expressed its deep appreciation to the above lecturers for their informative and excellent presentations.

12.3 The Panel welcomed and expressed its appreciation for the participation and contributions of Prof. Shishir Kumar Dube and Mr Ye Xiaodong, observers from IIT and China respectively to this session. It encouraged the continued participation of IIT and China in the work of the Panel.

13. DATE AND PLACE OF THE THIRTY-THIRD SESSION (Agenda item 13)

13.1 The representative of Maldives informed the Committee of their willingness to host the next session in 2007 subject to their government's approval. Oman is willing to host the session in case Maldives does not get government approval. However, Oman's offer is also subject to the approval of his government.

13.2 The Panel expressed its deep appreciation to the Government of Maldives and the Sultanate of Oman for considering to host the Panel's session in 2007.

13.3 The exact dates and venue of the next session would be determined based on consultation between WMO, UNESCAP, the host, Chairman of the Panel and TSU Coordinator. In determining the dates for the next session, RSMC New Delhi suggested February 2007 or later will give the centre sufficient time to finalize the annual report on cyclonic disturbances over the North Indian Ocean.

14. ADOPTION OF THE REPORT (Agenda item 14)

The report of the thirty-third session was adopted at 1255 hours on 4 February 2006.

15. CLOSURE OF THE SESSION

15.1 The Panel expressed its sincere appreciation to the Government of Bangladesh, the host country, for providing the excellent facilities, the venue, other arrangements and its warm hospitality. The Panel also expressed its deep appreciation to Mr Md. Akram Hossain, Chairman of the Panel, Mr Badar Al-Rumhi, vice-Chairman of the Panel as well as Mr S.K. Subramanian, Chairman of the Drafting Committee, for their successful conduct of the session. The Panel wished to express its gratitude to Dr Samarendra Karmakar (Chairman, LOC), Mr Nur Mohammad Miah (Coordinator, LOC), officers and staff of BMD for their hard work in organizing the session, assistance provided to the participants, for producing a session report, which is definitely of high quality and for providing a copy of the presentations and photos in CD-ROMs to all the participants.

15.2 The Panel expressed its gratitude to the BMD for arranging the visit to its offices and to several interesting places in the city of Dhaka.

15.3 The thirty-third session of the Panel was concluded on 4 February 2006 at 1420 hours.

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LIST OF PARTICIPANTS

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APPENDIX II

AGENDA

1. OPENING OF THE SESSION
2. ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN
3. ADOPTION OF THE AGENDA
4. WORKING ARRANGEMENTS
5. FOLLOW-UP ACTION ON PTC-32
6. REVIEW OF THE 2005 CYCLONE SEASON
7. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME
8. REVIEW OF THE COORDINATED TECHNICAL PLAN AND CONSIDERATION OF THE WORK PROGRAMME FOR THE NEXT FIVE YEARS
 - 8.1 Meteorological component
 - 8.2 Hydrological component
 - 8.3 Disaster prevention and preparedness component
 - 8.4 Training component
 - 8.5 Research component
 - 8.6 Storm Surge Project
 - 8.7 Publications
9. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN
10. TECHNICAL SUPPORT UNIT
11. SUPPORT FOR THE PANEL'S PROGRAMME
12. SCIENTIFIC LECTURES
13. DATE AND PLACE OF THE THIRTY- FOURTH SESSION
14. ADOPTION OF THE REPORT
15. CLOSURE OF THE SESSION

APPENDIX III

ACTION SHEET

THIRTY-SECOND SESSION OF THE WMO/ESCAP PANEL ON TROPICAL CYCLONES

(New Delhi, India, 21 to 26 February 2005)

Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
1	Hosting of the session	Letter of appreciation to India.	WMO (TCP)	ASAP	Letter sent 19 May 2005
4.3	Extending the Area of Responsibility of RSMC New Delhi Area	RSMC New Delhi to make a formal request to WMO summarizing the technical and legal background of the issue.	RSMC New Delhi	SAP	
4.4	Landfalling tropical cyclones	Address the issue of landfalling tropical cyclones.	Research Community/WMO (PTR)	ASAP	
5.5	Attachment Training at the Indian Institute of Technology (IIT) Kharagpur	Arrange attachment of two forecasters, one from Myanmar and one from Pakistan to IIT for training in implementing and running a storm surge/wave model.	WMO (TCP)	Aug 2005	08-19 Aug 2005
5.7	Workshop on Hurricane Forecasting and Warning	Consider inviting a cyclone expert from the Panel to be one of the resource persons in future workshops.	WMO (TCP)	Oct 2005 for the 2006 workshop	
6.0.1	Coordinated Technical Plan (CTP)	Distribute for comments the draft CTP submitted by the Chairman of the Working Group to all Members, TSU, WMO and ESCAP.	TSU	ASAP	
6.1.4	Observational Programme and Data Exchange	Take necessary action to ameliorate its implementation in particular upper-air observations and data exchange.	Members		Continuous activity

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Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
6.1.18	Tropical Cyclone Names	Review the implementation of the naming of tropical cyclones in the Panel area and report at the next session.	Members	33rd session of the Panel	
6.1.23	Aeronautical Fixed Telecommunication Network (AFTN)	Review the AFTN addressing used by TCAC New Delhi and MWOs	TCAC New Delhi and ICAO	ASAP	
6.2.10 and 6.8.1	Integrated Tsunami and Storm Surge Early Warning System (ITSSEWS)	(a) Set up an ITSSEWS; (b) Assess the needs of Members for enhancing the capabilities of NMHSs in the establishment of an ITSSEWS.	Members WMO (RCD)	ASAP ASAP	
6.3.19	(a) Additional Web site for the Panel (b) ADRC's Visiting Research Programme	(a) Develop an additional Web site for the Panel, complementing the existing Web site developed by TSU; (b) Apply for the Visiting Research Programme.	ADRC, TSU, WMO, UNESCAP Members who are ADRC member countries	ASAP ASAP	
6.4.4	National Training Facilities	Make maximum use of national training facilities of other Members.	Members		Continuous activity
6.4.6	Attachment of forecasters at the RSMC New Delhi	Arrange attachment of three forecasters one from Maldives, one from Oman and one from Thailand at RSMC New Delhi in October 2005.	WMO (TCP)	October 2005	
6.7.3	Regional Early Warning System on Storm Surge	Establish an effective regional early warning system on storm surge in the Panel area.	Members	ASAP	
7.3 7.4	Tropical Cyclone Operational Plan for the Bay and the Arabian Sea (WMO/TD-No. 84)	(a) Communicate amendments of the plan to the focal point; (b) Issue updated Operational Plan (2005 edition).	Members WMO (TCP)	15 March 2005 ASAP	

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Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
9.1	Technical Cooperation Programme (TCO)	Increase support and give priority to the WMO/VCP and TCDC.	Members		Continuous activity
9.2	Resource Mobilization	Approach the various national economic sectors in the effort to mobilize resources for the Panel's activities.	Members		Continuous activity
9.5	Panel on Tropical Cyclones Trust Fund (PTCTF)	Enhance contributions to the PTCTF.	Members		
10.4	Numerical Weather Prediction Models and Products	Request advanced global numerical weather prediction centres to provide their initial and boundary conditions to Panel Members.	WMO (TCP)	ASAP	
10.5	Consensus tropical cyclone forecasts	Undertake a study on the use of consensus forecasts by warning centres worldwide.	WMO (AREP)	ASAP	
10.6	Modified SAFFIR-SIMPSON scale for tropical regions and the IMD version	Distribute to Members the Modified SAFFIR-SIMPSON scale for tropical regions and the IMD version and upload in the TCP and Forecaster's Web sites.	WMO (TCP)	ASAP	
10.9	Technical Conference	(a) Organize a technical conference during 33 rd PTC session; (b) Select a theme for the technical conference.	TSU Chairman in consultation with Members, WMO and UNESCAP	ASAP ASAP	 Nov 2005

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Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
11.	Thirty-third Panel session	(a) Send to WMO early confirmation of the hosting; (b) Determine exact dates and venue; (c) Prepare provisional agenda and documentation plan.	Bangladesh WMO (TCP), UNESCAP, host, TSU, and Chairman of the Panel WMO (TCP) in consultation with UNESCAP and TSU	Jul 2005 Aug 2005 Sep 2005	

2005 CYCLONE SEASON SUMMARY

CYCLONIC ACTIVITIES OVER NORTH INDIAN OCEAN DURING 2005

The year-2005, was a year of near normal cyclonic activity over north Indian Ocean. This basin witnessed the formation of twelve disturbances (Table 2.1) (against a normal of fifteen). Out of twelve disturbances, four (against a normal of five to six) intensified into cyclonic storms and three concentrated only upto deep depressions. There was one land depression during this year. Tracks of the systems are shown in fig. 2.

The Arabian Sea was less active and was devoid of any cyclonic storm. Only two depressions formed over that basin. On the other hand, the Bay of Bengal was more active with formation of four cyclonic storms, three deep depressions and two depressions during the year.

The first system, Cyclone “**HIBARU**”, developed from a low pressure area which concentrated into a depression over southwest Bay of Bengal and adjoining Indian Ocean on the evening of 13th January, 2005. It remained practically stationary and intensified into a deep depression on the morning of 14th and into a cyclonic storm on the morning of 15th. Moving slowly in a westerly and then in a west-southwesterly direction it maintained its intensity till the morning of 17th, when it weakened into a deep depression and then into a depression on the same afternoon. On the same night, the system further weakened into a low pressure area over southwest Bay of Bengal and adjoining Indian Ocean.

The cyclone “**PYARR**”, developed from a low pressure area over eastcentral Bay of Bengal on 16th September, 2005. Subsequently it intensified into a depression on 17th morning. The system initially moved in a west-northwesterly direction and then in a westerly direction and intensified into a deep depression in the morning of 18th. Subsequently the system moved in a southwesterly direction and intensified into a cyclonic storm in the same evening. Continuing to move in a southwesterly direction, the cyclone “**PYARR**” crossed north Andhra Pradesh coast close to Kalingapatnam in the morning of 19th. It remained as a cyclonic storm over north coastal Andhra Pradesh close to Kalingapatnam till the evening of 19th. It then moved west-northwestwards and weakened gradually into deep depression and then as a depression. On 22nd morning, it was seen as a well marked low pressure area over western parts of central India.

The third system formed from a well marked low pressure area which was seen over south Andaman sea and adjoining southeast Bay of Bengal on the morning of 27th November, 2005. It concentrated into a depression on the morning of 28th. Moving in a westerly direction, it intensified into a cyclonic storm “**BAAZ**” around midnight of 28th. Thereafter it moved swiftly in a northwesterly direction till the same evening. Then “**BAAZ**” became sluggish in its movement and hovered around the area till the morning of 01st December, 2005. Thereafter the system moving in a northwesterly direction, gradually weakened and dissipated over sea itself on the morning of 02nd December.

The cyclonic storm “**Fanoos**”, developed from a low pressure area over south Andaman Sea. It intensified in to a depression and lay over southeast Bay of Bengal in the morning of 06th December 2005. Moving in a northwesterly direction, it further intensified into a deep depression in the same afternoon. Thereafter, it took a steady westerly direction and intensified into a cyclonic storm in the morning of 07th. It had southwestward movement till the morning of 08th. Thereafter it moved westwards till 10th morning. On 10th morning due to proximity to land, it weakened into a deep depression and crossed north Tamilnadu coast south of Nagapattinam (close to Vedaranyam) around 0530 UTC. After landfall, it rapidly weakened into a depression at 0600 UTC of the same day. Moving in a westerly direction, it weakened further into a low pressure area in the morning of 11th December.

Comprehensive information on Tropical Cyclone activity over the north Indian Ocean for last five years is given in table 2.2. The frequency of cyclonic disturbances over the north Indian Ocean was highest after 1992.

Some of the characteristic features of these twelve cyclonic disturbances are given in Table 2.3. The statistical data pertaining to the monthly frequencies, total life time (days), frequency distribution (intensity-wise and basin-wise) are given in Table 2.4.

RSMC, New Delhi mobilized all its resources, both technical and human, to track these tropical disturbances that formed over the north Indian Ocean and issued timely advisories to WMO / ESCAP Panel countries.

Salient features :

- The formation of cyclonic storm in the month of January over low latitude is very rare, last such occurrence was in the year 1987 (30 Jan. – 4 Feb, over the Bay of Bengal). Though the system attained and remained as cyclonic storm for about two days, its movement was very sluggish (only about 50 km per day).
- No cyclonic disturbance developed over north Indian Ocean during the pre-monsoon season (April – May).
- Monsoon season was quite active, compared to recent years in the past with the formation of one cyclonic storm and five depressions / deep depressions.
- During post monsoon season (October- December), systems formed over the southern latitude and had their movement restricted only upto 15 degree north. Most of the systems during this period weakened before the landfall due to large vertical wind shear.
- No system intensified beyond the stage of cyclonic storm.

