WMO

WORLD METEOROLOGICAL ORGANIZATION

AND

ECONOMIC AND SOCIAL COMMISSION
FOR ASIA AND THE PACIFIC

ESCAP

WMO/ESCAP PANEL ON TROPICAL CYCLONES

THIRTY-SECOND SESSION

New Delhi, India

(21 to 26 February 2005)

FINAL REPORT

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (Agenda item 1)

1.0.1 The thirty-second session of the WMO/ESCAP Panel on Tropical Cyclones was held at the India Habitat Centre, in New Delhi, India from 21 to 26 February 2005.

Attendance

1.0.2 The session was attended by representatives of seven of the eight Member countries of the Panel, namely: Bangladesh, India, Maldives, Oman, Pakistan, Sri Lanka and Thailand. The session was attended by observers from China, Saudia Arabia, Asian Disaster Reduction Center (ADRC), International Civil Aviation Organization (ICAO), and invited experts from Denmark and the Indian Institute of Technology (IIT)-Kharagpur. The session was also attended by representatives from WMO, UNESCAP and Technical Support Unit (TSU). The list of participants is attached as Appendix I.

1.1 Opening of the session (agenda item 1.1)

1.1.1 The opening ceremony commenced at 10.00 a.m. on Monday, 21 February 2005 at the the India Habitat Centre.

1.1.2 Mr Bhukan Lal, Additional Director-General of the Indian Meteorological Department (IMD), extended a cordial welcome to all the participants. He mentioned that the purpose of the annual sessions was to review every aspect of cyclone–related disaster prevention and preparedness activities in the Panel. He also stated that this session gains an added relevance in the wake of the disastrous tsunami which has highlighted the need for an extremely rapid response system that can even be an extension of the existing cyclone warning system. Mr Lal further said that the services rendered by the Regional Specialized Meteorological Centre (RSMC) located at IMD New Delhi are extremely significant in this regard and can be geared to suit the emerging requirements of the entire region. He wished the delegates a pleasant and enjoyable stay in New Delhi.

1.1.3 On behalf of Mr Michel Jarraud, Secretary-General of WMO, Mr Eisa H. Al-Majed, the representative of the WMO Secretariat, welcomed all the participants to the session and expressed the appreciation of WMO to the Government of India for hosting the session and for the excellent arrangements made. He reiterated WMO's condolences and sympathy to all governments and peoples of all those countries affected by the unprecedented disastrous tsunami on 26 December 2004. He said that WMO had emphasized that the development of a tsunami early warning system and national alert and response mechanisms should be carried out with a multi-hazard approach. He pointed out that nearly 90% of natural disasters are weather, climate and water-related hazards, such as tropical cyclones, severe storms, storm surges, floods, heat waves and cold spells. Mr Al-Majed highlighted some of the activities of the WMO Tropical Cyclone Programme and the Panel in promoting and coordinating efforts to minimize the impact of tropical cyclone disasters. He mentioned that the accuracy of track forecasts and the timeliness of warnings have been steadily improving. However, there are still inadequate tropical cyclone forecasting and warning services in some Member countries, which need further improvements. Mr Al-Majed assured the session that WMO would continue making every effort to support the Panel's work to the extent possible.

1.1.4 The Executive Secretary of UNESCAP, in his message transmitted by Mr Le Huu Ti as representative of UNESCAP, expressed his appreciation to the Government of India for hosting this session and also for the provision of advisory services of the Regional Specialized Meteorological Centre at New Delhi. He also expressed appreciation to the Government of Pakistan for hosting the Technical Support Unit and providing the services of a coordinator and a meteorologist to support the activities of the Panel since 2000. He

pointed out that the tsunami on 26 December 2004 in the Indian Ocean was one of the most tragic disasters in the recent history of mankind and another strong testimony of the urgent need to address the risk of common threats caused by natural disasters to sustainable development in the region. He underlined the fact that the loss of lives of more than 240,000 people, including over 47,000 people from five Member countries of the Panel, in a single disaster had accounted for more than 60 per cent of the total number of deaths caused by all natural disasters during the previous 14-year period from 1990 to 2003. The tsunami disaster had tragic and severe impacts on the economic conditions of these developing countries, especially Maldives and Sri Lanka, in relative terms of their respective GDPs. He expressed the commitment of UNESCAP to further its efforts to assist the developing countries in enhancing their capacity to integrate disaster risk management into the socio-economic development process and would expand its ongoing activities in assisting countries (i) in the application of comprehensive assessment methodologies of socio-economic impacts of disasters including tsunami for better integration of disaster risk management into the reconstruction and development process, (ii) in the development of strategies for quick recovery and stabilization of the livelihood of affected communities and strengthening regional mechanisms for better warning and communication systems, and (iii) in capacity building for community-based disaster risk management.

1.1.5 Dr Qamar-uz-Zaman Chaudhry, the Coordinator of Technical Support Unit (TSU) expressed his deep grief and concern over the unprecedented loss of life and property caused in coastal areas of five out of eight Panel Member countries because of the history's ever deadliest tsunami, generated by the great Sumatra earthquake on 26 December 2004. While placing faith in the wisdom and deep insight of participating delegates, he hoped that they would conduct meaningful deliberations and come up with concrete proposals, aimed at having in place some integrated early warning and response systems against water related disasters that would ensure safety of their vulnerable communities. Dr Chaudhry assured the participants of his complete support in their endeavors and wished all the delegates and observers a most happy and memorable stay in New Delhi.

1.1.6 In his inaugural address, Professor V.S. Ramamurthy, Secretary, Department of Science and Technology expressed that the session had assumed considerable significance after the recent Indian Ocean tsunami and that this issue was included in the programme. He mentioned that the Panel has been doing excellent work for the last 32 years in coordinating the efforts in monitoring, forecasting and warning of tropical cyclones and that the Panel owes its success to the effictive coordination of the Member countries, WMO and ESCAP. Prof. Ramamurthy highlighted the important role of the India Meteorological Department in tropical cyclone programmes and that the Government of India has given high priorty to IMD advancements in all aspects. He added that the Panel countries had been making substantial progress in improving their facilities and skills in matters related to tropical cyclones. In his view, early detection, accurate monitoring and speedy dissemination of warnings and effective coordination with user agencies during pre and post-landfall stages are the basic key to success in this area. He extended a warm welcome to the delegates and wished them a pleasant stay in New Delhi.

1.1.7 In his inaugural speech, Mr Kapil Sibal, Honourable Minister of State for Science and Technology and Ocean Development, welcomed all delegates. He was glad to note that a special agenda item on integrated tsunami and storm surge early warning and response system in the Indian Ocean would be deliberated at the session. In this regard, action relating to the establishment of an early warning system for tsunami and storm surge has to be vigorously pursued to regain public confidence. The Honourable Minister recalled that the Panel was established in 1973 and since then the Member countries have been making substantial progress in improving their facilities and capabilities and he commended the support of the international organizations and development partners such as ESCAP, ICAO, UNDP and WMO. Mr Sibal stressed the importance of timely and accurate warnings and early preparation which are critical in ensuring disaster preparedness and mitigation. The Hounourable Minister mentioned that the comprehensive programme for upgrading IMD's infrastructure, to improve its processing and forecast models and warning dissemination

system would go a long way to strengthen the capacities of RSMC New Delhi and improving the cyclone warning services to the Panel region. He wished the participants success in their deliberations.

1.1.8 Mr S.R. Kalsi, Additional Director-General of IMD, offered a note of thanks and acknowledged the contribution, the valuable support and guidance provided to IMD and the Panel by all concerned.

1.2 Election of the Chairman and Vice-Chairman (agenda item 1.2)

1.2.1 Mr Bhukan Lal (India) and Mr Md Akram Hossain (Bangladesh) 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

1.2.2 Mr Ali Shareif (Maldives) was elected as Chairman of the drafting committee.

1.3 Working Arrangements (agenda item 1.3)

The Panel decided on its working hours and the arrangements for the session.

2. ADOPTION OF THE AGENDA (Agenda item 2)

The Panel adopted the agenda as given in Appendix II.

3. FOLLOW-UP ACTION ON PTC-31 (Agenda item 3)

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

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

4. REVIEW OF THE 2004 CYCLONE SEASON (Agenda item 4)

4.1 The representative of India presented a review of the 2004 cyclone season on the basis of the comprehensive report entitled “REPORT ON CYCLONIC DISTURBANCES OVER NORTH INDIAN OCEAN DURING 2004”, which had been prepared by RSMC-tropical cyclones New Delhi.

4.2 The Director of RSMC New Delhi informed the Panel that the North Indian Ocean witnessed the development of ten disturbances, out of which four systems attained cyclonic storm intensity. One was a very severe cyclonic storm and the other three were severe cyclonic storms. Four of the disturbances were depressions, two of which became deep depressions while the other two were land depressions. Out of the four cyclones, three developed over the Arabian sea and only one formed over the Bay of Bengal. Two depressions formed over the Bay of Bengal and two in the Arabian sea. In addition there were two depressions that developed over land.

4.3 In noting that a cyclone had formed close to the equator in 2004 (south of 5°N), the Panel recognized the need to ensure that the arrangement among RSMCs should also adequately cover the area below 5 degrees N. In that context, the Panel was gratified to note the readiness of RSMC New Delhi to cover this additional area as desired by some of the Members and ICAO. The Panel agreed to this suggestion to extend the area of responsibility of RSMC New Delhi up to the equator and cover North Indian Ocean east of longitude 45°E. The Panel requested RSMC New Delhi to make a formal request to WMO summarizing the technical and legal background of this issue.

4.4 Panel also noted that most of the cyclones dissipated during this year over the sea without making landfall. The Panel felt concerned about the continued problems of landfalling tropical cyclones and urged the research community to suitably address this issue.

4.5 The representatives of Bangladesh, Maldives, Oman, Pakistan, Sri Lanka and Thailand reported to the session a review of the 2004 cyclone season of their respective countries. A summary of which is given in Appendix IV.

4.6 The Panel expressed its appreciation to the RSMC-tropical cyclones New Delhi for the valuable contribution to its Members and further emphasized the importance of strengthening the existing symbiotic relationship between the national warning centres and RSMC New Delhi.

5. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME (Agenda item 5)

5.1 The Panel expressed its appreciation for 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-first session of the WMO/ESCAP Panel on Tropical Cyclones (Colombo, Sri Lanka, 1 to 6 March 2004).