List of cyclonic disturbances during 2005

1.	Cyclonic Storm "HIBARU" over the Bay of Bengal, January 13-17
2.	Depression over the Arabian Sea, June 21-22
3.	Land depression June 27- July 05
4.	Deep Depression over the Bay of Bengal, July 29-31
5.	Depression over the Bay of Bengal, September 12-16
6.	Depression over the Arabian Sea, September 14-16
7.	Cyclonic Storm "PYARR" over the Bay of Bengal, September 17-21
8.	Deep Depression over the Bay of Bengal, October 26-29
9.	Depression over the Bay of Bengal, November 20-22
10.	Cyclonic storm " BAAZ" over the Bay of Bengal, November 28 - December 02
11	Cyclonic storm "FANOOS" over the Bay of Bengal, December 06-10
12	Deep Depression over the Bay Bengal, December, 15- 22

Table 2.2

**The frequency of cyclonic disturbances over north Indian Ocean
and adjoining region during 2000-2005**

Year		D	DD	CS	SCS	VSCS	Total
2000	BOB	1	--	3	--	2	6
	ARB	--	--	--	--	--	-
2001	BOB	2	--	1	--	--	3
	ARB	--	--	2	--	1	3
2002	BOB	1	1	2	1	--	5
	ARB	--	--	1	--	--	1
2003	BOB	2	2	--	1	1	6
	ARB	--	--	--	1	--	1
2004	BOB	2	--	--	--	1	3
	ARB	--	2	--	3	--	5
	LAND	2	--	--	--	--	2
2005	BOB	2	3	4	--	--	9
	ARB	2	--	--	--	--	2
	LAND	1	--	--	--	--	1

D: Depression**SCS:** Severe Cyclonic Storm**BOB:** Bay of Bengal**DD:** Deep Depression**VSCS:** Very Severe Cyclonic Storm**ARB:** Arabian Sea**CS:** Cyclonic Storm

Table 2.3

Some Characteristic features of cyclonic disturbances during 2005

Cyclonic Storm / Depression	Date, Time (UTC) & lat. ^o N / long. ^o E of Genesis	Date, Time (UTC) place of landfall/ dissipation	Estimated lowest central pressure, Date & Time (UTC) & lat. ^o N / long. ^o E	Estimated Maximum wind speed (kt), Date & Time	Maximum T. No. attained
Cyclonic Storm "HIBARU" over Bay of Bengal, January 13-17	January 13, 1200 UTC near 5.5 / 87.0	Weakened over southwest Bay of Bengal in the night of January 17	1000 hPa at 0600 UTC on January 15 near 5.5/87.0	35 kt at 0300 UTC on January 15	T 2.5
Depression over Arabian Sea, June 21-22	June 21, 0300 UTC near 21.5 / 68.5	Weakened over northeast Arabian Sea around morning of June 23	992 hPa at 0300 UTC on June 21 near Porbandar (42830)	25 kt at 0300 UTC on June 21	T 1.5
Land depression, June 27 -July 05	June 27, 1200 UTC near 21.5 / 88.0	Weakened over northwest Madhya Pradesh and adjoining west Uttar Pradesh in the morning of July 06	990 hPa at 1200 UTC on June 27 near 21.5/88.0	25 kt at 1200 UTC on June 27	
Deep Depression over Bay of Bengal, July 29-31	July 29, 0300 UTC near 21.5 / 87.5	Crossed Orissa coast close to Balasore (42895) around noon of July 30	988 hPa at 1200 UTC on July 30 near 21.5/85.5	30 kt at 0300 UTC July 30	T 2.0
Depression over Bay of Bengal, September 12-16	September 12, 0300 UTC near 20.0 / 88.0	Crossed Orissa coast near Paradip (42976) around afternoon of September 12	992 hPa at 0300 UTC on September 12, near 20.0/88.0	25 kt at 0300 UTC on September 12	T 1.5
Depression over Arabian Sea September 14-16	September 14, 0300 UTC near 20.0/ 68.5	Crossed north Saurashtra coast north of Porbandar (42830) around midnight of September 16	996 hPa at 0300 UTC on September 14, near 20.0/68.5	25 kt at 0300 UTC on September 14	T 1.5
Cyclonic Storm "PYARR" over Bay of Bengal, September 17-21	September 17, 0300 UTC near 20.0 / 90.5	Crossed Andhra Pradesh coast near Kalingapatnam (43105) in the morning of Sept. 19	988 hPa at 2100 UTC on September 18, near 18.5/84.5	40 kt at 1800 UTC on September 18	T 2.5

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Deep Depression over Bay of Bengal, October 26-29	October 26, 0300 UTC near 12.0/ 84.5	Crossed south Andhra Pradesh coast near Ongole (43221) in the afternoon of October 28	998 hPa at 0600 UTC on Oct. 27 near 13.0/81.5	30 kts at 1800 UTC on October 26	T 2.0
Cyclonic Storm / Depression	Date, Time (UTC) & lat. °N / long. °E of Genesis	Date, Time (UTC) place of landfall/ dissipation	Estimated lowest central pressure, Date & Time (UTC) & lat. °N. / long. °E	Estimated Maximum wind speed (kt), Date & Time	Maximum T. No. attained
Depression over Bay of Bengal, November 20-22	November 20, 0300 UTC near 8.0/ 84.5	Crossed Sri Lanka coast around 00 UTC of Nov. 22	1002 hPa at 0300 UTC on November 20	25 kt at 0300 UTC on Nov. 20	T 1.5
Cyclonic storm "BAAZ" over Bay of Bengal, November 28 – December 02	November 28, 0300 UTC near 10.5/ 90.5	Weakened over southwest and adjoining westcentral Bay of Bengal on December 02 around noon	998 hPa at 0600 UTC on November 29 Near 11.0/86.0	45 kt at 0300 UTC on November 29	T3.0
Cyclonic storm "FANOOS" over Bay of Bengal, December 6-10	December 06, 0300 UTC near 10.5° N/89.5° E	Crossed Tamilnadu coast; Close to Vedaranyam (43349) south of Karaikal (43346) the forenoon of December 10	998 hPa at 0900 UTC on December 7 near 11.0/86.5	45 kt at 0900 UTC on Dec. 7	T3.0
Deep Depression over Bay of Bengal, Dec. 15-22	December 15, 1200 UTC near 8.0/ 87.0	Weakened over southwest and adjoining central Bay of Bengal on December 22 forenoon	1000 hPa at 0300 UTC on December 17 Near 8.0/84.0	30 kt at 0300 UTC on December 17	T 2.0

Table 2.4

**Statistical data relating to cyclonic disturbances
over the north Indian Ocean during 2005**

a) Monthly frequencies and total lifetime of cyclonic disturbances (CI \geq 1.5)

S.No	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Life Time in (Days)
1.	D						↔ ↔			↔ ↔		↔		22
2.	DD							↔			↔		↔	15
3.	CS	↔								↔		↔	↔	20
4.	SCS													
5.	VSCS													
6.	SuCS													

b) Frequency distribution of cyclonic disturbances of different intensities based on satellite assessment.

CI No.	≥ 1.5	≥ 2.0	≥ 2.5	≥ 3.0	≥ 4.0	≥ 5.0	≥ 6.0	≥ 7.0
No. of Disturbances	12	7	4	2	-	-	-	-

c) Basin-wise distribution of cyclonic disturbances

Bay of Bengal	9
Arabian Sea	2
Land depression	1

APPENDIX V

OVERALL FRAMEWORK OF THE CTP (2006-2010)

Visions of the Panel. The Panel adopted the following visions:

- a. To provide high quality tropical cyclone forecasts and warnings by highly trained professionals using the best available technology to mitigate the effects of tropical cyclone disasters
- b. To obtain through effective tropical cyclone disaster mitigation and water resource management for humanitarian, social, and economic benefits to achieve maximum sustainable development and
- c. To derive maximum benefits to provide the high quality forecasts and warnings and effective mitigation actions through combining resources, sharing of meteorological and hydrological data, sharing of experiences in disaster prevention and preparedness and cooperative and collaborative research and training.

Emerging prioritised overall goal. To establish an effective integrated regional early warning system for hydro-meteorological disasters in the Panel's Area covering all the five components of the WMO/ESCAP Panel on Tropical cyclones.

Specific objectives

- a. To develop an effective mechanism and subsequently a regional project for the establishment of an integrated regional early warning system for hydro-meteorological disasters in the Panel's Area.
- b. To mobilize resources for an early implementation of the above objectives

1. METEOROLOGY

Broad Goal. To establish an efficient expanded observational network, to provide accurate and timely forecasts and warnings and to reduce loss of lives and properties that may be caused by tropical cyclones and associated phenomena. These goals are expected to be achieved through the latest technology, improved exchange of data and development of skills of personnel of the panel through national, bilateral and regional programs.

Specific objectives

1.1 To improve and expand the observing system of surface , upper air , ship, buoy , aircraft, radar and satellite observations in all the Panel Countries by at least 10 percent in the next two years (2006 – 2007) and by 20 percent during the five year period (2006-2010).

1.2 To improve through national, bilateral and regional programs the telecommunication systems by upgrading the existing point to point teleprinter circuits at least to 64 kbps digital TCP/IP operation in the next two years (2006 - 2007), by internet email, ftp , VPN and mobile wireless technology and augmenting the above with the regional satellite broadcast receiving systems. To organise training of personnel in the operation and maintenance of the telecommunication system in the panel countries also on high priority and whenever necessary.

1.3 To upgrade the computing facility of RSMC New Delhi (2006-2007) so as to facilitate efficient data processing and data assimilation from different observing systems / platforms to run high-resolution global, regional and mesoscale numerical models and ensemble prediction system for generating products-their retrieval, display and compositing to suit the needs of the NMHSs in the region.

- 1.4 To develop regional plans for utilization of these NWP products for their integrated developments of storm surge prediction models.
- 1.5 To promote exchange of information among the Panel Members to enhance regional cooperation in meteorology.

Priority projects

- 1.1 Upgrading of observational network in member countries, wherever necessary
- 1.2 Upgrading of computing facility at RSMC New Delhi to generate improved NWP products for use by all Panel Members.
- 1.3 Improving data and information exchange among the Panel Members to enhance regional cooperation in meteorology.

2. HYDROLOGY

Broad Goal: To formulate accurate and timely forecasts and warnings on floods and other water related hazards with a view to support preparedness and response mechanisms among the member countries.

Specific Objectives:

- 2.1 To improve regional cooperation in real time monitoring and exchange of relevant data and information and technical expertise related to all hydrological hazards by:
 - a) Developing and implementing regional information exchange strategy during 2006-07.
 - b) Organising regional workshops on data transmission mechanisms with special reference to water related hazards and sharing information through PTC web site.
 - c) Collaborating with Commission for Hydrology (CHy).
- 2.2 To improve flood forecasts and warnings particularly in deltaic and coastal areas by coupling meteorological storm surge forecasts with river flow forecasting by:
 - a) Developing delta hydraulic models for river forecasting by coupling MIKE 11 (or any other model being used in the countries) with the storm surge forecasts for at least one river delta in each country during the next five years.
 - b) Organising workshops for enhancing the capabilities of the countries to meet above objectives; and
 - c) Collaborating with CHy in the preparation of flood forecasting manual.
- 2.3 To enhance regional capabilities relating to flood hazard mapping in delta and coastal regions through continued interaction with the user agencies by:
 - a) Undertaking flood hazard mapping at least in one major delta/coastal area in each country during the next five years.
 - b) Organising workshops for capacity building.
 - c) Collaborating and sharing experiences with Typhoon Committee.

Priority projects

- 2.1 Improved flood forecasting services and capacity building
- 2.2 Priority cooperation area on flash flood forecasting
- 2.3 Pilot projects on flood inundation and hazard mapping

3. DISASTER PREVENTION AND PREPAREDNESS

Broad Goal. To improve disaster prevention and preparedness in the region including enhanced public awareness, establishment of institutional and legal framework and participation of stakeholders for more effective disaster management. These are expected to be achieved through improvement in standard procedures on DPP and exchange of national and international experiences and information on disaster management among the Panel Members.

Specific objectives

- 3.1 To improve regional cooperation in policies and strategies on DPP, especially those related to tropical cyclones by:
 - 3.1.1 Establishing a regional information system to support development of policies and strategies on DPP at the regional level as well as at the national level by creating a regional database on disaster information and best practices on DPP from 2006 onward.
 - 3.1.2 Improving public awareness of the impacts of tropical cyclones and possible mitigation and response actions through effective communication with the media prior to, during, and after tropical cyclone occurrences.
 - 3.1.3 Improving coordination and interaction between meteorological/hydrological services on the one hand and emergency management/disaster response agencies on the other through integrated emergency management, disaster response and preparedness programs.
- 3.2 Strengthening regional cooperation on DPP information exchange through networking by making available disaster preparedness and mitigation information through Internet web sites and other means.
- 3.3 Improving disaster risk management, especially those related to cyclone-related disaster preparedness by developing and implementing national pilot projects on multi-hazard disaster risk management programmes into the development plan of the Panel Members in the next five years.
- 3.4 Facilitating improved awareness through video programmes on tropical cyclone preparedness.

Priority projects

- 3.1 Improved community-based disaster risk management
- 3.2 Implementation of the Hyogo Framework for Action in the Subregion of the Panel on Tropical Cyclones
- 3.3 Regional cooperation on mainstreaming disaster risk reduction in the education curriculum.

4. TRAINING

Broad Goal. To enhance capacity building through strengthening skills of personnel engaged in various aspects of cyclone-related disaster management through regular training programmes including organization of workshops, seminars etc.

Specific objectives

4.1 Arrange training programmes on:

- The use of NWP model products, Doppler Weather Radar products and their application in cyclone forecasting (track and intensity) and storm surge prediction
- Media coordination during disasters and their effectiveness on “human response”

4.2 Arrange:

- Exchange visits of faculty members among Member countries to share their experiences and expertise on cyclone & related disaster management aspects
- Introduction of “Disaster Management” in the High School curricula

Priority projects

- 4.1 Training on the use of NWP model products, Doppler Weather Radar products and their application in cyclone forecasting (track and intensity) and storm surge prediction.
- 4.2 Exchange visits of tropical cyclone experts among Member countries to share their experiences and expertise on cyclone & related disaster management aspects.
- 4.3 Institutionalization of storm surge training modules to Panel Members. Prof. S.K. Dube has been nominated Chairman of this project.
- 4.4 Training on hydraulic modeling of extreme hydrometeorological events including dam break simulation.

5. RESEARCH

Broad Goal. To collaborate on research activities related to updating forecasting technologies, including NWP, storm surge and flood forecasting models.

Specific objectives

- To take up as a pilot R&D project on coupling of storm surge and flood forecast model over a specific river Basin (e.g. Mahanadi) for coastal inundation and river flood forecast.
- Updating of vulnerability maps for various parameters like wind force /peak storm surge etc. based on latest available database.

Priority projects

- 5.1 Take up R&D on coupling of storm surge and major river/estuary for forecasting coastal inundation.
- 5.2 Update vulnerability maps for various parameters like wind force /peak storm surge etc. using all available database in the Panel region.

- 5.3 Develop a Forecast Demonstration Project initially for India and Bangladesh with the assistance of WMO's Commission on Atmospheric Sciences.

APPENDIX VI

SUMMARY OF THE METEOROLOGICAL ACTIVITIES OF THE MEMBERS

BANGLADESH

Development Plans of BMD:

To equip BMD with the latest technicalities and attain advancement in forecasting as well as other fields of Meteorology, a number of projects have been taken up:

On-going Projects:

- Improvement of Seismological Services.
- Establishment of Numerical Weather Prediction System.
- Improvement of Meteorological Radar System at Cox's Bazar & Khepupara.
- Meteorological cum Hydrological S-Band Doppler Radar at Moulvi Bazar Radar.

Long-term Development Plans:

- Upgradation of BMD's Data Collection and Processing System with Automation and Networking.
- Upgradation of GTS Link from 2,400 bps to 64 kbps at National Meteorological Communication Centre (NMCC) at Dhaka.
- Modernization of Data Processing and Archiving System of Climate Division of BMD Head Office. Suitable climatological software for climate data processing (input, retrieval etc.) will be required. In this respect, BMD need assistance from WMO/any Donor agency.
- Upgradation of the Training Institute and Research & Development Cell. Higher Training Courses on Electronic, Communication and mechanical Engineering and Meteorology need to be introduced. One consultant should be appointed in this respect to evaluate the needs for the upgradation of Meteorological Training Institute and the R & D Cell established in the Institute.
- Human capacity building on operational weather analysis & forecasting and relevant technical issues.

Assistance is required for upgradation of the Meteorological Training Institute and the R & D Cell of BMD as well as for the capacity building with higher training/degree in Meteorology.

INDIA

A Surface Observatory Network:

- a) Surface observatory was established at Hubli.

Future Plans:

- i) Process for procurement of 100 State-of-the-art AWS of Sutron make is in progress. 25 indigenous ASTRA make AWS are also being procured. Installation of all 125 AWS in field sites will commence within the next few months.
- ii) Action is in progress for the procurement of 500 ARGs for installation at different parts of the country to augment the existing rainguage network.

- iii) In addition, it is planned to procure 900 AWSs and 3500 ARGs within the next few years to augment the observational network further.

B Upper Air Network:

- a) **RS/RW Stations:** RS Jaipur was commissioned with effect from May 2005 and currently taking one observation per day at 00 UTC. Action for relocation of RS-RW Mangalore Observatory is in progress.
- b) **Cyclone Detection RADAR:** There are 11 nos of S- band CDR stations along the Indian Coast out of which 7 are conventional RADARs, 4 stations viz. Chennai, Kolkata, Machilipatnam and Visakhapatnam have DWRs imported from M/s Gematronik, Germany and one station SHAR, Sriharikota has indigenous DWR developed by ISRO. The DWR at Visakhapatnam will be operational very soon.

Future Plans:

- i) RS Kochi is to be upgraded to RS/RW station.
- ii) Action is in progress for procuring 5 nos of wind profilers to get reliable wind data frequently.
- iii) The proposals for replacing conventional RADARs by latest state-of-art S-band imported DWRs at Mumbai and Paradip and with indigenous DWRs at Bhuj and Kochi respectively have been approved.

C Meteorological Satellites:

a. **Analog Cyclone Warning Dissemination System (CWDS)**

For speedy dissemination of Cyclone Warnings in the East & West Coast areas of India 250 Nos. of INSAT based Cyclone Warning Dissemination System (CWDS) were installed by IMD during the period 1985-95. These are very useful for quick and timely dissemination of Cyclone Warning messages to the concerned State Govt. authorities in maritime states.

b. **Digital Cyclone Warning Dissemination System (DCWDS)**

IMD has also procured & commissioned 100 Nos. of Digital Cyclone Warning Dissemination systems with new improved state of art technology along Andhra Pradesh coast during 2002-2003 under the World Bank Funded Project of Andhra Pradesh Hazard Mitigation & Emergency Cyclone Recovery Project (APHM & ECR Project). One more DCWDS station has been commissioned in Kavarati of Lakshadweep Island in June, 2005.

The new system has better features like small size (70 mm) receive antenna and high quality digital sound broadcasting. It also has the facility of receiving acknowledgement of Cyclone Warning messages at the maintenance centre at Chennai.

c. **INSAT – Automatic Weather Station/ Automatic Rainguage system (INSAT-AWS/ ARD)**

Hundred Data Collection platforms (INSAT-DCP) were established during 1984-85 by IMD all over India in order to provide Meteorological data from remote inaccessible field stations. The system has since outlived their useful life and it is under replacement soon. Eleven INSAT-AWS systems are functional as on date in the field units at Ahmedabad, Dwarka, Chennai, Pune, Ratnagiri, Harnai, Kolkata, Delhi, Thiruvananthapuram, Goa, and Mumbai. The performance of these systems has been found to be very satisfactory. These

systems have built-in memory for storing 6 to 8 months data, which could be retrieved on a laptop or PCMCIA card. The quality of data from these systems has also been found to be satisfactory within WMO specified norms. However there is a need to improve the rainfall sensor (TBRG) which needs frequent visits due to its inherent electro-mechanical design. Efforts are being made to redesign the sensor so that it could work at least for six months without any visit to the station.

These INSAT-AWS are to be replaced by new state of art improvised technology during next two years.

d. Meteorological Data Dissemination (MDD)

The processed INSAT clouds imageries are broadcast through INSAT using S-band broadcast capability of the satellite, in analog mode every three hours during normal weather and every hourly during cyclones in the Arabian sea & the Bay of Bengal. Meteorological data i.e. SDUC satellite cloud imageries & T/P data (conventional Meteorological Data) are transmitted to various field stations through MDD network. At present there are 33 MDD stations in India and one each in Maldives and Sri Lanka. During cyclone situations, actual position of system and its intensity and related forecast are also being transmitted to field stations every hour. MDD units have also been provided with work stations for detailed analysis of cloud imageries. Action is in progress for upgradation of these systems into Digital type.

Future Plans:

- i) There is a proposal to replace CWDS with new improved technology Digital CWDS Receivers and add 50 more receivers to expand the existing network to 300. Procurement process is already in progress.
- ii) About 40 numbers of Digital MDD Stations will be installed under the upgradation plan.

D Telecommunication:

Present Operational Status of RTH, New Delhi

	Name of the circuit	Present Operational Status
A. MTN CIRCUITS		
1.	New Delhi-Moscow	Upgraded to 64 Kbps via Frame relay of RMDCN of RA-VI via Equant w.e.f. 15 th October, 2004.
2.	New Delhi-Tokyo	Upgraded via Frame Relay of RMDCN of RA-VI of Equant w.e.f. 20 th August, 2004.
3.	New Delhi-Cairo	Upgradation to 64 Kbps under progress and is expected soon.
B. MAIN REGIONAL CIRCUITS		
1.	New Delhi-Tehran	Upgradation to 64 Kbps under progress.
2.	New Delhi-Bangkok	200 baud. Upgradation under process.
3.	New Delhi-Jeddah	Upgraded to 64 Kbps w.e.f. 14 th January, 2005.
C. REGIONAL CIRCUITS		
1.	New Delhi-Colombo	50 baud
2.	New Delhi-Dhaka	2400 bps. Upgradation under process.
3.	New Delhi-Karachi	64 Kbps.
4.	New Delhi-Kathmandu	50 baud Cable
5.	New Delhi-Male	Through Internet
6.	New Delhi-Yangon	50 baud
7.	New Delhi-Muscat	Through Internet.
D. INTER-REGIONAL CIRCUIT		
1.	New Delhi-Melbourne	Through Internet
E. BILATERAL		
1.	New Delhi-Beijing	Upgraded via Frame relay of RMDCN of RA-VI of Equant w.e.f. 16 th December, 2005.

Upgrading of New Delhi-Colombo, New Delhi-Kathmandu and New Delhi-Yangon GTS circuit via Internet or on 64 Kbps lease limit GTS socket communication has been proposed.

Upgrading of communication links between RTH New Dehi & Indian Ocean Rim Countries:

- o Shri M.C. Rastogi, Director, Telecom was deputed to WMO Global Telecommunication System (GTS) Expert Team Mission to Indian Ocean Countries viz. Sri Lanka, (19-21 July), Maldives (22-25 July) and Bangladesh (26-29 July 2005) for assessment of the respective National GTS upgrade for Indian Ocean Tsunami Warning System.
 - o Shri M.C. Rastogi, Director, Telecom was deputed to Geneva, Switzerland from 17 to 19 October 2005 to attend WMO Expert(s) Coordination Meeting on GTS upgrade in the Indian Ocean.
 - o Shri M.C. Rastogi, Director, Telecom was deputed to Bangkok, Thailand from 28 to 30 December 2005 for a Coordination visit for upgradation of RTH Bangkok -RTH New Delhi GTS links.
- i. India Meteorological Department is continuing its meteorological data broadcasting service using World Space 'Asia Star' satellite. The footprints of this broadcast cover large areas of Middle-east and South-East Asia at a download frequency of 1467-1492 MHz.

The Meteorological data and weather products presently being broadcast are:-

- a) Indian Satellite Images Visible, Infrared, Colour and Water Vapour Images.
 - b) GTS data (SYNOP, PILOT, TEMP, METAR, TAF etc.) of India and its neighbouring countries.
 - c) Weather charts and Model outputs.
- ii. RTH, New Delhi has plans to introduce internet VPN technology as replacement of circuits in its national network.
- iii. IMD's websites (<http://www.imd.ernet.in>) and <http://www.imd.gov.in> are operational and have become extremely popular amongst the meteorological researchers and common public. All the forecasting products like Charts, Warnings, Satellite Imageries, Rainfall information are placed and timely updated in IMD's website. The Regional Meteorological Centers have their own websites and many stations have been provided with internet facility. More than 5 lakhs hits have been recorded in our website so far. Average hits per month is 10,000.
- iv. Interactive Voice Response System (IVRS) popularly known as 'Weather on Phone' can be conveniently accessed by dialing Toll free No.1600-180-1717 and weather for 150 cities is available on this system. The systems installed at the four metros have been upgraded recently. These upgraded systems have the facility of ingesting short weather warning messages also during periods of disturbed weather.
- v. Arrangements for transmission of cyclone related warnings to the population using mobile phone network through SMS & Cell broadcast have been worked out.
- vi. The Telecommunication Training Centre at New Delhi is one of the International Training Centres recognized by the World Meteorological Organization. This centre imparts training in the field of telecommunication to the departmental as well as foreign trainees sponsored under various technical programmes.
- vii. Under the Marine Meteorological Broadcast system GMDSS (Global Maritime Distress and Safety System) of WMO/ IMO, two bulletins are broadcast at 0900 and

1800 UTC everyday through INMARSAT Safety Net System. Additional bulletins are broadcast during cyclone period.

- viii. The OPMET data received through SADIS (Satellite Distribution System) terminal installed at RTH, New Delhi are being sent to AMSS Mumbai, Kolkata and Delhi for Flight Planning Documentation.
- ix. At NMTC, current meteorological observational data is available on FTP server and can be accessed by authorised users.
- x. Annual Global Monitoring for 1-15 October 2005 have been conducted at RTH New Delhi and the results have been sent to WMO via Internet and the summary given below:

S.No.	Name of the Country	SYNOP	TEMP	
			Part A	Part B
	India	93%	90%	85%
	Sri Lanka	88%	--	--
	Bangladesh	91%	12%	10%
	Maldives	80%	--	--
	Nepal	44%	--	--
	Pakistan	83%	--	--
	Myanmar	61%	--	--

- xi. Antarctic Monitoring results have also been conducted at RTH, New Delhi during 1-15 January 2005 and the result communicated to WMO.
- xii. Some additional information.
 1. There are 84 Telefax stations and 14 VSAT stations installed at CDR/ CWC/ MC/ Seismological Stations/ Observatories. Fax and RTT broadcast are being replaced by digital MDD systems.
 2. Point to point links have been provided between All India Radio and important Cyclone Warning Centres/ Stations for dissemination of Warnings. Satellite based Cyclone warning dissemination are also being operated.

Upper air Observation

Since the Radiosonde observation has started at the Meteorological Office, Gan (WMO # 43599) on 14 September 2004 under the Global Upper-Air Network (GUAN), a 1200UTC TEMP message is transmitted daily through GTS from this station.

No observations were made at Male' (WMO # 43555) in the year 2005. The WF100 wind finding radar with the hydrogen generator remained unserviceable for several years.

The location of Maldives in the Indian Ocean happens to be a data sparse area, upper air observations from the south and central Maldives are very important to us and as well as the entire meteorological community in the region. Hence, Maldives urge assistance from WMO/ ESCAP and Panel members to re-build their upper air network.

Surface Observations

Maldives has 5 meteorological stations of which four are manned 24 hours and both synoptic and aviation reports are made on all five stations. Only two of them are categorized additionally as upper-air stations.

- Hanimaadhoo (43533) surface
- Male' (43555) surface + upper- wind
- Kadhdhoo (43577) surface
- Kaadehdhoo (43588) surface 00 – 15 UTC
- Gan (43599) surface + radiosonde

Meteorological Satellites

The INSAT receiving system remains unserviceable since 2003. Discussions held between two countries during 2004/ 2005. Efforts been made to repair the system failed and finally the India Meteorological Department has agreed upon replacing the old analogue MDD system with a new digital MDD system in a very near future.

Imageries from METEOSAT and satellite wind that were available on various internet sites are also used for weather forecasting and analyzing. On the same way numerical model outputs were also been used.

Telecommunications

The computer based telecommunication system between the local Meteorological Offices and the National Meteorological Centre (NMC), functioned very well during 2005.

The TCP/IP GTS link between Male' and New Delhi was working satisfactorily last year. The annual maintenance check was carried out by the software vendor, 3A Corporation of Pakistan during March 2005. As a result, an audible alarm is generated whenever a tsunami warning bulletin is received on the GTS.

The WMO Expert team mission for on-site assessment for upgrading/ strengthening National GTS components of the NMCs, arrived Maldives on 22 July 2005.

The Experts were Mr. Mahesh C. Rastogi, India Meteorological Department and Mr. Takahiro Saito, Japan Meteorological Agency. During this three-day mission, they compiled a technical survey on the current operational status of the Maldives GTS components and its future upgrade and implementation requirements.

Forecasters' workstation

The **A**nalyzing, **F**orecasting, **D**ata-processing and **O**perating **S**ystem (AFDOS) remain unserviceable and needed to be upgraded soon. Negotiations were held with the Chinese counter-part in 2004. Yet, waiting for a proper solution.