5.2 The Panel noted with appreciation the success of the Second WMO Regional Technical Conference on Tropical Cyclones, Storm Surges and Floods which was held in Brisbane, Australia from 1 to 3 July 2004 in association with the International Conference on Storms (Brisbane, 5 to 9 July 2004). The Regional Technical Conference provided a forum for the exchange of views and experience on improving tropical cyclone, storm surge and flood forecasting and also strengthened cooperation and coordination between TC regional bodies having common interests, in particular, the Panel and the Typhoon Committee.

5.3 The Panel was informed that TCP published the "Annual Summary of Global Tropical Cyclone Season 2003" (WMO/TD-No. 1194) (TCP-49) in December 2004 in CD-ROM format and was distributed to all the Members of the five tropical cyclone regional bodies. Publication of the 2004 Global Summary is scheduled in September 2005.

5.4 The Panel was pleased to note that TCP had received the detailed pilot study in the Philippines on the economic and social impacts of tropical cyclones with emphasis on the assessment by end-users of relevant weather services. The said study would be used as a basis for undertaking similar studies in other tropical cyclone-affected areas in the world.

5.5 The Panel expressed its appreciation to WMO and IIT Kharagpur for arranging the attachment of two experts from Maldives and Oman at the Indian Institute of Technology (IIT, Kharagpur, 4 to 15 October 2004) in the implementation and running of a PC-based high-resolution storm surge/wave model. The Panel expressed its appreciation to IIT for this valuable contribution to the Panel's activities and requested WMO to make similar arrangements with the IIT for the year 2005 for the attachment of storm surge/wave forecasting experts from Myanmar and Pakistan.

5.6 The Panel was informed that steps are underway to organize the Third Workshop on Tropical Cyclones, Storm Surges and Wave Forecasting – A Hands-on Training Laboratory in Beijing, China tentatively from 25 to 29 July 2005. The Members were pleased to note that all the Panel Members will be invited to participate at the said workshop.

5.7 The Panel noted with appreciation that forecasters from Bangladesh, Oman and Sri Lanka would participate at the forthcoming RA IV Workshop on Hurricane Forecasting and Warning and Public Weather Services (Miami, Florida, USA, 11 to 23 April 2005). Recognizing the fact that it would be advantageous for the trainees to know of the forecast

and warning experiences of cyclone forecasters in other tropical cyclone basins, the delegate from India urged WMO, in consultation with the workshop organizers, to consider inviting a cyclone expert from the Panel to be one of the resource persons in future workshops.

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

6.0.1 Mr Ahmed Hamoud Mohamed Al-Harthy (Oman), Chairperson of the working group tasked to carry out a detailed review of the Coordinated Technical Plan (CTP) submitted a draft plan for the Panel's consideration given in Appendix V. The Panel expressed its appreciation on the work done by Mr Al-Harthy. The Panel decided to circulate the draft plan to all Members, TSU, WMO and ESCAP for their comments and then to be finalized by the Chairperson.

6.0.2 The Panel established an *ad-hoc* group during the session to identify some of the specific issues to be addressed by the Members on the basis of the draft plan submitted by the Chairperson and the general framework for CTP (2005-2009) which was adopted during the 31st session. In this regard, the Panel agreed on certain specific issues in the overall framework of the CTP to be implemented during the next two years (2005-2006) as given in Appendix VI.

6.1 Meteorological Component (agenda item 6.1)

6.1.1 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 WWW 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 VII.

Meteorological Observing and Telecommunication Systems

6.1.2 According to the results of the WWW October Annual Global Monitoring (AGM) for the years 2003 and 2004, the average availability of SYNOP reports expected to be received during these two periods from RBSN of Members of Panel on Tropical Cyclones ranged from 28 to 100 per cent with Thailand providing the highest percentage of reports in the region, constituting 100 per cent of expected reports.

6.1.3 The availability of TEMP reports during the same October AGM period in 2003 and 2004 ranged from 0 to 94 per cent. India continued to provide the highest coverage of data from its 29 upper-air stations (94 per cent) while Pakistan showed a slight increase in the availability of reports.

6.1.4 The Panel felt that as in the past years, deficiencies in surface and 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 were destroyed during the tsunami event in South-East Asia region on 26 December 2004. It urged Members to take necessary action to ameliorate the implementation of the observational programme in particular upper air observations and data exchange.

6.1.5 The Panel was pleased to note that the implementation of point-to-point circuits required for the connection of the countries to the GTS had made significant progress, in particular:

(a) Upgrade of all but one of the MTN circuits in Region II through data-communication network services (e.g. New Delhi-Tokyo), according to CBS plans for the Improved MTN;

(b) Upgrade of several regional circuits to Frame Relay circuits, in the South-Eastern part of the Region (e.g. Bangkok -Tokyo); and

(c) Upgrade of several regional circuits to 64 kbit/s digital leased circuits, in particular in the area of responsibility of RTH Jeddah (e.g. Jeddah-Muscat), RTH New Delhi (e.g. New Delhi-Karachi); using the TCP/IP protocol, NMC Dhaka by a 2.4 Kbit/s circuit and New Delhi – Male by TCP/IP Socket protocol through internet.

6.1.6 The Panel was informed that the reception of data and products on the point-to-point circuits was complemented by the reception of satellite data-distribution systems. The INSAT satellite operated by India includes a Meteorological Data Distribution channel (INSAT/MDD), which can be received at NMCs associated to RTH New Delhi and located within the footprint of the satellite. INSAT MDD receiving systems were installed in Bangladesh, Maldives and Sri Lanka. RTH New Delhi has replaced and upgraded the HF radiobroadcast by a satellite–based system using Digital Audio Broadcasting (DAB) datacast techniques. EUMETSAT MDD receiving systems were installed in Oman and Pakistan. With Meteosat Second Generation (MSG), EUMETSAT had implemented a dissemination system via telecommunication satellite services, EUMETCast, based on Digital Video Broadcast (DVB) techniques, which included the MDD service.

6.1.7 All the RTHs were operating a web server. Almost all NMCs have access to the Internet, at least for e-mail services, and a number of NMCs are also maintaining a web site. Some RTHs' web servers were used as an efficient complementary means for providing data and products to the NMCs, in particular for those NMCs with low-speed or no connection to the GTS. Some RTHs were also collecting observational data from NMCs by e-mail.

6.1.8 **Bangladesh** informed the Panel that two S-band Radars at Cox's Bazar and Khepupara would be replaced.

6.1.9 **Oman and Maldives** informed the Panel that they had experienced irregular reception of RSMC New Delhi advisories. The Panel requested RSMC New Delhi and concerned Members to look into the matter.

6.1.12 **India** informed the Panel that cyclone detection radars were installed and commissioned at SHAR (Sriharikota Range Center) and Machilipatnam in April and August 2004. Another Doppler weather radar was installed in early 2005 at Visakhapatnam.

6.1.11 **Thailand** informed the Panel that in 2004, three C-band Doppler radars and Portable Doppler C-band weather radar were purchased by the Thai Meteorological Department. One of the C-band radars will be set up at the Krabi Airport in Krabi province while two will replace the old radars in Phuket and Rayong. Additionally, an S-band radar was installed in Khao Khiew District, Nakhon Nayok Province.

6.1.12 **Sri Lanka** informed the Panel that a proposal to acquire a microMET radar has been re-submitted to Japan for funding consideration.

Numerical Models

6.1.13 **Oman** informed the Panel that the Department successfully managed to develop its own verification package which verifies parameters such as T_2m, TD_2m and total precipitation and is used to determine the significant errors in the Model Output. The verification package is available to all Panel Members upon request.

Meteorological Satellites

6.1.14 The Panel noted with appreciation the latest detailed information on the status reports on the operational meteorological satellite systems that are presently providing data or having the potential to provide the data to Members in the Bay of Bengal and the Arabian Sea.

6.1.15 The Panel was pleased to note that EUMETSAT would continue to provide the Indian Ocean Data Coverage (IODC) service until the end of 2008. Then Meteosat-7 will take over from Meteosat-5 at 63^{o}E by 2006 subject to the successful launch and commissioning of the MSG-2 (M-9) satellite.

6.1.16 **India** informed the Panel that INSAT 3D would be launched in 2006, which will have an imager as well as sounder as meteorological payloads.

Tropical cyclone names

6.1.17 The Panel was pleased to note that the tropical cyclone name list was completed in May 2004 and has been adopted to name cyclones which formed in the Panel Area by RSMC New Delhi since September 2004.

6.1.18 The Panel also noted keen interest of the media in the names adopted by the Panel and of the time needed by several Panel Members to change the existing reporting systems to use the names in the list. It agreed to request RSMC New Delhi to continue assigning names based on the list for its advisories. The Panel agreed to review the implementation of this programme and report at the next session.

6.1.19 The Panel expressed its appreciation to Mr Al-Harthy for the work in this subject as Rapporteur on the Naming of Tropical Cyclones for the Bay of Bengal and the Arabian Sea.

ICAO

6.1.20 The ICAO observer expressed appreciation of the operation of TCAC New Delhi. Since early 2004, TC advisories for aviation have been issued regularly in the form of FKIN20 and FKIN21 bulletins for the Bay of Bengal and Arabian Sea, respectively. The bulletins are promulgated for international dissemination via AFTN and made available through the SADIS broadcast, operated by the UK Met Office. Some format issues have been resolved.

6.1.21 At the same time, the session was informed that some problems with the issuance and dissemination of TC SIGMET still existed. It was recalled that all Panel Member countries had designated Meteorological Watch Offices (MWO), which are listed in the ICAO's Asia/Pacific and Middle East Air Navigation Plans (ANP). Therefore, all countries had the obligation of issuing TC SIGMET and disseminate it using the ICAO dedicated aeronautical fixed network (AFS). The ICAO observer stressed that the lack of SIGMET could lead to several implications, such as: lack of important safety-related for airlines; no information for World Area Forecast Centres (WAFC) for inclusion of TC symbol on WAFS SIGWX Charts; and as a result, loss of credibility by the aviation users.

6.1.22 In order to identify the reasons for the existing deficiencies in the provision of SIGMET, ICAO has initiated regional SIGMET tests. The preliminary results of the first test conducted on 18 February 2005 indicated that the so called triggering test TC advisory was issued by TCAC New Delhi but the following test SIGMET was issued only by the Indian MWOs. It was apparent that there existed some communication problems, which, according to the ICAO observer, could be easily resolved.