Meteorological Information through internet

The official website of the Department of Meteorology www.meteorology.gov.mv was upgraded in 2005 and a mirror site <http://www.met.gov.mv> was launched for easy access and browsing. Forecasts, warnings, meteorological reports and aviation weather charts are timely updated and available for users of this webpage.

OMAN

2 Meteorological Facilities

2.1 Upper Air Observation

The Sultanate of Oman operates two upper air-observing stations, viz. Muscat (41256) and Salalah (41316). Both these are equipped with Vaisala's Digicora GPS wind finding system. The radiosonde was up graded to Visalla RS92 equipment. One flight is launched from each of these stations in a day.

2.2 Ship Weather Reports

Weather Reports from Ships are received through GTS as well as from Muscat Coastal Radio Station. In addition Ship reports are also received from the Royal Oman Navy.

2.3 Wave Measurements

One wave measurement station was installed offshore Sohar and the collected data is inserted on the GTS every three hours. Two more stations will be repaired and or replaced at Muscat and Salalah. One additional station is planned for Qalhat (Sur).

2.4 Synoptic Land Stations

The number of Synoptic Land Stations being inserted into the GTS still remained at 30 stations. Additional station will soon be included in the RBSN also.

2.5 Telecommunication

2.5.1 All the meteorological stations operated by the Meteorological Department are connected to the MSS computer located at the Central Forecasting Office at Seeb International Airport by a reliable dial-up telephone link.

2.5.2 The MSS is connected to the RTH Jeddah by a dedicated link at 64 kbps based on TCP/IP protocol.

2.5.3 In addition a 512 kbs Internet leased line has been established as well as an e-mail and FTP Server. All these are protected by a firewall.

2.5.4 A bilateral Internet Circuit, which was established between New Delhi and Muscat for the exchange of meteorological data, has proved to be very effective and useful.

2.5.5 Another bilateral Internet circuit link was also established between Abu Dhabi and Muscat for the exchange of meteorological data.

2.6 Satellite reception

The Department installed ground-receiving stations for intercepting High Resolution images from Polar Orbiting satellites operated by NOAA as well as from geostationary satellites operated by EUMETSAT.

2.7 Computer Workstations

2.7.1 Data Processing System

Numerical Weather Products are received via MDD, GTS and Internet from Bracknell, Toulouse, Offenbuch and Washington. A Local Oman Regional Model (ORM) was

established with the kind cooperation of the National Weather Service of Germany (DWD). We run three model versions as follows:-

- a] The ORM_28 covers the region 30.0 E, 07.0 N (Lower left corner) to 78.0 E, 35.25N (Upper right corner) with a mesh size of 0.25 degree (approx. 28km). There are 193 x 114 grid points and 40 layers. The model gives a 78-h forecast in the 12 processor E 4500 Sun Machine.
- b] The ORM_07 covers the region 51.0E, 16.5N(lower left corner) to 61.0E, 26.5N (Upper right corner) with a mesh size of 0.0625 degree (approx. 7KM). There are 161x161 grid points and 40 layers. The model gives a 78-h forecast in a 12 Processor E4500 Sun machine.
- c] A WAM based wave Model was established with the kind cooperation of GKSS of Germany, which covers the Arabian Sea, Gulf of Oman and Arabian Gulf.
- d] A SWAN Wave Model for shallow water and at high resolution.

2.7.2 Module Output Statistics (MOS)

The Department successfully established a MOS which is generated with each Model run. MOS is an approach to incorporate NWP forecasts information into statistical weather forecast. After installing MOS we noted improvement in Temperature and wind forecast. In addition we were able to get a probability forecast for thunderstorms and fog.

2.7.3 Verification Package

The Department managed successfully to develop its own verification package which was led by Computer Scientist Sultan Al Yahyai. The developed system verifies the continuous weather parameters such as T_2m, TD_2m and for the categorical weather parameters such as Total precipitation. The system generates different statistical scores such as Hit rate with a margin of error, Bias, Root Mean Squared Error (RMSE). The package provides a friendly UGI to allow the user to select different choices (Model type, stations list, observation time, weather element and statistical score) to be verified. This system will help find the systematic errors in the Model output, which can be tuned. The package is being in several countries. Panel Members may get a copy also if they request Oman's P.R.

3 Aeronautical Services

3.1.1 In order to meet ICAO recommended practices and to fulfill the requirements for Aviation the Department installed a SADIS workstation as early as 1996. Effective Last year the Department started to pay to the UK Met Office the annual contributions for obtaining SADIS data and Products. In addition all the SADIS data and products are also received thru an FTP Server from UK as a back-up.

3.1.2 A new service was also established last year for the provision of en-route flight folders for all Airlines operating in the sultanate to be accessed on our web site.

PAKISTAN

(i) Improvement of facilities:

- (a) WMO allotted index numbers in respect of new meteorological observatories Thatta (41783), Mitti(41786), Mirpur Khas (41767) and Dadu (41743) established during 2003.
- (a) In compliance of directive of the Sindh Chief Minister, 51 ordinary rain gauges were supplied to the Additional Relief Commissioner, Sindh for installation at important Taluka headquarters during July 2004 with the request to supply the recorded rainfall data on monthly basis to the local Met. Stations or the Regional Met. Centre, Karachi for its publication as climatic record.
- (b) Revised and extended lists of RBSN and RBCN stations were provided to the WMO.
- (c) Under the 16th Science & Technology Protocol between China and Pakistan, a six-membered Chinese delegation, led by the Deputy Administrator of CMA, would be visiting Pakistan from 12–19 March 2005 for the supply of meteorological satellite data receiving, processing and applications system to Pakistan alongwith useful discussions on various issues relating to meteorology, climate and use of AFDOS software etc.

(ii) Technical Advancement

For speedy transmission of data, V-Sat facility was provided to 11 Met. Stations during 2004. Data communication through mobile phone SMS services between 18 Met. Stations is also in progress and would be commencing very soon.

SRI LANKA

Synoptic Observations: Data from the 20-station network was very good with over 90% messages received during the year, except from Pottuvil (43475) where the observations resumed after Tsunami catastrophe only in April 2005.

Meteorological data exchange via RTH New Delhi is very good except for a few interruptions, particularly several days in April 2005 and few isolated incidences in May, July, October and December. MDD system is still non-operational as there is no signal. IMD is currently attending to this.

Upper-air Observations: Very few Radiosonde observations at Colombo were conducted due to defective equipment. But observations at all Pilot wind stations Hambantota, Puttalam and Trincomalee continued at 0000, 0600 and 1200 UTC satisfactorily. The Government of India generously continued to supply Radiosonde transmitters, accessories and consumables for Radar-Radiosonde observations.

Meteorological Satellites: HRPT receiver of NOAA imageries was defective at times and all corrected locally, but a defect in movement of antenna is being repaired at present.

Ships and Aircraft Reports: Ship Reports are still not received at Colombo radio shore station, as latest INMARSAT capabilities are not present in Colombo. AIREPs reception at Airport Meteorological office is poor but whatever received is transmitted to WAFS centers regularly.

Improvement of Facilities/ Technical Advancements

WMO sponsored team of experts (Japan and India) visited SLMD for a period of one week in July 2005 to study and make recommendations to upgrade local/regional communication system (especially TCP/IP GTS linking with RTH New Delhi) and to report to the WMO.

KOIKA sponsored team of experts from KMA spent two weeks at SLMD in December 2005 to introduce NWP technique in daily operational weather forecasting using MM5 model in a PC cluster environment.

Funds for up-gradation of software and hardware of SADIS WAFS data system to second generation has been granted by the Government of Sri Lanka; international quotations were called in November 2005.

Subsequent to several attempts for foreign funding failed, the SLMD succeeded in securing 400 million Rupees Government allocations for 2006, for the procurement of Doppler Weather Radar.

SLMD is pleased to seek the WMO assistance and recommendation in the procurement of the SADIS system up-gradation and the Doppler Weather Radar.

SLMD was linked with the PTWC and JMA via dedicated fax/telephone lines for Tsunami information, by late March 2005 after the Sri Lanka Government designated SLMD as the focal point for Tsunami warning.

Re-location of synoptic observation station Badulla (43479) due to increasing environmental changes and possible unrealistic values is in progress and expected to complete in the first quarter of 2006. Building construction at synoptic observation station Pottuvil (43475) that was completely washed-away due to the Tsunami waves is in progress partly as Tsunami shelters as well, and Mannar (43413) is also chosen to be re-constructed with local funding.

Observing and Telecommunications: The Internet is being used extensively in daily forecasting, especially during cyclonic threat situations. Local Area Network is established in the Department.

The Government of Sri Lanka wishes to thank KOIKA, WMO – especially the Secretary General Mr. Michel Jarraud who paid a brief visit to Sri Lanka in early November 2005 and other Institutions for their keenness in assisting to improve capabilities at SLMD.

THAILAND

3. Meteorological Component

a. Improvement of facilities

- TMD has set up a plan to upgrade hardware, software and equipment of the GTS between Bangkok-Singapore and Bangkok-New Delhi in the near future. National budget has been set up last year (2005) for this purpose.
- To strengthen disaster watch and warning of the nation, three more rain gauge stations were set up: one in Rayong, two in Chiang Mai.
- Progress on installation of equipment under aeronautical meteorological project at Suvarnabhumi Airport, the new International Airport of Thailand, has been made as below:

- ❖ The Automatic Weather Observation System (AWOS) and the Doppler Radar had completely been installed during 2005;
- ❖ Other necessary systems such as lighting protection system and windshear observation system has been installing and expected to be completed in early 2006.

b. Technical Advancement

- NWP models have been run at TMD with a number of domains: global (100 km resolution), Southeast Asia (48 km resolution), Thailand (17 km resolution), and Bangkok (5 km resolution). All models are based on the Unified Model. At present, TMD usually runs the Global, the Southeast Asia, and the Thailand models as a part of its operation for 168, 72 and 36 hours forecasts, respectively. The Southeast Asia Model products and the Thailand Model products are also provided on website of TMD.
- TMD increased an application of NWP for forecasting tropical cyclones and organized training courses in this field for forecasters during the year in order to increase knowledge and NWP technique for them and expand a number of NWP trained staff. The efforts had been made to improve accuracy and efficiency of weather forecasts.
- The two computer programmes namely: Climatic Database Management System (CDMS) and Agrometeorological Database (AgDb) have already operated from the mid of 2005 with high successfulness. Those programmes can manipulate a proper time in data recording, processing, reporting and printing in various materials. In addition to particularly CDMS, it has been using a major tool to distribute and support all meteorological geo-information like as NWP products, radar and satellite imageries, Telemetering data and weather forecast from the headquarters to the meteorological stations throughout Thailand for warning and alleviating a weather hazardous, which might be effect on causalities and properties of human being.
- The agrometeorological model so-called "SWAP" has been installed and integrated with the techniques of RS&GIS to define and classify drought areas throughout Thailand at preliminary stage.
- The techniques of GIS like as IDW Kriging, etc., have been used to display properly the NWP products on a map of Thailand at scale 1:250,000 and then, applied for weekly weather outlook for agriculture and agrometeorological forecasting with high success.
- Under TMD, disaster warning and preparedness project in local areas was planned to implement in cooperation with the Local Authority Unit, for the safety and well prepared for people in disaster risk areas.
- TMD has improved the provision of tropical cyclones data and information to meet the requirement of the users in Thailand as below:
 - ❖ Using more graphics and satellite imagery to show the storm natures and tracks;
 - ❖ Providing weather report and warning via mobile phone;
 - ❖ Providing live TV broadcasting of weather forecast by forecaster from TMD's studio.
- TMD continued participation in the World Weather Information Service (WWIS) by providing weather information as well as weather outlook for each of 15 tourist destinations of Thailand in order to make it possible and easy for the tourists to access the information of those places.

- Aside from radar, satellite, synoptic data and NWP products from Thailand model, TMD has also brought NWP products from other weather centers to jointly use for weather analysis and forecasting.
- TMD has increasingly exchanged data and information on the tropical cyclones between NMHSs via Internet and also made available of Thailand's weather data and tropical cyclone forecasts and TMD's website.
- To be able to reach people directly all, TMD produces and broadcasts weather report and forecast, warning and other meteorological knowledge via 6 TMD's radio broadcasting stations located in each part of Thailand. The interesting broadcasting programme includes:
 - ❖ TMD Hour for Public
 - ❖ Our Weather Situation
 - ❖ TMD Radio for Community.
- TMD educated meteorological and disaster related knowledge to 1,244 students to understand the real nature of meteorology.
- During 2005, two sets of software have been used in the data based of the marine meteorological tasks of the TMD:
 - ❖ "GTS_SHIP Translation" for conversing synoptic raw data observed from the sea surrounding Thailand (collected by the GTS_SHIP) into the literate form for the data; and
 - ❖ "Platform Program" for conversing synoptic raw data (obtained from the UNOCAL) into the literate form of the marine meteorological data.
- A marine meteorological research using hard (WAM) and soft (ANN) computing techniques were still introduced at the TMD during last year.
- The data base of marine meteorology has been created in a certain format, on trial basis, in which the users can pick any grids in the interests (with the grid system of 0.083 degree x 0.083 degree) to access the marine meteorological data in the chosen grid.
- An ocean wave model has been run for ocean wave forecasts in both the Gulf of Thailand and the Andaman Sea on the regular basis in order to add the model outputs in three websites: www.tmd.go.th/~marine, www.marinemet.com, and www.marine.tmd.go.th, which have been provided to convey the knowledge about marine meteorology and ocean wave forecasts in both Thai and English to the users.

APPENDIX VII

SUMMARY OF THE HYDROLOGICAL ACTIVITIES OF THE MEMBERS

BANGLADESH

BMD provides all sorts of data, information and weather forecast to the Flood Forecasting & Warning Centre (FF&WC) of Bangladesh Water Development Board (BWDB). Representative from Flood Forecasting and Warning Centre of BWDB is requested to speak on the hydrological aspects of Bangladesh.

INDIA

The southwest monsoon season of 2005 had its own uniqueness. Delayed onset, prolonged weak monsoon conditions during June & August, plentiful rains during July & September and all these leading to a near normal seasonal rainfall are some of the salient features. IMD's Long Range Prediction on Southwest monsoon rainfall came correct. There were many high impact weather events during this season which merit detailed investigation by the research community. The unprecedented extreme heavy rainfall on 26/27th of July 2-5 was the most important event. For the country as a whole the rainfall in June was 88% of LPA, in July was 114% of LPA, in August was 73% of LPA and in September was 118% of LPA. The seasonal rainfall for the country as a whole was 99% of LPA.

In addition July & September witnessed many major flood events causing widespread damage to life and property. They are detailed below.

1. Kinnaur and Kullu districts of Himachal Pradesh (26–29 June 2005)
 - Sulej River suddenly rose 12 to 15 m in Himachal Pradesh.
 - Damage: It flooded large areas of Kinnaur and Kullu districts, forcing evacuation of 5,000 people. Six people died, several bridges and roads were destroyed, 2 villages inundated and 50 houses submerged.
 - Cause: A landslide created lake on the Pareechu River in Tibet overflowed due to heavy rains and snowmelt. Meteorological data not available.
2. Southern and central parts of Gujarat (28 June–15 July 2005)
 - This was reported to be one of the worst floods in Gujarat in the past 40 years.
 - Damage: According to media reports, 202 people lost their lives, more than 7,200 villages were inundated and around 1,76,000 people left homeless.
 - Cause: Continuous spell of heavy rains caused rivers to overflow.
3. Baitarni river and its tributaries in Orissa (29 June–3 July 2005)
 - Baitarni River overflowed its banks following two days of heavy rain.
 - Damage: It flooded the areas in Bhadrak, Jajpur, Anandpur, Dhamnagar and Chandbali districts killed 1 person and 220 villages were evacuated.
 - Cause: Heavy rain.

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4. Sagar, Chattarpur & Damoh districts in Madhya Pradesh (2–15 July 2005)
 - Flooding in upper Narmada and Son rivers.
 - Damage: Sixty two people lost their lives and 1 million people in 6 towns and 358 villages were severely affected. Sagar, Chattarpur, Damoh, Sahra, Riva and Katni were the worst affected areas.
 - Cause: Persistent exceptionally heavy rainfall.
5. Northwest India (5 –26 July 2005)
 - Flood occurred in Himachal Pradesh (Kullu, Chamba, Rohru), Punjab, Jammu & Kashmir (Doda and Jammu districts) and Haryana.
 - Damage: Forty people died and thousands of people were evacuated in Kullu region of Himachal Pradesh. Landslides and flash floods triggered by torrential rains in Jammu & Kashmir forced the Amarnath yatra to be suspended, even as thousands of pilgrims were stranded along yatra route. There was widespread damage as flood waters ravaged area around river banks and landslides cut off access to different areas in the state. Water flowed above the danger mark in 3 rivers – Chenab, Tawi and Ujj in Jammu region. Haryana also experienced damage when Jhelum River remained above the danger level during 21 to 23 July.
 - Cause: Heavy rainfall and landslides.
6. Uttar Pradesh and Uttaranchal (7 – 27 July 2005)
 - Rivers Ganges and Yamuna were flooded.
 - Damage: Fiftyfive people died and 4,000 were evacuated from the Ganges river banks in Uttar Pradesh.
 - Cause: Heavy rainfall triggered flash floods and landslides. Also, the water released by Nepal into Sharda and Gandak rivers on 20 July flooded 20 villages in Uttar Pradesh.
7. Northeast India, Bihar and Gangetic West Bengal (7–27 July 2005)
 - River Brahmaputra and its tributaries flooded Assam and Arunachal Pradesh, Muzaffarpur, Darbhanga and Madhubani districts of Bihar. Birbhum district of West Bengal also experienced flood situations during the period.
 - Damage: Fifteen people died in Assam, 1.9 million people were displaced and 400 villages were under water in Assam. In Arunachal Pradesh 4,000 people were left homeless.
 - Cause: Heavy rainfall.
8. Andhra Pradesh (10 & 11 July 05)
 - Coastal Andhra Pradesh, Telangana and Rayalaseema experienced flood situations.
 - Damage: Twelve people died and thousands of people in low lying areas were evacuated.
 - Cause: Incessant rain.
9. Nagpur (11 July 05)
 - Two villages in Yeotmal were flooded.

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- Damage : Two villages were swept away causing the death of 7 people.
 - Causes : Flash floods in River Dhawanda due to breach of a dam because of heavy down pour.
10. Maharashtra and Goa states (26 July–2 August 05) :
- These states experienced severe and prolonged flood situations, unprecedented in the recent past. Mumbai (Santracruz) reported a record rainfall of 94.4 cm on 27 July 05. Other affected areas were, Raigad district (Roha, Mahad, Mangaon, Kandiwale, Poladpur, Jui), Ratnagiri district (Khed, Chiplun, Alore), Sakinaka, Thane (Mumbra, Kalyan, Badlapur, Vitthalwadi) and north and south Goa districts.
 - Major rivers like Koyna, Kal, Savitri, Pawana, Mithi, Mutha, Mula and the upper reaches of Krishna were flooded.
 - Damage: The death toll was estimated to be nearing 1000. Heavy rains during 25 & 26 July severely affected Goa, leaving 7 labourers dead in a landslide. The unprecedented heavy rainfall of 94.4 cm. recorded at Mumbai (Santacruz) on 27 July crippled the lifeline infrastructure at Mumbai for days together. More than 150 people were killed in Raigad district in the worst floods and landslides in 16 years. About 400 people died in Mumbai alone and 969 for Maharashtra state. About 76,000 animals have been killed, and 7,00,000 hectares of land and 2,83,000 houses have been damaged. 16,000 villages were affected by the floods. The damages were estimated to be of the order of several billion rupees in Maharashtra. 2,25,000 hectares of crops in 15 districts were destroyed.
 - Cause: Exceptionally heavy rainfall.
11. Karnataka State (3 August 05)
- Krishna and Cauvery rivers were flooded affecting Chikmangalur, Shimoga, Harihar, Kodega, Belgaum and Bijapur etc. districts.
 - Damage : 10,000 evacuated from 202 villages along Krishna river in Bagalkote and Bijapur in Karnataka. Flood situations claimed 109 lives and 83,000 hectares of crops were destroyed.
 - Cause: Water released from the over full dams of Maharashtra.
12. Telangana region (10–23 July 05)
- Adilabad, Karimnagar, Khammam, Warangal, Kurnool, Hyderabad, Nizamabad, etc. districts were affected. Rivers Krishna, Godavari and their tributaries were flooded.
 - Damage : 27 people died and more than 5000 were left homeless.
 - Cause : continuous heavy rains
13. Orissa (30 July–3 August 05)
- Jajpur, Bhadrak and Kendrapara districts and many towns were affected.
 - Damage: Eight people died. Bramhani and Kharashrota rivers breach 23 embankments in Jajpur districts marooning 320 villages. 800 houses were damaged. 75,780 hectares of crops submerged in Bhadrak district and 3, 44,857 people were evacuated.
 - Cause: The break/release of dams following heavy rainfall.

14. Andhra Pradesh (14–26 September 05)
 - Khamam, east Godavari, west Godavari, Krishna, Nizamabad, Kothagudam, Vijayawada etc. districts were affected. Krishna and Godavari rivers and their tributaries were flooded.
 - Damage: Seventy-four people died, 2,00,000 were displaced or homeless, 1,11,299 hectares of crops were destroyed.
 - Cause: Heavy rainfall.
15. Chattisgarh (14–26 September 05)
 - Rajnandgam and Durg districts were affected.
 - Damage : Nine people died, 2,50,000 left homeless and 835 villages in the above two districts were inundated.
 - Cause : Heavy rainfall
16. Uttar Pradesh and Uttaranchal (16–30 September 05)
 - Muzaffarnagar, Meerut, etc. districts in Uttar Pradesh and Uttamsighnagar city and Bhojpur in Uttaranchal were affected.
 - Damage: Thirteen people died and 32 villages were devastated by floods from Ganga canal.
 - Cause: Floods and landslides due to heavy rain.

Observational Programme and Data Exchange

The Central Water Commission is disseminating real time flood forecasts for 173 flood forecasting stations (145 water level forecast stations and 28 inflow forecast stations) promptly to the users agencies, such as civil/ engineering authorities of concerned States, defence, railways/ highways authorities, industrial and other important establishments located in the flood prone areas through telephone/ fax/ e-mail/ special messenger for taking advance action for flood fighting & evacuating population from the areas likely to be flooded along with movable properties and other actions towards flood damage mitigation. Forecasts are also being given to Radio, Television and News Agencies for the benefit of the likely flood affected population. Daily flood bulletins are also hosted on the website for quick dissemination. CWC has launched website www.india-water.com in which all information about flood forecast are available.

During the monsoon season of 2005 total 5619 flood forecasts were issued for 28 inflow forecasting stations and 145 stage forecasting stations with an overall accuracy of 96.55%.

The updated Hydrological Programme and Implementation Plan of facilities and sources concerning Flood Forecasting system in the rivers falling in the Bay of Bengal and Arabian Sea.

In the Mahanadi & adjoining east flowing rivers in the State of Orissa during the years 2003 & 2004, ten new sites viz. Pubansa (seasonal), Indupur (seasonal), Marshaighai (seasonal), Kanas (seasonal), Khandapara Bridge, Padmavati, Arampur, Deogam, Gopalpur and Mahulpalli were established in Orissa. No additional site was established during the year 2005. Under telemetry system, rainfall and water level sensors are going to be installed at eight sites viz. Alipingal, Nimapara, Khandapara Bridge, Padmavati, Arampur, Deogam, Gopalpur and Mahulpalli before October, 2006.

In the Krishna and Godavari river basins, comprehensive telemetry system consisting of data sensors, transmitter etc is under installation by the Central Water Commission and the work will be completed before October, 2006.

The total no. of station proposed under telemetry in the Krishna and Godavari basin is as under.

Sl. No.	Sensor Type	Krishna Basin	Godavari Basin	Total
1.	Rainfall sensor (Type 1)	17	1	18
2.	Rainfall & water level sensor (Type 2)	24	62	86
Total		41	63	104

The data bank for the storage of hourly gauge as well as rainfall data collected in real time over the past several years was prepared in Central Water Commission where the data of part of southern rivers like Krishna, Godavari, Pennar etc. were included. In addition the data of some reservoirs maintained by various State Governments and other agencies were included in the data bank. The objective is to modernize the flood forecasting methodology by using enhanced and advanced software like MIKE11 in respective jurisdiction in phased manner.

It is now proposed to issue inundation maps also of the area likely to be flooded for which the topographical data of major flood prone basins are being digitized. Under Ministry of Home Affairs USAID project on climate forecasting, a team of Indian engineers interacted with USGS/USWB expert to study various models being used abroad for flood forecasting and develop appropriate models for Mahanadi Basin as a pilot project wherein it is also proposed to forecast area likely to be flooded in addition to river stage and inflow forecasts.

MALDIVES

No much of hydrological issues in the country. Ministry of Environment, Energy and Water look after the issues of those few lakes exist in Maldives.

PAKISTAN

Flood season 2004

The main water reservoirs in Pakistan namely Mangla & Tarbela largely depend upon the snow melt contribution which starts increasing with the increasing temperatures in the snow covered mountain areas. The increase in temperature starts from the middle of April. Summer monsoon starts around 1st of July with pre-monsoon rains in the second half of June. Obviously, if the temperatures are higher in May and monsoon rains are normal, then the water inflow in Mangla & Tarbela is more with the likelihood of touching their maximum conservation level by the first or second week of August. But in the absence of any one or both the factors, sufficient water would not be available in the reservoirs for irrigation as well as electricity generation purposes.

This situation has been observed during the flood season 2004 when the monsoon rains in the upper catchment of the river Jhelum & Indus were below normal and temperature in the snow covered mountain areas was also not high due to frequent cloud cover without any precipitation.

Following is the detail of the lean monsoon season:-

- i. A pre-monsoon spell between 20th to 27th June due to accentuation of seasonal low with the interaction of a passing westerly wave in the north resulted in wide spread rainfall in the NWFP, Punjab and Azad Kashmir. Major portion of this rain giving system was observed in the lower catchment areas. For example, Rawalakot (118 mm), Faisalabad (115 mm), Oghi (96 mm), Marala (102 mm), Mangla (82 mm), Bahawalnagar (78 mm), Islamabad (89 mm), Zafarwal (82 mm). Due to this spell only low flood was observed in river Indus at Tarbela on 22nd June. The level in Tarbela rose from 1395.34 feet to 1421.38 feet during this spell.
- ii. A second rainy spell was also observed between 12th to 14th July due to another westerly wave interacting with moisture incursion from Arabian Sea and gave considerable amount of rain. For example Marala (244 mm), Khairabad (162 mm), Kotli (76 mm) but 75% of the rain was recorded below rim stations. Consequently no effect on the flow of the rivers was observed and all the rivers remained normal. There was another rain spell during the last days of July caused by westerly wave interacting with the monsoon trough. This spell also gave widespread rains in the upper catchment areas of river Indus and river Ravi, registering a rise of more than 100,000 cusecs at Tarbela and 23,000 cusecs at Jassar respectively.
- iii. Two spells were recorded during the month of August 2004, but no significant contribution was observed in the Mangla and Tarbela reservoirs. However, in the first week of October, a tropical storm developed in the Arabian Sea and after crossing southeastern coast of Sindh, it passed over southern Sindh and adjoining Rajisthan. Due to this, widespread rain was recorded in the Sindh province resulting in a large contribution in the water reservoirs in Sindh. For example Hub dam was filled upto its full capacity and sufficient water would be available during the coming months.

Analyzing the whole monsoon season it has been observed that lower catchment areas, below rim station received more rainfall as compared to the upper catchment areas. Moreover, these weather systems did not allow rise in temperature in the mountain areas thus causing less snow melt. Due to this phenomenon, acute water shortage in the country was observed.

Reformulated 2nd Flood Protection Sector Project (FPSP-II)

In order to augment flood forecasting capabilities in the reformulated FPSP-II, package C comprising following components has been approved:

- i. Enhancement and expansion of the existing meteorological and hydrological observation and communication systems,
- ii. Improvement of forecasts of catchment rainfall and river flows through meteorological studies,
- iii. River survey to measure extreme flood flows and river cross-sections,
- iv. Mapping of flood plains along major rivers,
- v. Completion of the flood forecasting system, and
- vi. Enhanced use of Mangla reservoir for flood management.