6.1.23 The Panel ageed that the issues raised by ICAO should be pursued by all Panel Members and the deficiencies related to SIGMET should be resolved. It was informed that most of the Panel Members had already implemented the ICAO requirements on SIGMET, however, there existed some communication inconsistencies. In particular, the AFTN

addressing used by TCAC New Delhi and the MWOs should be reviewed. It was agreed that TCAC New Delhi would coordinate this effort. ICAO will also povide any assistance regarding the procedures through its Regional Office in Bangkok.

6.1.24 The Panel considered the ICAO attendance at the Panel's sessions as very beneficial for the Member countries by providing them with timely updates on the ICAO requirements for TC related information for the international air navigation. Therefore, the Panel felt that the close cooperation with ICAO and invitations for ICAO to attend the Panel's sessions should continue.

6.2 Hydrological Component (agenda item 6.2)

6.2.1 Under the hydrological component, the Panel reviewed the activities of its Members, UNESCAP and WMO. The representatives of the Members reported the activities of their respective countries as reflected in Appendix VIII. In 2004, several important improvements in the hydrological component had been made by the 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.

6.2.2 The Panel was informed of continued good cooperation among the concerned Members in the exchange of hydrological data in the international river basins. It was particularly pleased with commitment of Governments of Bangladesh and India to exchange water level data continuously during the period from 15 May to 15 October every year to enhance effectiveness of flood forecasting operations. The Panel urged these Members to continue this kind of cooperation to further improve flood forecasting services for better protection of the lives of the people and hoped that this spirit of cooperation for humanitarian cause be highlighted at various international fora to reflect the enhanced spirit of cooperation among the Panel Members.

Activities of WMO

6.2.3 The Panel was informed that a number of activities have taken place during the intersessional period of the Panel on Tropical Cyclones, which have the potential of strengthening its hydrological component.

6.2.4 The Panel was informed of the WMO flood forecasting initiative. 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, North America and the Caribbean) in Valencia, Spain, in March 2004. Further regional workshops are planned for West Africa, Regions II (Asia) and V (Australia and the Pacific) in 2005. The Panel was also informed of the planned international workshop to be organized jointly with NOAA on flash flood forecasting in Costa Rica in September 2005. Panel Members were invited to participate in the workshop. More information is available under: http://www.wmo.int/web/homs/index.html.

6.2.5 To strengthen services related to disaster mitigation, prevention and preparedness, the WMO Working Group on Hydrology (WGH) of RA II (Asia) was established during its session in July 2004 in Bangkok which included a theme area "Disaster Mitigation – Improvements to Short-duration (Flash) Flood Forecasting Capabilities in Urban Areas" in its proposed work schedule for the period 2005–2008. The WGH had also proposed to include a theme "Development of scientific methodology and resources to provide hydrological information and hydrological predictions" with an aim to improve forecasting services issued by National Hydrological Services. The Panel Members were urged to participate in these activities.

6.2.6 In 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, a draft Strategic Plan for the Enhancement of NHSs in RA II had been developed for the period 2005-2008. In general terms, 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 fulfil countries' commitments under regional and international agreements and conventions. It was urged that the activities of the Panel should be formulated in the light of the Strategic Plan.

6.2.7 The Panel was informed that WMO has established a new, cross-cutting programme on Natural Disaster Prevention and Mitigation (DPM). Pre-disaster preparedness is a focal orientation of the programme. To follow its activities at the regional level in RA II (Asia) a working group on natural disaster prevention and mitigation has been established by WMO's Regional Association (RA) II (Asia) during its thirteenth session in Hong Kong, China, December 2004. Members were requested to communicate their national focal points for the regional planning and implementation of the programme. In this regard, importance of development of an effective hydrological component to effectively contribute to disaster prevention in coastal areas endangered by storm surges and combined river and tidal floods, was emphasised.

6.2.8 The Panel was informed of the need to consider the integrated approach to deal with issues related to Coastal Flood Management as a component of Integrated Flood Management irrespective of the fact whether such floods are a consequence of storm surge or tsunami in a proactive manner to reduce vulnerability of the population to loss of lives and property.

6.2.9 The Panel on Tropical Cyclones was requested to explore more efficient communication and cooperation mechanisms that allow an enhanced collaboration between relevant programmes of WMO including the HWRP and the DPM as well as the Commission for Hydrology and the regional Working Group on Hydrology as well as national focal points related to the DPM. In the light of the recent tsunami catastrophe, the Panel was in particular urged to promote the development and establishment of an early warning system that integrates the needs of a Storm Surge Early Warning System with those identified for the proposed Tsunami Early Warning System.

6.2.10 The Panel was urged to consider setting up an integrated Tsunami and Storm Surge Early Warning System that could build on existing observational and telecommunication systems as well as lines of communication to disseminate warning messages down to the local level in most potentially affected countries and the application of preventive measures against resulting flood disasters.

Activities of UNESCAP

6.2.11 In 2004, UNESCAP completed activities related to water resources management under the project on "Capacity-building in strategic planning and management of natural resources in Asia and the Pacific". The activities included application of the Guidelines on Strategic Planning and Management of Water Resources to promote integrated water resources management in 17 countries, including four Members of the Panel, namely Myanmar, Pakistan, Sri Lanka and Thailand. The Concluding Regional Workshop on Strategic Planning and Management of Natural Resources was held in Bangkok in November 2004 to consolidate the findings and recommendations of the project. The Guidelines on Strategic Planning and Management of Water Resources, which had been posted on UNESCAP Website since February 2002 and regularly updated, was published in November 2004.

6.2.12 Following the close collaboration between WMO and UNESCAP in organizing the meeting of the WMO Working Group on Hydrology (WGH) of RA II (Asia) in July 2004 in Bangkok aiming at strengthening services related to disaster mitigation, prevention and

preparedness, UNESCAP commissioned an Assessment of Water Resources in Asia and the Pacific in the 21st Century by Prof. Igor Shiklomanov (Russia) to stimulate future improvements on water assessment. The study was presented at the Concluding Regional Workshop on Strategic Planning and Management of Natural Resources.

6.2.13 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.

6.3 Disaster Prevention and Preparedness (DPP) Component (Agenda item 6.3)

6.3.1 Under this agenda item, the Panel reviewed the activities of its Members and discussed the related activities of WMO, UNESCAP and ADRC. 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 the future plans. The Panel noted with appreciations the participation of the DPP experts from the host country, India. In view of the importance of DPP for effective impacts of the Panel's activities, the Panel urged Members to send their DPP experts to take part in future sessions.

6.3.2 In most of the Panel Members, efforts were continued to provide training to stakeholders to enhance awareness and participation. A summary of DPP activities of Panel Members is given in Appendix IX.

Activities of WMO

6.3.3 In preparation for the World Conference on Disaster Reduction (WCDR), WMO formed a task team well in advance of the conference, identified and divided the responsibilities, and organized potential contributions of WMO Members as well as those of the Secretariat. Under the coordination of the Secretariat, the WMO WCDR task force, several Permanent Representatives (PRs) and various meteorological and hydrological experts worked together as a team in developing a comprehensive programme that addressed WMO strategic goals for WCDR, particularly related to importance of risk assessment and early warnings for weather-, climate- and water-related hazards. The Natural Disaster Prevention and Mitigation Programme (DPM) with extensive input from all scientific and technical programmes at WMO, developed a pamphlet, a brochure and the WMO Disaster Prevention website, providing information on WMO's activities in disaster risk reduction.

6.3.4 In response to the tragic tsunami event in Asia and in preparation for WCDR, WMO developed a concept paper on the organization's strategy and relevant capabilities in this area. Furthermore, WMO held a joint press conference with UNESCO-IOC.

6.3.5 The conference was divided into three segments: Intergovernmental Segment, Thematic Segment and the Public Fora.

6.3.6 During the Intergovernmental Segment, the Secretary General of WMO gave two statements, one during the Tsunami Session, describing WMO strategic goals and capabilities related to natural disaster risk reduction. The outcome document explicitly stated that near 90% of disaster are related to weather, climate and water related hazards. The importance of preventive strategies, with focus on integration of risk assessment and early warning has been highlighted in the document negotiated with the delegations.

6.3.7 In the Thematic sessions, WMO was a co-organizer of the nine sessions of the Thematic Area 2: Risk Identification, assessment, monitoring and early warning. TCP in cooperation with NWS/NOAA (USA) organized Thematic session 2.3 "Reducing Risks

Through Effective Early Warnings of Severe Weather Hazards" under Cluster 2 "Risk Identification, Assessment, Monitoring and Early Warning". WMO sponsored 16 speakers in the nine sub-sessions; Important Thematic sessions to WMO were those on severe weather (TCP coordinated), urban risks (WCP coordinated), global observations (WCP coordinated), and Integrated Flood Risk Management (HWR coordinated). In every session either the WMO secretariat or one of the invited NMHSs speakers interjected the WMO viewpoints. Specifically, WMO has stressed through its presentations and interventions that:

- Disaster risk prevention must be viewed with a multiple-hazards approach for warning purposes;
- Future early warnings must be carried out in a cooperative manner with other agencies and the NMHSs. In addition to Cluster 2, WMO Secretariat gave presentations in several other Thematic sessions. These included:
    - Thematic Session - Promotion of Tsunami Early Warning System in the Indian Ocean – Towards establishment of early warning system – WMO presented the relevant capabilities and goals of the organization related to this area and encouraged a multi-hazard and global approach to tsunami early warnings;
    - New international initiatives for research and risk mitigation in floods (IFI) and landslides (ICL);
    - Disaster Risk Management and Climate Change Adaptation;
    - Earth Observations for Disaster Reduction - WMO presented assimilation of observation and the need for GEOSS for expanded observations, as critical elements for enhancement of early warnings.

6.3.8 During the Public Forum Segment WMO, together with the Japan Meteorological Agency, organized a full day workshop, entitled "Reducing Risks of Weather, Climate and Water Extremes Through Advanced Detecting, Monitoring, Early Warnings and Opportunities of Information Society".

6.3.9 WMO had a booth and a poster at the poster session. At the booth, an Information Kit on WMO's natural disaster related activities, various programme materials, posters and movies were displayed.

6.3.10 The Secretary-General served as a panelist in a high profile public Symposium, *"Living With Risk",* which was sponsored by the Government of Japan and the Asian Disaster Reduction Center (ADRC), held on 17 January 2005. This programme was broadcasted through Japan on the national TV.

6.3.11 WMO's potential contribution to tsunami early warning system was presented during the Second Thematic Tsunami Session, after the closing of WCDR, co-sponsored by UNESCO-IOC and the ISDR Platform for Early Warnings, held on 22 January. WMO encouraged a multi-hazard global approach to early warnings to ensure that all countries around the world can benefit from these capabilities. Furthermore, WMO outlined how it can contribute to the tsunami early warning initiative, and stressed the critical need for strong partnerships, and building on the current capabilities of potential partners.