In this connection, after site selection, bids have been floated for the procurement and installation of a 10 cm Doppler Weather Radar at Mangla. Allocation of sufficient funds has also been made for the up-gradation of 5.6 cm QPM Radar at Sialkot to 10 cm Doppler Weather Radar, maintenance of 10 cm Doppler Radar at Lahore and for research studies on various operational topics relating to flash flood forecasting, hill torrents and radars' calibration etc.

SRI LANKA

The Hydrology Division of the Irrigation Department collects hydrological data that enables quantification of surface water hydrology analyze and archive these data as the only such institution concerned with surface water measurements in the island.

This division at present is collecting hourly water levels at 69 river gauging stations and calculating daily river discharges from 39 stream gauging stations located at 17 major river basins and it covers over 60% of the total basin area in the island. The hydrological data thus collected is made available for water resources development, planning and research work. In addition to the above work Hydrology Division collects daily rainfall records from 33 rain gauges out of which 28 gauges are established in stream gauging stations. This division also maintains 10 evaporation pans to collect daily evaporation records and also one weather station maintained by Hydrology Division.

(a) Improvement of Facilities

Assignments undertaken and completed under Interim-National Water Resources Authority (I/NWRA) are:

1. Establishment of Weather station at Dunamalle;
2. Construction of Field quarters at Horowpathana;
3. Establishment of weather station at Horowpathana;
4. To construct Automatic Water Level Recorder Structure:- work is in progress.

Following Instruments are supplied by National Water Supply & Drainage Board to enhance the data collection capabilities.

1. Current meters for measuring river flow velocities by wading and by boat.
2. Cable suspended current meter for measuring river flow velocities for use in cableway system and accessories.
3. Cable suspended current meter for measuring river flow velocities for use from the bridge and accessories.
4. Cableway installation mechanical double drum winch 100 kg.
5. Integrated bubble in sensor water level monitoring instrument.
6. Class "A" evaporation pan with still well.
7. Tipping Bucket Rain Gauge with integral rainfall data logger.
8. Simple rain gauge for measuring daily rainfall.
9. Radio Transceiver.
10. Strain gauge sensor water level monitoring instrument.
11. Vota-2 portable computers.

Technical Advancements, Flood Forecasting and Warning

Hydrology Division operates flood warning system for Kelani Ganga for the safety of the city of Colombo and also operates flood warning system for Kalu Ganga, Gin Ganga and Nilwala ganga.

For water resources planning, Hydrologic modeling and data processing, latest version of the following computer application packages are used.

1. MIKE II Hydraulic model
2. HEC HMS
3. HEC RAS
4. HEC DSS Vue
5. Mike BASIN

In addition to above, monitoring and measuring of high flood levels, discharge measurements during floods, and flood mapping of most of the main basins are in progress.

THAILAND

a. Improvement of facilities

- The third phase of the Telemetry System Project (which was firstly established by the TMD in late September 1999) has been carried out since 23 August 2004. Under this phase, 53 automatic rainfall/hydrometeorological stations must be constructed in 5 main river basins in the upper part of Thailand. During 2005, four rainfall/hydrometeorological stations have already been constructed. The rest ones are being done during 2006. This phase is expected to be completed by the end of September 2006.
- In case of the Royal Irrigation Department (RID), there are three ongoing telemetry projects this year for Ping, LamPao and Chantaburi river basins which are located in the northern, north-eastern and central part of Thailand, respectively. The real-time in situ and remotely sensed data collection was planned on hourly basis. In these projects, "NAM-model" will be employed to simulate hydrological behaviour in the upstream area and create the input to "MIKE II" model to proceed further in order to produce the channel routing which gives flood forecasting and warning flood forecasting and warning. The remotely sensed data will be collected at the control rooms and disseminated to the concerned agency.

b. Technical Advancement

- At this moment, the forecasted results from other completed telemetry projects of RID are disseminated to the concerned agencies and warning is provided via internet, radio and television.
- At RID, the unit hydrograph is employed to demonstrate that this technique is also applicable to medium size of catchment. There is no result at this moment, it still needs time to verify this methodology.
- Exchange of in situ and remotely sensed data and uses can be easily done in the future via the internet. The information gained during this period is expected to help improve forecasted results.

c. Flood Forecasting and Warning

- RID has installed many telemetry systems in various parts of Thailand. These chosen areas are subjected to flood and/or inundation almost every year. The five most important projects can be described as below:

(1) The Chao Phraya River Basin

The telemetering system was installed in the basin which covers the uppermost area of Ayuthaya Province and extends downstream to the center of Bangkok and Samut Prakarn Provinces. Since the system was firstly operated last year, it has been concluded that further extension is necessary to get good results in flood forecasts. The extension is required to cover the upstream areas from Ayuthaya Province to the Bhumiphol Dam in Tak Province. The whole project is expected to be complete in 2008.

(2) Flood Management System in the Lam Pao Sub-basin of the Chi River

Once a pilot project, financed by the Canadian International Development Agency (CIDA), to implement the LBG/SNC-Lavalin flood management system in the Lam Pao Sub-basin of the Chi River was reported to the RID, it decided to start implementing another telemetering system in parallel from 2004. According to the plan, this system will be ready for the operation in 2006. The collected data from it will be shared to the CIDA's Project as well.

(3) Telemetering System in the Tha Taphao River Basin (Tha Sae-Rab Ro, Chumporn province)

The system has been operated since 2003 and the forecasting results obtained from it were found to be in the satisfying level so far. However, many flow measurements at different sites will be implemented in the near future in order to improve the accuracy of the forecasting results.

(4) Telemetering System in the U Taphao River Basin (Songkhla province)

The system was completely constructed and has been operated since the beginning of 2004. The forecasting results were verified accordingly as the data used to calibrate the model have just been obtained for a short period of time. In addition, there were severe storms over this area last year in November to December 2005. Therefore, the accuracy of the system has been examined by the presence of a big flood and effective warning to the people in the hazard zone.

(5) Flood forecasts in the Pasak River Basin

The telemetering system was completely assembled and has been implemented since 2001. The forecasted inflows, based on the collected rainfall data and the unit hydrograph technique, were very accurate in terms of times to peak and the flood volumes.

(6) Telemetering System in the Chantaburi River Basin (Chantaburi Province)

The system has been operated since August 2004. The forecasting results obtained from the system are satisfactory and accurate for early warning.

d. Comprehensive Flood Loss Prevention and Management

- All of the telemetering systems have been operated with the aim to spare leading the time in forecasting activities and allow enough time for the people in the flood prone areas to be warned and prepare themselves prior to floods. In case of very severe floods, the RID will operate their structures (gates and reservoirs, etc.) to minimize the levels of inundated water in affected areas. In all cases, the forecasted water levels are usually disseminated to the concerned agencies in order that they can participate in flood warning and flood mitigation measures.

APPENDIX VIII

SUMMARY OF THE DPP ACTIVITIES OF THE MEMBERS

BANGLADESH

BMD disseminates the Tropical Cyclone Warnings and other adverse weather warnings as per Standing Orders on Disaster to the Disaster Management Bureau (DMB) and Ministry of Food and Disaster Management (MOFDM) in time. The representative from DMB is requested to speak on the activities of Disaster Prevention and Preparedness (DPP) in Bangladesh.

INDIA

India is actively participating in Disaster Management and mitigation meetings, and is already supplying Cyclone Warnings and advisories to ESCAP Panel members.

An earthquake of great magnitude 8.3 on Richter Scale occurred on 28th March 2005 at 21 hours 40 Min. 1ST with its epicenter off West Coast of Sumatra Island, Indonesia. IMD is monitoring the aftershock activities in the region.

An earthquake of great magnitude 7.4 on Richter Scale occurred on 8th October 2005 at 09 hrs. 20 Minutes 1ST with its epicenter at 34.6°N Latitude and 73.0°E Longitude in Muzafarabad, Pakistan Region. The earthquake has been felt widely in parts of the North India and also caused damage to property and life in some parts of Jammu & Kashmir and Himachal Pradesh. This earthquake is followed by several after shocks of moderate magnitude. The after shocks activity are still continuing and is being monitored.

IMD had organized an Indian Ocean Rim -Association of Regional Cooperation (IOR-ARC) Workshop on Disaster Mitigation & Management -Tropical Cyclone & related issued at TERI RETREAT, Gurgaon on 16-17 March 2005. The workshop was inaugurated by Prof. V.S. Ramamurthy, Secretary, Department of Science & Technology on 16 March 2005. Seventeen foreign delegates from Member States viz. Australia, Oman, Mauritius, Malaysia, Mozambique, Sri Lanka, South Africa, Tanzania, Thailand, Yeman including IOR-ARC Secretariat Mauritius. Twenty-four participants including eleven Resource persons from various Govt. / Non Govt. agencies of India attended the workshop.

Shri D. Chakraborty, DDGM(Telecom) participated in the Multidisciplinary Workshop on the Exchange of Early Warnings and Related information including Tsunami held in Jakarta, Indonesia from 14 to 18 March 2005.

Shri S.K. Subramanian, DDGM(CW) participated in the International Workshop on Tsunami response and Disaster Preparedness in Honolulu, Hawaii from 6 to 10 June 2005.

Shri R.S. Dattatrayam, Director attended a Study Conference on Tsunami Early Warning System (TEWS) in Berlin, Germany from 8th to 12th August 2005 as a Member of Indian Delegation.

Shri B.P. Yadav, Director and Shri N. Chattopadhyay were deputed to Dhaka, Bangladesh from 28th to 30th November 2005 to attend 2nd Training Workshop on Nomination and Early Warning of Droughts.

Dr. A.K. Shukla (Seismology), Director attended 5th International Workshop on Seismic Analysis in the South Asian Region held in Xian, China from 13 to 16 November 2006.

Shri H.S. Mandel, Met. Gr.II is deputed to Japan to participate in the Group Training Course in Seismology and Earthquake Engineering and Disaster Mitigation from 27th September 2005 to 16th September 2006 under Technical Cooperation Programme of Govt. of Japan.

Shri G. Suresh, Director (Seismology) and Shri O.P. Sreejith, Met. Gr. II were deputed to Singapore from 21-23 November 2005 to participate in WMO Workshop on Multi hazard Early Warning Centres concept of Operations for the Indian Ocean Tsunami Warning System.

All the maritime state governments have constituted State level disaster mitigation committees under the Chairmanship of Chief Secretary and various departments of central and state government to review and draw up fresh contingency plans in accordance with the recommendations of the High Power Committee on Disaster Management appointed by the Government of India. The action committees at the state level continue to meet twice in a year before cyclone season to discuss various measures to be undertaken during cyclone situation. At district level also under the chairmanship of collectors similar committees are functioning to implement the disaster prevention measures.

As part of pre-cyclone exercise IMD and state government authorities take all necessary steps for better reception and dissemination of forecast and warnings on cyclonic storms. IMD officers participate in the state and district level pre-cyclone meetings conducted by the state governments and explain the salient features and the effects of the storm and precautions to be taken during the storm season.

Prior to every cyclone season officers from IMD deliver talks in AIR and Doordarshan about the cyclone warnings and precautions to be taken by the people during the cyclone season as part of public awareness programme.

Various trainings are conducted by both Government and non-government organizations with regard to cyclone mitigation and disaster management. Exhibitions are conducted by some educational institutions on the role of IMD in weather warning.

Various officers of the regional and cyclone warning centres of the Department actively participated and delivered lectures in a large number of symposiums, conferences and public interaction meetings related to cyclone disaster management programmes.

MALDIVES

Warnings and advisories

The Department of Meteorology, Maldives (DMM) issued timely and accurate severe weather or tropical cyclone warnings and disseminated them to the public through mass media and web-page. It helped immensely to minimize the damages to property and loss of life due to floods/ landslides, risks to fishing vessels or passenger boats encountering stormy weather in the open seas.

Apart from severe weather or tropical cyclone warnings, tsunami warning reports received through GTS were also dispatched satisfactorily in time.

The DMM has installed 3 hotlines between the National Meteorological Centre and Television Maldives, Voice of Maldives, Coast Guard for quick dissemination of the warnings.

OMAN

Disaster Prevention and Preparedness

Disaster Prevention and Preparedness operates under the Directorate General of Civil Defense of the Royal Oman Police. On yearly basis, they run awareness programs, roving workshops, rehabilitation programs, etc.

The Public Relation Office of the Royal Oman Police issues warnings and Advisories to the public through different Media channels.

There is a very good coordination and cooperation between this entity and the Meteorological Department.

Earthquake Monitoring Center

The Sultan Qaboos University established a Center for Earthquake Monitoring in order to fulfill its mandate on a national program for the assessment and mitigation of earthquake hazard in the country. The Director of Meteorology is one of the members in the coordination technical committee.

Disaster Preparedness Plan

A new Natural Disaster Management Plan is drawn up by Directorate General of Civil Aviation and Meteorology – Department of Meteorology in coordinating with the National Civil Defense as a part of the National Natural Disaster Plan.

Future Activities

WMO World Weather Information Service Web Site

Tsunami cooperation regionally on exploring the best mechanism required for early warning system for the region.

Second Generation Satellite ground receiving station

Hosting the second EUMETSAT Satellite Applications Course For The Middle East. Hosting Satellite Applications Training Center for the countries in western RAIL under the foot print of EUMETSAT satellite.

SRI LANKA

A long-felt need, Sri Lanka Disaster Management Act 13 of 2005, was passed in the Parliament in May 2005, and consequently a new organization, Disaster Management Centre (DMC) was established in September 2005, in addition to the existing National Disaster Management Centre (NDMC). DMC with the SLMD playing a major role in early warning, is considered a monitoring, coordinating and early warning Agency while, NDMC takes up preparation and implementation of awareness projects and response, relief and recovery work.

DPP Activities

Awareness and Educational Programmes

1. Following training programmes were conducted by the NDMC to educate government officials such as Additional District Secretaries, Divisional Secretaries, Assistant Divisional

Secretaries, Social Services Officers, newly recruited Development Assistants and other relevant officers.

- Six programmes of National Certificate Course on Disaster Management – No. of participants – 184;
- A three days workshop - No. of participants 35.

2. DMC too has conducted 3-day Training of Trainers programmes in 9 districts, in addition to awareness programmes, district level, community based and village committee level.

3. The NDMC, DMC and the SLMD have published many leaflets and posters on disasters (cyclones, floods, tsunamis, landslides, lightning etc.) to educate the general public and in particular the school children.

Disaster Risk and Vulnerability Reduction and Mitigation Programmes

In order to reduce the risk and vulnerability of natural hazards, many programmes have been implemented by the NDMC, DMC and the SLMD in collaboration with the UNDP, JICA, French Government, Swedish SIDA, Italian Government (Lidar Survey), USAID, USTDA, NOAA, FEMA, Forest Services (USA), UNICEF, GEF, APN, ITDG (Intermediate Technology Development Group). Rainwater harvesting, construction of agro wells and to rehabilitate small-scale tanks and irrigation canals, including preparation of Disaster Preparedness Action Plan for the Divisional Secretariats to facilitate reducing risks in areas of high vulnerability to disasters, are among these programmes. The project on Transitional Recovery Support to Flood Disaster in Sri Lanka estimated Rs. 109 million is also implemented by the NDMC with the financial assistance of (UNDP).

NDMC operated a special unit after the 26 December 2004 Tsunami, to monitor activities of relief measures, disseminate and accumulate of information and to offer instructions and guidelines and other information to the public officials in the devastated areas.

Disaster Information System

A software "*Des Inventar*" was introduced by the NDMC to develop a Disaster Inventory System to the country. The centre is now in the process of developing a Disaster Information System, making use of past records in newspapers and historical records at District and Divisional Secretariats. Actions are also taken to develop a web-site for the NDMC.

Integrated Tsunami and Storm Surge Early Warning System (ITSSEWS)

Since the tragic tsunami event of December 2004, the SLMD is functioning as the Tsunami Early Warning Centre (EWC) for Sri Lanka. To enhance warning generation and dissemination capabilities, some of the facilities in the Department have been improved. Facilities are now available in the EWC to receive information on earthquakes within 10-15 minutes of their occurrence and tide gauge data on near real-time basis. Several communication pathways have been identified and put into operational use to disseminate warning/advisory information from the EWC.

Sri Lanka is of the opinion that an early warning system alone has limitations in their life saving capabilities, if not combined with 'people centred' networks. As such several programs such as the establishment of tsunami-ready model villages etc., are presently underway to strengthen the resilience of vulnerable communities.

Seismological station network in Sri Lanka too is presently undergoing upgrading and the establishment of a seismic data analysis centre is expected shortly. The tide gauge network

has been improved by establishing two new gauges in Kirinda and Trincomalee in addition to upgrading the gauge in Colombo.

A roadmap for a Safer Sri Lanka, a comprehensive multi hazard disaster risk management framework was launched in Sri Lanka recently by the newly established Disaster Management Centre to coordinate multi stakeholder efforts in the next 10 years through a holistic strategy. As per this strategy, a Multi Hazard Early Warning Centre is to be established for early warning activities of natural as well as man-made disasters.

Sri Lanka is actively participating, in the UNESCO-IOC initiative of establishing a Tsunami Early Warning System for the Indian Ocean (IOTWS).

THAILAND

a. DPP Activities

Since 2003, the Department of Disaster Prevention and Mitigation (DDPM) has installed 3,750 simple rain gauges in 2,410 vulnerable villages all over the country for observing, notifying, forecasting and warning about local flood conditions.

Besides launching the Community-Based Disaster Management (CBDM), the DDPM has also organized and trained the Civil Defence Volunteers to become the disaster tackling network. In 2005, DDPM has provided the CBDM courses in 75 provinces (596 communities) except in Bangkok, due to it is under the responsibility of the Bangkok Metropolitan Administration (BMA). In 2004, DDPM planned to increase the rate of Civil Defence Volunteers at 1% of the total number of the country population. However, for 2005 the DDPM has raised their target to increase the rate of volunteers to 2% of the total number of population. At present, there are 473,795 Civil Defence Volunteers throughout the country.

DDPM has initially launched the website: www.disaster.go.th for disaster and knowledge dissemination only in Thai version. At present, the website has been improved and another new version in English was created for foreigners to have the best information source of the central coordination agencies of disaster management in Thailand.

Establishment of National Disaster Warning Center

Following the catastrophe of the Tsunami on December 26, 2004, Thai Government has taken action to establish the National Early Warning System. The first step is planning to set up the Committee for the Development of an Early Warning Center and subsequently establishing a National Disaster Warning Center (NDWC). The objectives of the organization not only to be responsible for natural disaster but also the man-made disasters. The NDWC is located in Nonthaburi province and it has triggered out the warning alerts on March 28, 2005 and July 24, 2005 when it was reported that the earthquakes were occurred on Sumatra and Nichobar Islands, respectively.

The first three of 30 warning towers have been installed at Pathong Beach as an offer from Germany. Also, DDPM has already disseminated the evacuation drills for the people in the six Andaman provinces.

Japanese International Cooperation Agencies (JICA) has provided the disaster management specialist for DDPM in order to recommend the policy for Disaster Management. While GTZ (German Technical Cooperation) from Germany has assisted the DDPM in three fields as the follows: improve personnel capacity, CBDM and enhance the network of working groups among concerned agencies of disaster management. Moreover, UNDP has launched the two phased project for DDPM. At the first phase, their objectives are to improve the warning system (end-to-end) and increase the potential of the community for disaster management in

their community (budget is 20 million Baht (USD 500,000)). The duration is starting from July 2005 to March 2006. Their activities are including the installation 2 Sea Level Observing Stations with Global Sea Level Observing System, GLOSS, especially Tsunami early warning at the Tapaonoi Island in Phuket province and Meang Province at the Similand Islands and the cooperation with the University of Hawaii's Sea Level Center.

b. Disaster Statistics

Statistical data of disasters and damages in Thailand during 2001-2004, together with statistical data of 26 December 2004 earthquake/tsunami, were reported by DDPM as in the Tables 2, 3 and 4 on the following pages.

APPENDIX IX

SUMMARY OF THE TRAINING ACTIVITIES OF THE MEMBERS

BANGLADESH

Foreign Training attended by BMD during 2005

Except the participation in different Workshop, Seminar and Conference, officers of BMD underwent foreign training in different countries as follows:

Participant	Training Title	Funding	Host Country	Duration
1.	RA-II/V Training Workshop on Ensemble Prediction System.	WMO	China	18-23 April 2005
2.	Regional Training Seminar for National Trainee of RA-II and RA-IV.	WMO	Malaysia	16-27 May 2005
3.	Fifth Post Graduate Course in Satellite Communications (SATCOM).	Indian Government	India	01 August 2005 – 30 April 2006
4.	Geoinformatics for sustainable Agriculture.	TCS Colombo Plan Fellowship	India	16 August – 09 Sep. 2005.
5.	Group Training Course on Meteorology.	JAICA	Japan	10 Sep. – 17 Dec. 2005
6.	Group Training Course in Mitigation Strategy for Mega-Urban Earthquake Disaster.	JAICA	Japan	10 October – 26 Nov.

METEOROLOGICAL TRAINING INSTITUTE OF BMD ACTIVITIES:

This institute imparts in-service training to the BMD's officers and staffs as per syllabi of the scheduled courses approved by WMO. It conducts and coordinates research and investigations on various meteorological problems particularly relating to Bangladesh and the region. The training courses include both theoretical and practical aspects. The practical courses include weather observation at the surface and upper levels, recording, data analysis and issue of forecasts. Besides the departmental employees, this institute also conducts special training courses on meteorology for other organizations too. Meteorological instruments and meteorological communication system are also imparted to the students of various educational institutions. This institute also guides the M. Sc. students of various universities, who are doing their theses in the field of Meteorology. In every training course, clear conceptions about disaster preparedness and management and related Standing Orders are also imparted. This institute also conducts and coordinates research and investigations on various meteorological problems particularly relating to Bangladesh and the region. So far the institute conducted 2-3 courses in an average every year.

Regular Courses

The regular scheduled courses are:

Class-II Forecaster's Course for Class-I Officers.

Class-III Assistant's Course.

Class-IV Observer's Course

Class-II Forecaster's Refresher Course for Class-I Officers.

Areas of Training and Training Method

Science and Meteorology,

Observation of weather phenomena,

Transmission and exchange of weather data,

Analysis of weather elements and charts,

Forecasting & monitoring of the all types of weather & natural disasters

Recording and monitoring of Earthquake,

Satellite & Radar Meteorology,

Electronic and communication,

Research on Meteorology,

Seminars and workshops in the disaster prone areas,

Practical training on Storm Surge Model (Dube Model) with two hours training everyday for two months.

Training Institute imparts training to all Meteorological personnel on the above-mentioned fields through theoretical and practical classes as per the syllabi approved by World Meteorological Organization.

Monitoring Evaluation

Training has been conducted according to the standard syllabi approved by WMO. The standard of trainees have been selected and classified through interim, final, practical and viva-voce examination (lowest pass marks is 50%) on different subjects of each course.

Training Programmes Conducted by BMD in 2005

1. Class-II Forecasters' Course, Batch 10/2004-2005 during 17 April 2004-16 April 2005.
2. Class-II Forecasters' Course, Batch 11/2005-2006 during 1 June 2005-31 May 2006.
3. Short Class-III Assistants' Course, Batch No. 1/2005 during 5 February 2005-17 March 2005.
4. Class-III Assistants' Course, Batch No. 23/2005 during 14 May-09 January 2006.
5. Industrial Attachment Training Course on Meteorology, Meteorological Instruments, Electronics and Communication System ---- **6 courses completed** (Students of different Polytechnic Institutes and Vocational Training Institutes).
6. Special Orientation Courses on Weather Mapping, Communication and Electronics ---- **5 courses completed** (Students of Universities, BUET).

The Meteorological Training Institute of BMD needs to be upgraded by introducing new courses on Advanced Meteorology, Communication, Electronics and Equipment. It is essential to introduce Class I Forecaster's Course for officers (Forecasters). It is also necessary to introduce computer courses for trainees of different levels. In this respect, **assistance is necessary.**

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Advanced Meteorological Training (Revised) for non departmental officer trainees of Indian Navy, coast guard, IITM Pune and Foreign countries of southeast Asia (Region RA II) which commences from 2nd week of September every year are being held at Central Training Institute, Pashan, Pune. Training events relevant to the Panel's programme carried out since March 2003 are as follows.

Country	Course attended	No. of trainees
ETHIOPIA	Advance Met. Course 11.11.2002 to 5.9.2003	3
SRI LANKA	Intermediate Met Course 14.7.2003 to 7.11.2003	1
MALDIVES	Intermediate Met. Course 10.11.2003 to 5.3.2004	2
SRI LANKA	Intermediate Met. course 8.11.2004 to 11.3.2005	1
MALAYSIA	Intermediate Met course 8.11.2004 to 11.3.2005	1
ETHIOPIA	Intermediate Met. Course 8.11.2004 to 11.3.2005	3
ETHIOPIA	Advanced Met. course 13.9.2004 to 9.9.2005	1
KENYA	Advanced Met. course 13.9.2004 to 11.1.2005	1
MALAYSIA	Advanced Met. course 8.11.2004 to 9.9.2005	1
MALDIVES	Basic Met. course 9.5.2005 to 10.8.2005	1
MALDIVES	Intermediate Met. course 14.11.2005 till date	4
MALDIVES	Advanced Met. course 14.11.2005 till date	1
LESOTHO, SOUTH AFRICA	Advanced Met. course 12.9.2005 till date	2

Future Plans

Advanced Refresher Course will be arranged on topics pertaining to the growing needs of the meteorological community.

The tentative plan of **ARCs** in coming years is as under.

- 2006:
 - 1 Forecaster's Meet and User's Meet
 - 2 Telecommunication system present and anticipated future.
 - 3 Refresher course on Aviation Meteorology
- 2007:
 - 1 Service capability (including a product dissemination system. Disaster weather events in metropolitan cities and its mitigation).
 - 2 Increasing aerosols & their effects on various time scales pertaining to weather over India.
- 2008:
 - 1 Mapping and Analysis of Long Range transport of air pollution and its relation with Air quality.
 - 2 Sea and swell wave monitoring and its prediction.
- 2009:
 - 1 Mid Tropospheric cyclones and weather
 - 2 Operational NWP models
 - 3 Stratospheric meteorology.
- 2010:
 - 1 Special Refresher course for operational Aviation Weather Forecasters.

Tentative plan of Workshops to be organized in the coming years is given below

- 2006:
 - 1 Out reaching to common citizens through media. An Interactive Workshop with Media persons.
 - 2 Statistical Techniques for monitoring trend and predicting weather events – with practical.
- 2007:
 - 1 Storm surge prediction for Indian coasts with practical
 - 2 Average Areal Precipitation monitoring and prediction of quantitative precipitation over river basins and sub catchments.
- 2008:
 - 1 Application of Satellite derived parameters in weather prediction on different time scales.
- 2009:
 - 1 Increasing importance Aerosols and Planetary Boundary Layer in Meteorological studies.
- 2010:
 - 1 Special workshop for Indian Navy.
 - 2 Recent Met. Modellings and its application for improving short, medium and long term predictions.

Also various similar programmes will be held, based on the demand.

MALDIVES

As per the item No. 6.4.6 of the final report of 32nd Session of the Panel, Ms. Azeema Ahmed, the Meteorological Forecaster attended the attachment training program from 17-28 October 2005 at RSMC, New Delhi.

Third Regional Workshop on Storm Surge and Wave Forecasting held in Beijing, 25-29 July 2005 and China Study Tour 2005 were also attended by Maldives. The DMM is grateful to the Panel, WMO/ESCAP, IMD, CMA and other countries for their valuable contribution to the important training events.

For 2006, the Department of Meteorology needs to train staff in the field of oceanography, aviation and synoptic meteorology. Training of personnel in software development and other computer related areas are also highly important for a smooth functioning of our National Met. Service.