6.3.12 The Secretary-General of WMO served along with heads of four other UN Agencies in an event for the launch of the Platform for Early Warning Systems. He gave a statement on the importance of strong partnerships and laid out WMO's mandate and multi-hazard early warning activities related to this event.

6.3.13 Prior to the conference, WMO held a joint WMO/UNESCO-IOC press conference in Geneva, and held several media interviews on strategic goals of WMO for WCDR. The interviews were broadcasted on BBC and a number of other major networks prior and during WCDR.

Activities of UNESCAP

6.3.14 The Tsunami disaster in the Indian Ocean has boosted the priority that UNESCAP attached to its activities on disaster prevention and preparedness, including those dealing with water-related disasters reduction. In this connection, UNESCAP has established ***a Tsunami Disaster Task Force*** to mobilize internal resources and coordinate cooperation with other international organizations in assisting affected countries in dealing with the impacts of the recent tsunami disaster and the development of a regional tsunami early warning system.

6.3.15 UNESCAP started the implementation of a project aiming at promoting methodologies for better 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), especially the methodology developed by ECLAC for this purpose. In 2004, a regional workshop was held in May 2004 to review existing methodologies in the region and examine the ECLAC methodology. Subsequently case studies were arranged to be carried out in seven countries, including three Members of the Panel, namely Pakistan, Sri Lanka and Thailand. Direct application of the ECLAC methodology is also being attempted for the tsunami disaster. The Panel Members are encouraged to use the methodology for better integration of disaster reduction activities into the development process.

6.3.16 In 2004, UNESCAP in cooperation with the Asian Disaster Preparedness Centre (ADPC) completed Phase II 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 for training of several hundred practitioners on various aspects related to community-based disaster risk management, strengthening partnership at the regional and national levels and exchange of information and experiences, including publication of a set of Field Practitioners' Handbook on community-based disaster risk management. Following the successful completion of Phase II in June 2004, ECHO is considering possibility to fund Phase III in 2005-06 aiming at integrating Community Based Disaster Risk Management (CBDRM) into the socio-economic development process in South-East Asia. Phase III will also be implemented jointly by UNESCAP and ADPC.

6.3.17 UNESCAP in cooperation with ADPC organized the Annual Forum on Natural Disaster Reduction on 13 October 2004 to commemorate the International Day for Natural Disaster Reduction at the United Nations Conference Centre in Bangkok. The event included also the ADPC-UN/ESCAP Journalism Award for Outstanding Reporting on Emergencies and Disasters 2004, which was well received by the media.

Activities of other regional and international organizations

Asian Disaster Reduction Centre (ADRC)

6.3.18 The Asian Disaster Reduction Center (ADRC) was established in 1998 in Kobe, Japan, as a regional organization for multilateral cooperation composed of 24 member countries, five advisor countries and one observer. It promotes disaster reduction activities in Asia, in cooperation with its member countries and partner organizations, with a view to ensuring sustainable development of the region.

6.3.19 The Panel noted with appreciation the continuing cooperation between ADRC and the Panel as well as with various Panel Members. It agreed to continue cooperation with ADRC in various areas suggested during the 31st session, as follows: 1) It was proposed that ADRC discuss with the Techinical Support Unit (TSU), in consultation with WMO and UNESCAP, to develop an additional web site for Panel, complementing the existing web site developed by TSU (www.tsuptc-wmo.org). It would be useful to include hydrological information and information regarding disaster reduction of the Panel Members. 2) The

ADRC visiting researcher programme has been developed to assist its member countries in their efforts to enhance the capacity of personnel involved in disaster reduction. Panel Members who are ADRC member countries are encouraged to apply for the programme through the ADRC counterpart organizations.

6.4 Training (agenda item 6.4)

6.4.1 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 TCDC arrangements.

6.4.2 The Panel expressed appreciation for the number of training events and workshops, which were organized by WMO in 2004 for the benefit of its Members. The Panel noted that 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.

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

6.4.4 The Panel expressed appreciation to Panel Members 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 endeavors should continue in the future and be strengthened. The Panel urged its Members to make maximum use of such training facilities.

6.4.5 The Panel noted the information on the activities of the Training Library and the use made of its services by the Members. It also appreciated the continuous updating of the Virtual Training Library (VTL) in an effort to provide the latest and most suitable available training material through Internet and recommended that those actions should be encouraged and continued.

6.4.6 The Panel was pleased to note that arrangements are underway for the first attachment of tropical cyclone forecasters, possibly from Maldives, Oman and Thailand, at the RSMC New Delhi in October 2005.

6.4.7 The Panel was also pleased that operational tropical cyclone forecasters from Bangladesh, Oman and Sri Lanka would participate at the 2005 Miami Hurricane Workshop (see paragraph 5.7).

6.4.8 A summary report on the 2004 training activities and future plan of Members is given in Appendix X.

6.5 Research (agenda item 6.5)

6.5.1 The Panel was informed that copies of the Proceedings of the Fifth WMO International Workshop on Tropical Cyclones (IWTC-V) (WMO/TD No. 1165) have already been distributed to the participants and to Panel Members. This contains very important and useful recommendations separately addressed to WMO, the research community and the tropical cyclone operational scientists. Part of the recommendations of the workshop concerns proposals for the revision of the publication "Global Guide to Tropical Cyclone Forecasting". The IWTC-V noted that the publication was a valuable forecast reference and recommended that this guide should undergo an evolutionary revision and be reissued.

6.5.2 The Panel was pleased to note that IWTC–VI is scheduled to be held in Costa Rica in late 2006 and that the Director of RSMC New Delhi will serve as a member of the International Committee (regional representative from the Bay of Bengal and the Arabian Sea region).

6.5.3 The Panel was informed that WMO's Commission on Atmospheric Sciences Working Group on Tropical Meteorology Research was organizing an International Workshop on Tropical Cyclone Land-fall Processes to be held in Macao, China, from 21 to 25 March 2005. The overall objective of the workshop was to improve forecasts and warnings of tropical cyclone landfalls, and working with appropriate agencies to reduce the impacts (loss of lives and damage). The workshop will assess state-of-the-art of forecasting, research and impacts and design a plan for future activities in these areas that will contribute to the overall objective.

6.5.4 A summary report on the 2004 research activities and the future research activities of the Members is given in Appendix XI.

6.6 Publications (agenda item 6.6)

6.6.1 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.20 was published by TSU in October 2004.

Panel News No.21 was published by TSU in February 2005 and copies were distributed during the session.

(b) Annual Review

6.6.2 The "Panel on Tropical Cyclones Annual Review" for the year 2003 which was consolidated and finalized by the Chief Editor, Mr S.R. Kalsi (India) with contributions from the National Editors was submitted to WMO in January 2005 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.

6.7 Storm surge project (agenda item 6.7)

6.7.1 The Panel reviewed the status of this regional project and discussed directions to implement it at the regional level, in light of increased public concerns on impacts of the tsunami disaster and other natural disasters. The Panel reiterated the importance it attaches to the implementation of this project in the regional context.

6.7.2 The Panel recognized efforts made by several Panel Members in advancing the operational status of this important regional project, especially in India and Pakistan. It also recognized difficulties faced by several other Member countries in the implementation of various activities identified in the regional project plan, especially due to the lack of international financial assistance.

6.7.3 The Panel underlined the benefits that the regional storm surge project could offer to other early warning systems in the Panel Area, in terms of infrastructure that are in place or expected to be in place soon as well as human resources developed for an effective disaster prevention and preparedness system against cyclones and storm surges. In that context, the Panel expressed its sincere appreciation to the Indian Institute of Technology at Kharagpur, particularly Prof. Dube, for the efforts to build up technical capacity of all Panel Members, and called on WMO to continue its support to IIT in these human resources development efforts. The Panel unanimously agreed to continue their efforts to put in place

in the near future an effective regional early warning system on storm surge in the Panel Area. It also called on other national and international organizations to make use of the above achievements of the Panel Members in the field of storm surge in order to synergize all the related efforts, including for tsunami warning, for the benefits of people in the region.

6.7.4 In view of the increasing benefits of the storm surge project for regional efforts on dealing with natural disasters, the Panel called on all Members to enhance their efforts for an early operation of the planned storm surge early warning system. It also called on WMO and UNESCAP and international organizations to increase their assistance to the Panel and the Members in this respect.

6.7.5 The Panel recognized the important and active role of RSMC in dealing with cyclones and cyclone warnings and invited Mr S.K.Subramanian, Director of RSMC New Delhi to coordinate efforts for strengthening the storm surge project.

6.8 An Integrated Tsunami and Storm Surge Early Warning and Response System in the Indian Ocean (Agenda item 6.8)

6.8.1 The Panel recognized the increased concern for security of people against tsunamis, cyclones, and other natural hazards. It emphasised the need to coordinate the national, regional and international efforts for establishing an integrated early warning system. In this connection, the Members called for the assistance of WMO in assessing the needs of the countries for enhancing the capabilities of NMHSs in this regard. It was expected that a clear road map could be presented to the Panel for consideration at the nearest future.

6.8.2 The Panel expressed its appreciation to His Excellency Dr Harsh K. Gupta, Secretary of Department of Ocean Development (DOD) of Government of India for his presentation of the plan of Government of India to develop an Early Warning System for Oceanographic Disasters in Indian Ocean (Tsunami and Storm Surge) – The Indian Initiative, at the Technical Conference. It noted the plan to put the system into operation by 2007. It also noted the intention of DOD to make use of the existing infrastructure on basic data collection system and data transmission infrastructure such as GTS of WMO.

6.8.3 The Panel was assured of the plan of DOD to make use of existing human resources infrastructure already developed for storm surge for tsunami early warnings and the importance that DOD attaches to the complementarity between the high frequency of storm surge and the low frequency of tsunami occurrence. The Panel appreciated the integrated early warning approach of DOD and adopting a multi-hazard strategy for disaster risk managemnt.

7. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN (Agenda item 7)

7.1 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 records 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.

7.2 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 forecasters and other users, particularly under operational conditions.

7.3 The Panel noted that a lot of changes have to be incorporated to the text of the Plan (2004 Edition). Mr S.K. Subramanian (India) kindly offered to serve as a focal point for the editorial changes or minor amendments necessary with a view to issuing an updated 2005 Edition of the Operational Plan as early as possible. To this effect, the Panel urged the Members to communicate their amendments to the focal point by 15 March 2005.