Therefore, we call upon WMO/ ESCAP and Panel members for their cooperation and considerations on this issue. (Ref: Table A & B)

PAKISTAN

- (a) A Memorandum of Understanding (MoU) was signed between Pakistan Meteorological Department (PMD) and the COMSATS Institute of Information Technology (CIIT) during July 2004 for cooperation and collaboration in research and development activities and human resource development. Under this MoU, within available resources, PMD shall provide Lab. Facilities and supervision of research projects to the students and faculty members of CIIT whereas CIIT shall provide its education / training and research facilities to researchers and employees of PMD at concessional rates. Under this MoU, enrollment of suitable candidates, serving personnel of PMD as well as general students, was made and M.S. Meteorology classes have commenced w.e.f. 07 February 2005.
- (b) Efforts are underway for the affiliation of PMD's Institute of Meteorology and Geophysics (IMG) at Karachi with the University of Karachi for conducting Post-Graduate Courses in Meteorology.
- (c) PC-I regarding provision of Meteorological training facilities to the SAARC and other Developing Countries has been submitted to the government for approval and allocation of requisite funds.
- (d) An officer of the Hydromet Services of Bhutan was provided training facilities at PMD's training institute at Karachi in Preliminary Meteorology Course (WMO Class-III level) during 2004.

SRI LANKA

During the year eleven meteorologists, one engineer and two technical officers from the SLMD attended conferences/seminars/workshops/trainings sponsored by WMO.

- 1. 2nd Regional Seminar on Cost Recovery and Administration in RA II. Hong Kong, China.
- 2. Workshop on Enhancing South-Central Asian Climate Change Monitoring and Indices. Pune, India
- 3. CBS Technical Conference on Public Weather Services. St. Petersburg, Russia.
- 4. Training Seminar on Curriculum Development in Aeronautical Meteorology. Exeter, UK.
- 5. Multidisciplinary Workshop on the exchange of Early Warning and related information. Jakarta, Indonesia
- 6. Intermediate Training Course in Meteorological Instrumentation. New Delhi, India.
- 7. RA IV Workshop on Hurricane Forecasting, Warning and Public Weather Services. Miami, USA.
- 8. Training Workshop on Ensemble Prediction Systems. Shanghai, China.
- 9. WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation. Bucharest, Romania.
- 10. Regional Training Seminar for National Trainers of RAI and RAV. Kuala Lumpur, Malaysia.
- 11. Seminar on the Development and Transfer of environmentally sound technologies for adaptation to climate Change. Tobago.
- 12. The Aviation Seminar. Exeter, UK.
- 13. 7th Regional Training Course on Flood Disaster Risk Management, Bangkok, Thailand.

Two technical officers from the SLMD successfully participated in Intermediate Training Course in Meteorological Instrumentation and Intermediate Training Course in General Meteorology in India Meteorological Department.

Sri Lanka would like to express its sincere thanks to the WMO for providing its staff with opportunities for participating in these events during the year. Furthermore, we would like to express our gratitude to other International Organizations and Governments for providing assistance leading to human resource training.

SLMD especially thanks for the continuous assistance provided by the IMD and the PMD in training our Meteorological Observers. At least two places per year are kindly requested from these Institutions, as it is being provided now.

THAILAND

a. Meteorology

Local Training

Since 1 October 2004 till 30 September 2005, TMD had provided training courses to its staff on a regular basis with the hope to be able to enhance their potentials in order to prepare them to cope with the advanced technology and concerned recent academic development. The local training that had been conducted in the country is shown in Table 5.

Table 5

List of local training courses provided by the TMD for its staff

No.	Course title	Duration	No. of participants
1.	Computer Training Course for Administrators	13-17-Dec. 2004	32
2.	Training Course and Demonstration on Fire Disaster Protection	4 March 2005	50
3.	Training Course on Knowledge Management towards Quality Organization	22 March 2005	87
4.	Training Course on Organization of Learning and Knowledge Management	22-23 March 2005	140
5.	Training Course on Capacity Building of Civil Servants to meet the Major Competency	18-19 April 2005	71
6.	Training Course for Teachers on "Thailand Climate"	26-27 April 2005	53
7.	Training Course on Guidelines for Excel Loader Practices	15-16 June 2005	86
8.	The 1 st Training Course on Roles and Duties of Meteorological Stations	12-14 July 2005	35
9.	The 2 nd Training Course on Roles and Duties of Meteorological Stations	26-28 July 2005	33
10.	Training Course on Technology for Grid System	19-20 July 2005	50
11.	Training Course on Application of Weather Models	26-29 July 2005	45
12.	Training Course on e-Documentary System	15-19, 22 August 2005	229
13.	Training on Typhoon Forecast by Using NWP Technique	22-31 August 2005	35

Overseas Training

During 1 October 2004 to 30 September 2005, the staff of the TMD had joined overseas training as shown in Table 6.

Table 6

Overseas training courses which the staff of the TMD had joined

No.	Course Title(s)	Duration	Country	No. of participant
1.	Short Term Exchange Programme in Science and Engineering "Introduction to Atmospheric Environment Science and Soil Engineering and Independent Study"	1 Oct. 2004-30 Sep. 2005	Japan	1
2.	Pre-Symposium Training Course on Recent Trends in Seismic Networks, Data Processing and Exchange, Hazard and Risk Assessment Disaster	4-17 October 2004	Armenia	1
3.	Training Course on Agrometeorology	1-19 November 2004	China	1
4.	The 4 th Regional Training Course on Earthquake Vulnerability Reduction for cities (EVRC-4)	29 Nov.-3 Dec. 2004	Indonesia	1
5.	WMO Training Seminar on Curriculum Development in Aeronautical Meteorology	7-11 March 2005	UK	1
6.	Regional Training Seminar for National Trainers of RA II and RA V	16-27 May 2005	Malaysia	1
7.	First Combined Modelling and Data Management Training Workshop	4-10 September 2005	Belgium	1

APPENDIX X

SUMMARY OF THE RESEARCH ACTIVITIES OF THE MEMBERS

BANGLADESH

A Research and Development Cell has been established in the Meteorological Training Institute of BMD for undertaking research in Meteorology. Every division of the department is requested to involve in doing research work in the cell. They have shown their keen interest to do research in the cell. For the development of the cell computers, broadband Internet, soft wares on different models are necessary. BMD has already started research activity. Assistance is necessary for the development of R&D Cell.

INDIA

1. A paper titled 'Foreshadowing the tracks of tropical depressions and cyclonic storms and understanding their thermo dynamical structure over Bay of Bengal and Arabian Sea using TOVS and ATOVS data' by Dr. R. Suresh, Director was presented on proxy in the 14th International TOVS study conference (ITSC-14), Beijing, China during 25th to 31st May 2005.

2. The project on 'Computerised data base and derived products on Statistics of formation movement and coastal crossing of Cyclones and Depressions over Indian Seas, 1891-2004' was completed. A further refinement is in progress.

3. The following projects were completed:

- (i) Weakening of cyclonic storms over North Indian Ocean during 1994-2003;
- (ii) Increasing and decreasing trends in the frequency of occurrence of cyclonic disturbances (D & C) over North Indian Ocean;
- (iii) Mesoscale systems arising due to shearing of intense synoptic systems like cyclone using satellite images.

4. A project on 'Generation of Electronic Version of Cyclonic Atlas-generating tracks of cyclones and depressions over Indian Seas has been initiated.

5. A study to estimate the probable maximum storm surge over east coast of India is in progress.

6. The following projects have been initiated and are in progress:

- Diurnal variation of northeast monsoon rainfall over coastal Tamil Nadu and Andhra Pradesh during October to January.
- A Project on Mean OLR distribution around a cyclonic disturbance over Indian seas during post monsoon seas on, based on INSAT OLR data of 1987-2002.
- Probable causes of intensification and weakening of cyclonic storms emerging from NW Pacific to north Indian Ocean.
- A study on northward transportation of energy and momentum flux over Indian land mass and North Indian Ocean in northward and westward moving storms.
- Estimation of Cyclone Risk Index based on Met. Parameters and the Socio Economic conditions in different coastal belts.

MALDIVES

Meteorological research activities were not carried-out last year. However, some researches on air-pollution were carried-out in the Climate Observatory of Hanimaadhoo.

PAKISTAN

(a) Meteorology

Project regarding Wind Mapping of Coastal Areas of Sindh and Balochistan for Assessing Power General Potential (Phase-I)

The above project, which was approved by the government and undertaken by Pakistan Meteorological Department (PMD) during 2001, has recently been completed. Ministry of Science & Technology provided funding (Rs. 20.757 million) for the project. More than two years' wind data has been collected at about 45 locations along the Sindh-Balochistan Coast, analyzed and detailed reports have been published. From the project saving, collection of wind data is still continuing.

These technical reports, besides wind averages, also contain wind power density, possible hourly and monthly generated electric power from a wind turbine for each area along the coast. A number of local as well as foreign investors have shown their keen interest and have purchased wind data / reports.

Based on this survey, potential areas for installing wind power farms have been indicated. This area having coverage of 9700 km² in Sindh has a gross wind power potential of 43,000 MW and keeping in view area utilization constrains etc. the exploitable electric power potential of this area in Sindh is about 11,000 MW. Feasibility study for the installation of 18 MW Model Wind Power project has been prepared and submitted to the government.

PC-I regarding project entitled "Wind Mapping of northern areas of Pakistan (Phase-II)" has also been submitted to the government for approval.

(b) Hydrology

National Centre for Drought / Environment Monitoring and Early Warning

The most devastating consequence of desertification is drought which brings in its wake poverty, famine and other social evils affecting sustainable development and initiating environmental degradation.

Revised PC-I of the project at an estimated cost of Rs.164.844 million was approved by the government during early fiscal year 2004-2005 and out of the released funds amounting to Rs.164.844 million, land has been procured and construction of building is in progress. Under this project, besides a national centre and a research unit at Islamabad, four operational centres, one in each province would be established.

(c) Establishment of Research & Development (R&D) Division

Government approved the establishment of a Research & Development Division at Islamabad during 2003-2004 at an estimated cost of Rs.39.850 million. Out of the allocated funds to the tune of Rs. 19.950 million during 2004-05, construction of building and procurement of equipment has being undertaken.

This division has since been made functional by posting research oriented personnel out of the existing staff. Major part of the project spending, however, would be incurred on capacity building and human resource development of the personnel through Ph.D; M.S. and M.C.S;

both locally and abroad, in meteorology and other related disciplines and in computer sciences.

SRI LANKA

(a) Meteorology

The research programme titled Assessment of Impact and Adaptation of Climate Change in Tea and Coconut sectors in Sri Lanka funded by GEF was completed successfully during the year.

A series of climate change awareness seminars for the benefit of district level policy makers was conducted in collaboration of the Ministry of Environment and Natural Resources under Climate Change Enabling Activity – Phase II project.

A climate change awareness program is presently being conducted through a project sponsored by the Asia Pacific Network for Global Change (APN).

(b) DPP

Programmes were conducted by the NDMC in the flood and landslide prone areas in the country as a project on Risk and Vulnerability.

THAILAND

(a) Meteorology

The Researchers in the Field of Tropical Cyclone done by the staff of the TMD can be listed as below:

- The Relation of Tropical Depression and Wind Speeds in the Gulf of Thailand;
- Tropical Depression Behaviour Changes due to Surface Friction;
- Rainfall Estimation from GMS and TRMM over Thailand;
- A Study of Behaviour of Sea Surface Temperature Relating to Tropical Depression Formation Using TRMM;
- A Study of Winds and Rain Rates at Sea Surface in Tropical Cyclones Using Remote Sensing Data;
- Storm Surge Research Using Artificial Neural Network.

(b) Hydrology

Last year, research was on Pasak river basin, the derived unit hydrograph is applied to compute flood hydrograph this year. The forecasted results are quite satisfied as compared to the measured data. The results give lead time of at least a week to prepare for the flood. This year, research is running in the Mae Wang River basin, located in the northern part of Thailand, with a catchment size of 389 sp.km.

(c) DPP

The DDPM has been carrying out a research on “Community Based Disaster Risk Management” and follow-up for evaluation for the project until now. The conclusion of this research is expected to be applied in the set-up guidelines for the future development of the community-based disaster prevention, mitigation, and rehabilitation plan.

APPENDIX XI

EDITORIAL BOARD FOR THE 2005 ANNUAL REVIEW

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APPENDIX XII

STATEMENT OF TSU ACCOUNTS**(2005 - 2006)**

1.	Balance after 32 nd Session	Pak. Rs. 352,040.00
2.	Receipts during the inter-sessional period	NIL

	Total	<u>Pak. Rs. 352,040.00</u>

EXPENDITURE

1.	Running cost of TSU website for one year	Pak. Rs. 6,900.00
2.	Honorarium to TSU-Meteorologist and Technical staff	Pak. Rs. 59,000.00
3.	Purchase of Colour Laser Printer	Pak. Rs. 45,000.00
4.	Expenses incurred on the printing of 22 nd Issue of the Panel News	Pak. Rs. 20,000.00
5 (a)	Purchase of stationery for TSU use	Pak. Rs. 2,500.00
(b)	Expenditure on postage etc.	Pak. Rs. 5,000.00

	Total	<u>Pak. Rs. 138,400.00</u>
	Balance in hand	<u>Pak. Rs. 213,640.00</u>

APPENDIX XIII

INTERIM STATEMENT OF ACCOUNT OF THE PANEL'S TRUST FUND

PANEL ON TROPICAL CYCLONE TRUST FUND

Interim Statement of Account

as at 31 December 2005

	\$	\$
Balance of fund at 1 January 2004	41,264	
Contributions	24,000	
Interest	688	
Total revenue		65,952
Less: Expenditure		
Local administrative support to the TSU for 2003 printing of Panel News and development of TSU website	4,000	
Local administrative support to the TSU for 2004 printing of Panel News and development of TSU website	4,000	
UNDP charges	30	
Bank charges	45	
Support costs (13%)	1,044	
	<hr/>	9,119
Balance at 31 December 2005	\$	<u><u>56,833</u></u>
Represented by:		
Cash in Bank	\$	<u><u>56,833</u></u>

Country	Contributions			Total
	2003	2004	2005	
Bangladesh	2,000			2,000
India		2,000	2,000	4,000
Maldives		2,000	2,000	4,000
Oman	2,000	2,000		4,000
Pakistan	2,000	2,000		4,000
Sri Lanka		2,000		2,000
Thailand		2,000	2,000	4,000
Total	<hr/>	12,000	6,000	<hr/> <u><u>24,000</u></u>