7.4 The Panel invited WMO to issue the year 2005 Edition as soon as possible.

8. TECHNICAL SUPPORT UNIT (Agenda item 8)

8.1 The Panel expressed its gratitude to the Government of Pakistan for hosting the TSU and appreciated the services being rendered by Dr Qamar-uz-Zaman Chaudhry, Director-General of Pakistan Meteorological Department (PMD) in his capacity as the Coordinator and Mr Umar Hayat Ghalib as the TSU Meteorologist.

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

8.3 TSU informed the session that it circulated among its Members during September 2004 an abridged copy of the action sheet on the decisions and recommendations of the thirty-first session of the Panel which had been earlier circulated by WMO in April 2004.

8.4 The Panel was informed that the PTC Web site is: www.tsuptc.org ceased functioning since April 2004 due to uploading problems and lack of coordination with the host. The same, after refurbishing, was relaunched through COMSATS Internet Services during November 2004 which could now be accessed on http://www.tsuptc-wmo.org.

8.5 The Panel was informed that, on account of belated receipt of contributions/ materials from the Panel News correspondents, the 20th issue of the Panel News was printed in October 2004 and circulated during the first week of February 2005. The 21st issue however was printed during the second week of February 2005 and circulated during the Panel session.

8.6 TSU provided the Panel with a detailed breakdown of its expenses incurred during the intersessional period (see Appendix XII).

9. SUPPORT FOR THE PANEL'S PROGRAMME (Agenda item 9)

9.1 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 VCP and implementing projects. It urged its Members to increase their support and give priority to the WMO/VCP and Technical Cooperation among Developing Countries (TCDC).

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

9.3 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)

9.4 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 for provision of institutional support. It would be expected to play an important part in the Panel's programmes such as funding support to representatives of Panel Members attending training events and conferences.

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

9.6 The Panel endorsed the use of the Trust Fund for the following specific purposes from 1 March 2005 to 28 February 2006:

(i) Supplemental support for the attendance of storm surge experts from Members of the Panel to the Third Regional Workshop on Storm Surge and Wave Forecasting- A Hand-on Forecast Laboratory to be held in Beijing, China from 25 to 29 July 2005 (US$ 4,000);

(Total: US$ 4,000)

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

9.7 A detailed financial report on the Trust Fund for the balance of the fund as at 31 December 2003 and 31 December 2004 were submitted to the Thirty-second session of the Panel (see Appendix XIII).

10. TECHNICAL CONFERENCE (Agenda item 10)

10.1 A one-day technical conference on " Water related disasters with special reference to Storm Surges and Tsunamis and their Early Warning Systems" was held in conjunction with the thirty-first session of the Panel. The programme of the technical conference is given in Appendix XIV.

10.2 The Panel expressed its deep appreciation to the lecturers/presenters for their informative and scientific presentations. Some of the conclusions and recommendations were incorporated within this report under their related agenda items.

10.3 The Panel emphasized the importance of the Technical Conference as a forum for exchange of information related to advancement of work under the various components of the Panel and related experiences such as the recent tsunami disaster in the region.

10.4 The Panel expressed their appreciation that certain advanced global numerical weather prediction centers were already providing their forecast products through the GTS. It however requested that the said centers would also provide their initial and boundary conditions to the Panel Members to enable them to run their own limited area models.

10.5 The Panel urged the Members to practice the consensus forecasts in their warning operations and to constantly monitor their performance. It urged WMO to undertake a study on the use of the consensus forecasts by warning centres worldwide.

10.6 The Panel requested WMO to distribute to Members the modified SAFFIR-SIMPSON scale for the tropical regions and the IMD version. It was also requested that these be uploaded in the TCP Web site and the Forecaster's Web site which is currently on test status.

10.7 The representative of Danish Hydraulic Institute (DHI), Dr Karsten Havnö, presented the requirements for adopting an integrated approach to early warning system and expressed the willingness of DHI to support the efforts of the Panel Members countries both at national as well as regional level.

10.8 Overall message of the conference: While natural hazards cannot be avoided completely, the loss of life and property can be minimized through enhanced use of science and technology, specially those which enable the issuance of useful, timely and accurate early warnings of natural hazards.

10.9 The Panel decided to organize a similar one-day technical conference during the next session and requested the Chairman of the Panel in consultation with TSU, WMO, UNESCAP and the Members to select a suitable theme for the conference.

11. DATE AND PLACE OF THE THIRTY-THIRD SESSION (Agenda item 11)

11.1 The representative of Bangladesh reiterated the willingness of his Government to host the thirty-third session in early 2006 based on the decision of the thirty first session of the Panel (Colombo, Sri Lanka, March 2004).

11.2 The Panel expressed its thanks and deep appreciation to the Government of Bangladesh for the kind invitation to host the Panel's session in 2006.

11.3 The exact dates and venue would be determined based on consultation among WMO, UNESCAP, Bangladesh, Chairman of the Panel and TSU Coordinator.

12. ADOPTION OF THE REPORT (Agenda item 12)

The report of the thirty-second session was adopted at 1100 hours on 26 February 2005.

13. CLOSURE OF THE SESSION (Agenda item 13)

13.1 The Panel expressed its sincere appreciation to the Government of India, the host country, for providing excellent facilities, the venue, other arrangements and its warm hospitality for this year's session. The Panel also expressed its deep appreciation to Mr Bhukan Lal, the Chairman and Mr Md Akram Hossain, Vice Chairman of the Panel as well as Mr Ali Sharif, drafting committee Chairman, for their successful conduct of the session. The Panel wished to express its gratitude to Mr S.R. Kalsi and his able staff for their hard work in producing a session report, which is definitely of high quality.

13.2 The Panel expressed its gratitude to the Indian Meteorological Department for arranging the visit to Agra.

13.3 The thirty-second session of the Panel was concluded on 26 February 2005 at 1300 hours.

LIST OF APPENDICES

APPENDIX I

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APPENDIX II

AGENDA

1. ORGANIZATION OF THE SESSION

    1.1 Opening of the session
    1.2 Election of the Chairman and Vice-chairman
    1.3 Working arrangements

2. ADOPTION OF THE AGENDA

3. FOLLOW-UP ON PTC-31 ACTION ITEMS

4. REVIEW OF THE 2004 CYCLONE SEASON

5. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME

6. REVIEW OF THE COORDINATED TECHNICAL PLAN AND CONSIDERATION OF THE WORK PROGRAMME FOR THE NEXT FIVE YEARS

    6.1 Meteorological component
    6.2 Hydrological component
    6.3 Disaster prevention and preparedness component
    6.4 Training
    6.5 Research
    6.6 Publications
    6.7 Storm Surge Project
    6.8 An Integrated Tsunami and Storm Surge Early Warning and Response System in the Indian Ocean

7. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN

8. TECHNICAL SUPPORT UNIT

9. SUPPORT FOR THE PANEL'S PROGRAMME

10. TECHNICAL CONFERENCE “Water-related disasters with special reference to Storm Surges and Tsunamis and their Early Warning Systems”

11. DATE AND PLACE OF THE THIRTY-THIRD SESSION

12. ADOPTION OF THE REPORT

13. CLOSURE OF THE SESSION

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APPENDIX III

ACTION SHEET

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

(Colombo, Sri Lanka, 1 to 6 March 2004)

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
1	Hosting of the session	Letter of appreciation to Sri Lanka	WMO (TCP)		Done
3.2	Regional Project	Finalize documentation of the regional project between ROK and WMO on the use of PC clusters in NWP and submit this to Panel Members for consideration and appropriate participation	WMO (RCD)	December 2004	
3.3	Follow-up items/activities	Incorporate their follow-up items/activities implemented or action taken in “Remarks”, prior to submission of the action sheet for review at the Panel’s session	WMO (TCP)	February 2005	For PTC-32
5.3	Annual Summary of Global Tropical Cyclone Season 2003	Publish the 2003 global cyclone season summary in August 2004	WMO (TCP)	August 2004	Also post it to TCP home page
5.4	Conversion factors between WMO 10-minute average wind and 1-miute, 2-minute and 3-minute “sustained” winds	Include the technical report from the study in the updated edition of the Global Guide to Tropical Cyclone Forecasting and the Panel’s Operational Plan	WMO (TCP)	ASAP	
5.5	Training on Storm Surge/Wave Model in the Indian Institute of Technology (IIT) Kharagpur	Arrange attachment of 2 forecasters, one from Maldives and one from Oman to IIT for training in implementing and running a storm surge/wave model	WMO (TCP)	August 2004	

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
6.0.4	Working Group on Coordinated Technical Plan (WGCTP)	(a) Members of the WG CTP to carry out the revised Terms of Reference as adopted at the 31st session; (b) Mr Al-Harthy (Oman) to serve as new Chairperson of WGCTP by leading the Working Group; (c) Take active part in the work of WGCTP; (d) Assist in the work of WGCTP; (e) Submit its report to all the Panel Members.	Members of WGCTP Chairperson Members TSU, WMO (TCP/RCD) & UNESCAP Chairperson	Two months before the 32nd session	Through TSU
6.1.4	Observational Programme and Data Exchange	(a) Take necessary action to ameliorate its implementation; (b) Maintain and upgrade the programme in particular upper-air observations.	Members concerned Members		Continuous activity Continuous activity
6.1.5	Regional Telecommunications Network	Members to establish all point-to-point circuit between NMCs of the Member countries and RTH New Delhi to be upgraded to 64 kbps	Panel Members (Where applicable)	ASAP	
6.1.9	Cox's Bazar and Khepurara radars	Look into possible replacement	WMO (RCD)		

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
6.1.11	Cyclone detection radar at Trincomalee	Acquire a microMET radar from Japan	Sri Lanka		
6.1.13	METEOSAT-5 position over the Indian Ocean	Request EUMETSAT to continue to do so beyond 2005	WMO (SAT)	May 2004	Submitted its request to CGMS-XXXII
6.1.15 & 6.1.16	Tropical Cyclone Names	(a) Seek concurrence from the Permanent Representative of India with WMO for possible implementation of the name list on an experimental basis in the coming cyclone season; (b) Provide names from India for inclusion in the list; (c) Mr Al-Harthy to continue his assignment as Rapporteur on the Naming of Tropical Cyclones for the Bay of Bengal and the Arabian Sea, including the monitoring of implementation of this programme to enhance public awareness.	India India Rapporteur	April 2004 1 May 2004	 Names to be submitted to Rapporteur
6.1.18	New ASIA/PAC Regional SIGMET Guide	Use the guidance material in order to improve the availability and quality of the SIGMET information	Meteorological Watch Offices (MWO)		

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
6.2.3	Phase III of the project on "Capacity-building in strategic planning and management of natural resources in Asia and the Pacific"	Assist Myanmar, Pakistan and Sri Lanka in facilitating to participate in the national workshops to be held in 2004	UNESCAP	December 2004	
6.2.4	Water Resources Planning and Management	(a) Make use of the advisory services, which could be made available by UNESCAP; (b) Contribute their experiences, best practices and research results in this regard for publication in the Water Resource Journal of UNESCAP.	Members UNESCAP		
6.2.11	Hydrological component	Assist the Members in promoting exchange of experience with Members of the Typhoon Committee on hydrological component	UNESCAP/WMO (HWR)		
6.3.5.2	Regional workshop on Community-Based Disaster Management (CBDM)	Organize the workshop to discuss the application of a hand book on CBDM and possible follow-up	UNESCAP	May 2004	
6.3.5.3	Project on promoting methodologies for assessing socio-economic impacts of natural disasters in Asia	Implement the project as soon as possible	UNESCAP	December 2004	
6.3.6.3	High-level participation in the World Conference on Disaster Reduction (WCDR)	Seek possible participation of high-level delegates from Panel Member countries in the WCDR for effective implementation of outcomes of the WCDR	ISDR	December 2004	Consult with Japanese Government

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
6.3.6.5	Asian Disaster Reduction Center (ADRC)	(a) Discuss with TSU, in consultation with WMO and UNESCAP, to develop an additional Web site for the Panel; (b) Apply for the ADRC visiting researcher programme through the ADRC counterpart organizations.	ADRC Member countries of ADRC	ASAP	
6.4.4	National training facilities	Make maximum use of national training facilities under bilateral arrangements	Other Members of the Panel		Continuous activity
6.4.5	WMO Training Library (TLB) and Virtual Training Library (VTL)	Make use of TLB and VTL whenever possible	Members		Continuous activity
6.4.6	Attachment of tropical cyclone forecasters to RSMC New Delhi	Make necessary arrangements for attachment of forecasters from the Panel Members in October 2005	India	July 2005	In consultation with WMO
6.4.7	Workshop on Hurricane Forecasting and Warning at RSMC Miami-Hurricane Center	(a) Arrange for two WMO-sponsored trainees from Panel Member countries to participate in the 2005 Miami Hurricane Workshop; (b) Allocate an additional seat for a tropical cyclone forecaster from Oman as self-funded participant.	WMO (TCP/ETR) WMO (TCP/ETR)	December 2004 December 2004	
6.4.8	Roving Study Tour for the Panel Members including TSU	Assist for the Panel in seeking possible organization of a second Roving Study Tour for the Panel Members and TSU in 2005 or 2006	WMO (TCP)	November 2004	Request letter to Administrator of CMA

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
6.4.10	EUMETSAT Satellite Applications Course for the Middle East	Request EUMETSAT to continue to sponsor the training course, for not only participants from the Middle East, but also for trainees from the Panel Members of Bangladesh, Maldives Pakistan and Sri Lanka	WMO (SAT/TCP)	December 2004	To be discussed at CGMS-XXXII in May 2004
6.6.3	Panel on Tropical Cyclones Annual Review (PTCAR) for the year 2002	Publish the PTCAR for the year 2002 for distribution	WMO (TCP)	April 2004	
6.7	Storm Surge Project				
6.7.2		Obtain approval of their respective Governments and submit their national approval to WMO	Bangladesh, Maldives, Myanmar and Thailand	ASAP	Administrative assistance is provided from Coordinator of TSU, upon request
6.7.5		Make efforts to assist in the implementation of the project.	WMO (RCD/TCP)	2005	
7.4	Tropical Cyclone Operational Plan for the Bay of Bengal and the Arabian Sea (WMO/TD-No. 84)	Issue updated Operational Plan (2004 edition)	WMO (TCP)	May 2004	
9.1	Technical Cooperation Programme (TCO)	Increase support and give priority to the WMO/VCP and TCDC	Members		Continuous activity
9.4	Resource Mobilization	Approach the various national economic sectors in the effort to mobilize resources for the Panel's activities	Members		Continuous activity

Para. No.	Subject	Action required	Responsible	Deadline	Remarks
9.7	Panel on Tropical Cyclones Trust Fund (PTCTF)	Continue to enhance their contributions to the Trust Fund as a substantial support for the Panel's activities	Members	ASAP	
10	Technical Conference				
10.4		Assist the Panel Members in mobilizing financial resources to enable the Panel to prepare relevant documents for the WCDR	ISDR	December 2004	
10.5		Incorporate various proposals on capacity building of the Panel, including the need to organize study visits to learn from other Members on various aspects of cyclone-related disaster management, in the new Coordinated Technical Plan	WG CTP	December 2004	
10.6		(a) Make necessary arrangements for organization of a similar technical conference during 32nd PTC session;	WMO (TCP)/ UNESCAP/ TSU	September 2004	
		(b) Select a theme for the technical conference.	Chairman in consultation with Members & TSU		

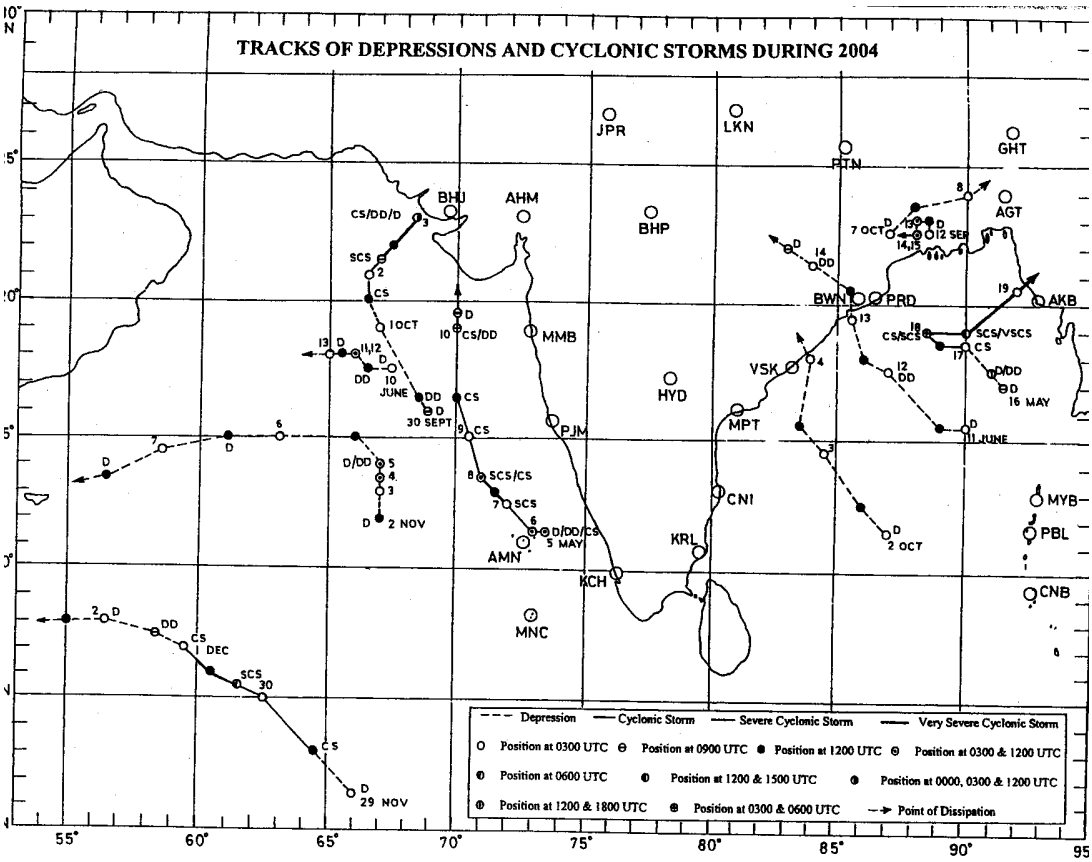
Para. No.	Subject	Action required	Responsible	Deadline	Remarks
11	Thirty-second Panel session	(a) Send to WMO early confirmation of the hosting;	India	August 2004	
		(b) Determine exact dates and venue;	WMO (RAP/TCP), UNESCAP, host, TSU, and Chairman of the Panel	August 2004	
		(c) Prepare provisional agenda and documentation plan.	WMO (TCP) in consultation with UNESCAP and TSU	September 2004	

APPENDIX IV

2004 CYCLONE SEASON SUMMARY

(Submitted by RSMC tropical cyclones New Delhi)

The North Indian Ocean witnessed the development of ten disturbances out of which four systems attained the intensity of Cyclonic storms viz., one Very Severe Cyclonic Storm and three Severe Cyclonic Storms. Four systems were depression out of which two became deep depressions. Remaining two are land depressions. Tracks of the systems are shown in the figure below.



During this year, out of the four cyclones, three developed over the Arabian Sea and only one formed over the Bay of Bengal. Two depressions formed over the Bay of Bengal and two in the Arabian Sea. In addition there were two depressions that formed over land.

The first cyclone formed over the Bay of Bengal as a low pressure area over southwest Bay of Bengal on 1 May. Moving across south of the peninsula, it emerged into the southeast Arabian Sea and concentrated into a depression in the morning of 5 May and further into a cyclonic storm by the same evening. Initially, the system moved in a northwesterly direction and attained the intensity of a severe cyclonic storm in the morning of 7 May. It then moved in a north northwesterly direction, weakened over the northeast Arabian sea off Gujarat coast in the evening of 10 May.

The second cyclone formed as a depression over east central Bay of Bengal on 16 May and moved in a northwesterly direction. It intensified into a cyclonic storm in the morning of 17 and further into a severe cyclonic storm in the noon of 18 over northwest Bay

of Bengal. The system then recurved and moved in an easterly direction and intensified into a very severe cyclonic storm on 18 night itself. Moving northeastwards it crossed Myanmar coast north of Akyab in the forenoon of 19 May and weakened gradually over Myanmar.

The third cyclone formed as a low pressure area over east central Arabian sea in the morning of 29 September 2004. It intensified into a depression and subsequently into a deep depression in the evening of 30 September. Moving in a northwesterly direction, the system intensified into a cyclonic storm in the evening of 1 October 2004. The system moved in a northerly direction for some time, then recurved northeastwards and further intensified into a severe cyclonic storm in the afternoon of 2 October. Moving in the same direction, the system weakened into a depression over Gujarat-Kutch coast in the evening of 3 October without crossing the coast.

The fourth cyclone formed as a depression over southeast Arabian sea close to the equator in the morning of 29 November. It intensified rapidly into a deep depression and then into a cyclonic storm in the evening of the same day. Moving slowly in a west northwesterly direction it intensified into a severe cyclonic storm in the morning of 30 November. The system moved in a northwesterly direction and gradually weakened into a cyclonic storm and then into a deep depression in the afternoon of 1 December and subsequently into a depression in the morning of 2 December 2004.

The notable features is that the Arabian sea was more active than the Bay of Bengal during 2004. Out of the total eight cyclonic disturbances that formed over North Indian Ocean, three cyclones and two depressions formed over the Arabian sea. Only one cyclonic storm and two depressions formed over the Bay of Bengal.

The Arabian sea sever cyclone “Agni” in November formed very close to the equator near latitude 1.5^{o}N. Cyclogenesis over the north Indian Ocean at such low latitudes has not occurred in the past. The cooexistence of cyclonic disturbances over the Arabain sea and the Bay of Bengal as occurred in June 2004 is also not common. This had however helped the progress of the southwest monsoon across the country during the onset phase.

APPENDIX V

DRAFT COORDINATED TECHNICAL PLAN (CTP) (2005-2009)

(Submitted by Mr A. H. M. Al-Harthy, Chairman Working Group, CTP)

I. EXECUTIVE SUMMARY

Background

This Coordinated Technical Plan for the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and Arabian Sea (2005-2008) has been developed taking into account the previous Plan for 2001-2004, the Sixth WMO Long-term Plan (6LTP) and from Members Country Report.

National Meteorological Services in the Panel

The Panel is composed of 8 Members. All countries have either a National Meteorological Service or a National Hydrometeorological Service. The term NMSs is used to indicate these Services. These Services vary in duties, size and status of advancement, geography and state of development. Therefore, they are highly differentiated in capabilities and vulnerabilities. There is a wide gap between the developed NMSs with very advanced facilities and the less developed NMSs with limited budgets; shortage of observation instruments, spare parts, consumables; lack of calibration, data collection, processing and communication facilities; insufficient qualified staff; and old technology.

The Coordinated Technical Plan aims to strengthen the capabilities of NMSs in the Panel Region to meet the growing demands for improved, reliable and timely weather forecasts and warnings to ensure the safety and well being of people; to contribute to achieving sustainable development; and to fulfill the commitments of their countries under regional and international agreements and conventions. The Coordinated Technical Plan seeks to achieve these aims through, among other things, assisting the NMSs:

(*a*) To develop and be provided access to appropriate databases, resources and expertise to produce appropriate advice and products required for forecasting and warning services to the private and public sectors as well as to the decision makers and ordinary people;

(b) To strengthen services related to disaster mitigation, prevention and preparedness; hydrology and water resources assessment and management;

(c) To develop Reaserch;

(d) To upgrade and modernize their Services including their infrastructure (buildings, equipment and facilities) and technology, and to have adequate qualified and trained staff.

Countries and organizations involved

COUNTRIES INVOLVED

Members in the Panel will work together to contribute towards the implementation of joint programmes and activities, deriving benefits from pooling of resources within the Region.

ORGANIZATIONS INVOLVED

(*a*) The World Meteorological Organization (WMO) has the overall responsibility for the development, delivery and management of programmes and projects; and

(b) ESACP in particular and other regional and international organization will be invited to contribute to and participate in the implementation of programmes and projects, and coordinate with their programmes in accordance with their mandates.

Duration of the Coordinated Technical Plan

The duration of Coordinated Technical Plan is four years. It will be revised and updated on yearly basis. The programmes, activities and projects will be developed in phases for implementation at the national and regional level.

1. INTRODUCTION AND BACKGROUND

1.1 The Panel Region

The terms “Panel Region” is used to describe that area encompassing the countries bordering the Bay of Bengal and Arabian Sea. There are 8 Members of the Panel as listed alphabetically below:

Bangladesh
India
Maldives
Myanmar
Oman
Pakistan
Sri Lanka
Thailand

The Panel Region covers a vast expanse of the Northern Indian Ocean and contains a large and diverse range of ecosystems, including deserts, forests, rivers, lakes and seas. The desert extends from Oman into Pakistan and northwest India.Compared to other WMOTropical Cyclone Regions, the Panel Region includes the highest mountains, the rainiest areas and the driest deserts, with their associated variation in culture and biodiversity. Over the long period of human occupation in the Region, exploitation of natural resources, urbanization, industrialization and economic development have led to land degradation and environmental pollution. Climate change and climate variations also represent future stress.

1.2 NMSs in the Panel Region

The NMSs in the Panel vary in size, status of advancement, geography and state of development and, therefore, are highly differentiated in capabilities. The gap is wide, with only one Member running a super-computer for modeling as well as a specialized meteorological centre. About two other Members or so operate regional modeling on high performance computing, while a few Members have no modeling capabilities and are less developed with limited budgets; shortage of observation instruments, spare parts, and consumables, lack of calibration equipment, data collection, processing and communication facilities, and insufficient qualified staff.

1.3 The role of NMSs in the Panel

The main role of NMSs is the provision of weather, climate, environmental monitoring, and other related services and activities to meet national responsibilities to

contribute to the safety, well-being and protection of property of all citizens, and sustainable social and economic development. In addition they help to meet international commitments and obligations under various conventions, in particular the effective implementation of the WMO scientific and technical programmes.

The NMSs are normally the official voice in issuing weather warnings for public safety as well as the primary national authority and official source of information and policy advice on the present and future state of the atmosphere and on other aspects of weather and climate in support of policy development.

The NMSs provide essential meteorological and related services for public safety and welfare. They collect and exchange meteorological and related data and associated products especially through the practice of free and unrestricted data exchange agreed under Resolution 40 of Twelfth Congress. Furthermore, they contribute to, and support, national strategies for sustainable development. They sustain environmental research and development of relevant applications and maintain the integrity and continuity of long-term national climate records.

1.4 Panel priorities

The Panel attaches the highest priority to the following issues:

(*a*) Maintenance and further development of existing observing and telecommunications systems and data processing facilities;

(*b*) Natural disaster reduction, mitigation and prevention through the implementation of improved detection, prediction and warning systems of tropical cyclones, monsoon depression and other extreme weather events, including associated storm surges, flash floods and droughts, tsunamis;

(*c*) Implementation of the Coordinated Technical Plan to provide better services, to the public, governments and users, through improved infrastructure and by modern technology;

(*d*) Development of effective public weather services to ensure better understanding and appreciation of the value of, and increased benefit from, weather and climate and related environmental information;

(*e*) Promoting and strengthening the principle of free and unrestricted international exchange of data and products among the Panel Members;

(f) Enhancement of capacity building, including human resources development, to bridge the gap between Panel Members and facilitating associated technical transfer through bilateral and multilateral arrangements;

(*g*) Enhancement of the collaboration and cooperation among all NMHSs in the Panel Region and between regional centers, in particular, RSMCs, RMTCs, RICs and climate centers, drought monitoring centers, by exchange of information and knowledge and research studies on meteorology, hydrology, climate change and related environmental sciences, including numerical modelling, in order to improve the understanding and the predictions;

(*h*) Strengthening meteorological applications and services for aviation and maritime transportation and agriculture;

(i) Formulation of the Coordinated Technical Plan for the enhancement of National Hydrological Services in the Panel, Enhancement of the planning and management of water resources, including assessment of surface and ground water resources, through:

(*i*) Improvement of the operational linkages between hydrological and meteorological services with the aim to improve hydrological forecasting and to minimize impacts of natural disasters;

(*ii*) Strengthening of the hydrological components of the Tropical Cyclone Development Plans in the Region;

(l) Strengthening of collaboration with relevant regional bodies, especially ECSAP, ESCWA, ASEAN, and others.

2. COORDINATED TECHNICAL PLAN FOR THE PANEL REGION (2005–2008)

2.1 The development of the Coordinated Technical Plan

This Coordinated Technical Plan of the National Meteorological Services (NMSs) in the Panel Region (2005-2008) has been developed taking into account the previous Plan for 2001-2004, the Sixth WMO Long-term Plan (6LTP) and suggestions from Members of the Region during the yearly sessions.

Account was also taken of the Report of the Second Session of the EC Advisory Group on the Role and Operation of National Meteorological and Hydrological Services held in Geneva from 8 to 12 April 2002, Final Report of the Regional Workshop on Management: Strengthening Capacity Building of the National Meteorological Services of Least Developed Countries (LDCs) held in Bangkok, Thailand, from 16 to 18 October 2002, Summary Report of the Third Technical Conference on Management of National Meteorological Services (NMSs) in Regional Association II (Asia) held in Muscat, Sultanate of Oman, from 14 to 18 December 2002 and the Seminar on Partnership Building on Meteorological Technology and Policy for NMSs held in Seoul, Republic of Korea, from 12 to 18 September 2004, finally the Strategic Plan for Enhancement for NMSs for RAII Asia (2005-2008) which was endorsed by the RAII-XIII Session which was held in Hong Kong, China from 7 to 15 December 2005.

2.2 The purpose of the Coordinated Technical Plan

The purpose of having a coordinated technical plan for the Region is:

(*a*) To develop an understanding among the Panel Members n the Region on the priorities and objectives for their individual development and for the overall development of the Region through cooperation; and to guide the implementation of programmes and activities for achieving these objectives;

(*b*) To encourage the development of joint projects by all Members or some of them with the projects under formulation and/or consideration by Members in the Region;

(*c*) To raise general awareness of the status of the work of NMSs and to have a framework under which development assistance would be provided and coordinated among Members in the Region and the various contributing agencies; and

(*d*) To develop a system for training NMS specialists, transferring and exchanging experience in observation and data processing, and taking advantage of advances in science and technology.

2.3 The vision of the Strategic Plan

What this Coordinated Technical Plan aims to achieve is:

(*a*) NMSs in the Region being able to provide high standard meteorological, hydrological and environmental services to meet national, regional and international requirements; and

(*b*) NMSs in the Region working together to contribute towards the implementation of the regional programme in the WMO Long-term Plan, thereby deriving the benefits of pooling of resources within the Region.

2.4 The mission of the Strategic Plan

The mission of the Coordinated Technical Plan is:

(*a*) To increase support to NMSs in the Panel so as to enable them to provide appropriate, effective and efficient meteorological services to their nations and to fulfill their national, regional and international obligations;

(*b*) To assist in capacity building of NMCs so that they would have appropriate infrastructure and facilities as well as fully trained professional, technical and support personnel to contribute to WMO Programmes and to provide advice to decision makers in the vital areas of climate change and climate variability and environmental related issues; and

(*c*) To strengthen cooperation among NMCs in the Region and to further cooperation with other regional and subregional organizations and institutions through joint cooperative arrangements and the organization of events.

2.5 Institutional arrangements

A regional programme consisting of a range of projects to be implemented over several years, isome or Panel Members that cannot be successfully implemented without adequate institutional arrangements. Such arrangements include mandate, programme management, human resources, funding, sectoral and organizational linkages, and reporting. These are to be considered when formulating projects.

2.6 Reporting

As part of its programme management responsibility, the TSU, WMO and to a certain extent ESCAP Secretariat will regularly report on progress on the implementation of the Coordinated Technical Plan to the Panel Members as well as to programme and project donors. This will be achieved through:

(*a*) The normal WMO reporting process to Members, including publications;

(*b*) The reporting requirements of individual funding arrangements to programme and projects donors;

(*c*) Summary of results of annual surveys on the basic capability of Members in the Region (survey form shown in Appendix I);

(*d*) Presentations at relevant sessions, meetings, technical conferences, workshops and seminars; and

(*e*) The regional Newsletter for the Panel.

2.7 Programmes and projects

Regional programmes and projects

Regional programmes or projects are those that address problems that are common to the whole Panel Region. Initial pilot phases may be undertaken in a limited number of countries only.

Subregional programmes and projects

Subregional programmes and projects are those which address problems that are common to only few countries of the Panel.

Country-specific projects

Country-specific projects are those which are specifically required by a particular Panel Member to address a problem in that country, given its particular circumstances. Country-specific projects are unique to individual countries and are identified through in-country consultations.

Steps for the implementation of the Coordinated Technical Plan

These include:

(*a*) The thirty-second Panel Session in New Delhi 21-26 February 2005 is required to consider and approve this proposed Coordinated Technical Plan;

(b) Members to take the Coordinated Technical Plan into account in developing their capacities and carrying out their national programmes in meteorology, climate, hydrology and related disciplines;

(c) Members to send in their projects which are already included in the ongoing National Five Year Development Plan to be reflected in the Coordinated Technical Plan;

(d) Members are urged to include projects related to the Panel when formulating their next National Five Year Development Plan so as to align it according to the Panels Coordinated Technical Plan;

(e) Identify projects which would require donors to implement them, regardless whether the project is intended for only one or all Members;

(f) A survey to be conducted on yearly basis that will ascertain the status of the projects that were implemented by Members which will have been reported under items c, d. and e above;

(g) The chairman of the coordinated technical plan will submit a status report on the coordinated technical plan which will be reviewed by the Panel sessions whenever the session is convened on yearly basis.

3. CHALLENGES AND OPPORTUNITIES

Panel Members are to take advantage of the challenges and opportunities facing them such as rapid changes in technology, globalization, commercialization and emerging scientific research results. At the same time, it is necessary for them to work together to develop a strategic regional approach to bridging the gap between NMSs of developing and developed countries, particularly in connection with the establishment, operation, maintenance, and enhancement of observation, telecommunication and data-processing

systems. A collective approach to some of the challenges faced by individual NMSs has practical and economic benefits.

This rest of this section of the Coordinated Technical Plan identifies in broad terms some of the needs of NMSs in achieving these ends and suggests possible ways to meet these needs.

3.1 Observation systems

Observation systems are fundamental to the operations of NMSs. Standardization of observation ensures that data collected by each country are compatible with other countries. This includes accuracy, instrument response times and other characteristics of instruments, frequency of observations, exposure, network densities and other related matters.

The existing gaps in the observational data coverage of the Panel region continues to be due to the deficiencies in the operations of both observing and telecommunication networks, high cost and therefore the lack of consumables and spare parts especially in developing countries and in countries with economies in transition.

With the closure of the Omega radio navigation system, a few Members of the Panel may not have been able to switch over to GPS sondes due to its high cost. There is a need to consider an alternate observing system which does not require expensive consumables, i.e. sondes, yet is capable of yielding data of required accuracy.

New types of earth observing satellites including meteorological satellites which are useful to weather monitoring, forecasting, and research have been launched from time to time. However, no single receiving system is capable of receiving and processing the data from all these satellites. This poses difficulty to some Members of the Panel that may not afford to have more than one satellite receiver. It would be useful if imageries and data from different satellites can be put under and distributed through one or two low cost distribution channels.

There is a need for a survey of the current situation of stations, regionally, to determine the specific needs of each country to meet its obligations.

The Panel to consider the possible solutions to observation systems issues

(*a*) For maintaining the integrity of the RBSN, it would be necessary to keep under review RBSN stations of the Region and identify defaulting stations on the basis of quality monitoring reports. It would also be necessary to pursue continuous feedback on the status of RBSN stations, with National Focal Points on matters related to RBSN recently appointed by Members;

(*b*) For maintaining the integrity of the RBCN, it would be necessary to keep under continuous review the availability of CLIMAT/CLIMAT TEMP reports from RBCN stations in the Region. Efforts should be made by NMSs to ensure that their operational observing stations compile and transmit the CLIMAT/CLIMAT TEMP messages according to existing regulations;

(*c*) As a motivating force in the maintenance of essential observation systems, regular feedbacks and encouragement from global and regional NWP centres (e.g. New Delhi and JMA) to NMSs on data availability and quality may be considered;

(*d*) To help NMSs to reduce costs of upper-air observations, the possibility of bulk procurement of GPS sondes through a Central Nodal Agency should be explored;

(*e*) The combined use of a wind profiling radar and a radio acoustic sounding system for upper air measurement has been demonstrated to be viable and cost-effective, providing data with a very high temporal resolution which could be very useful to Global Data Processing System centres. Therefore, due consideration should be given to using wind profiling radars with radio acoustic sounding systems at upper air sites where observations have discontinued due to non-availability of Omega Navigation System;

(*f*) As AMDAR data have been found to have a positive impact on NWP, to pursue a substantial increase of AMDAR data over the Region;

(*g*) Weather radars are very useful for monitoring weather conditions especially during the approach of cyclones/typhoons and other severe weather. The establishment of networks of radars in the Region is to be encouraged. Establishing a central expertise for several installation sites would also be a useful approach;

(*h*) As an alternative to setting up meteorological satellite ground receiving stations in each NMS, the possibility of obtaining satellite data via the Internet may be employed for less developed Members. The establishment of a register of useful Websites for this purpose should be also explored;

(*i*) To assist NMSs in planning reception facilities and the use of satellite data, the development of a concerted long-term strategy on satellite observation programmes within the Region, that takes account of the WMO Space Programme Long-term Strategy, should be considered; and

(*j*) Collection and exchange of non-conventional meteorological data (such as precipitable water vapor retrieved from the Global Position System and observations related to the renewable energy resources) for application in weather forecasting, numerical modeling, etc., should be encouraged.

(k) NMSs should be fully involved in the planning and implementation of the Global Earth Observing System of Systems (GEOSS).

3.2 Telecommunication

The collection of observational data within each country and the exchange of observational data and processed information between countries are made through the national meteorological telecommunication networks (NMTNs) and the regional meteorological telecommunication networks (RMTNs), respectively.

The NMTNs are implemented and operated by each country according to both the telecommunication services available and the financial and technical capacities of each country. There is a need to modernize and reinforce the NMTNs to ensure a cost-effective collection of observational data in the countries.

The implementation of RMTN circuits in the Region has made significant progress, in particular the implementation of the IMTN plan for MTN circuits in the Region according to CBS plans; the upgrade of a number of regional circuits to Frame Relay circuits in the southeastern part of the Region; the upgrade of a number of regional circuits to 64 kbit/s digital leased circuits, in particular in the area of responsibility of regional telecommunication hub (RTH) Jeddah; the upgrade of a number of regional circuits to V.34 (19.2-33.6 kbit/s) leased circuits in the northern part of the Region; upgrades of data-dissemination systems by the replacement of an HF radiobroadcast by a satellite–based system using DAB techniques (RTH New Delhi) and in the satellite-based TV-Inform-Meteo system; and the introduction of the TCP/IP procedures.

However, there are still a number of shortcomings in the RMTN. In particular, four NMCs were only connected by GTS connections operating at low speeds (Colombo, Katmandu, Male and Yangon); five NMCs have no connection to the GTS (Baghdad, Dushanbe, Kabul, Phnom Penh and Sana); and a number of regional circuits were operating at low speed, with a very low cost-effectiveness.

There is a serious threat to the future of the RMTN if it fails to evolve, which could undermine the whole WWW structure and operation.

The Panel to consider possible solutions to telecommunication issues

These include:

(*a*) It is important to implement and improve the RMTN using modern cost-effective network services such as frame relay network services and managed data-communication network services.

(*b*) Each RTH in the Panel should survey the technical status, capabilities and opportunities of its associated NMCs, as well as the data-communication network services that are commercially available and cost-effective in their respective zone;

(*c*) RTHs in the Panel should assist their associated NMCs in developing implementation plans, including target implementation dates. These plans should include the migration to TCP/IP, which is a key factor for enabling the use of cost-effective systems and communications, and the migration to Table Drive Code Forms (TDCFs);

(*d*) As an initial step, current circuits should be upgraded as soon as possible using data-communication services that are the most cost-effective, such as Frame Relay services where available;

(*e*) NMHSs should take the necessary measures for ensuring an adequate training of the technical staff of NMCs on the relevant information and communication technologies for the Improved RMTN;

(*f*) Financial assistance is expected to be required for a number of NMCs for the implementation of the Improved RMTN, through individual VCP projects on the basis of NMC/RTH plans, or other cooperation projects;

(*g*) The use of the Internet as a method of communication of all types of information to a wide audience needs to be considered and all NMSs in the Region need to enhance its use;

(*h*) The Internet may be used to supplement the GTS in the exchange of meteorological data. Particularly for Members who are still not connected to GTS, similar methods of transmission may be considered; and

(*i*) Efforts to explore the use of alternate means for the exchange of meteorological information, such as the use of virtual private network over the Internet, should continue in the framework of the Future WMO Information System (FWIS).

3.3 Data-processing and forecasting systems

While there had been considerable improvements in the infrastructure and models in some Global Data Processing System (GDPS) centres of the Region, there are still large deficiencies in the data processing capabilities of some Members. Some of the data processing systems of NMSs have not been automated and the Members concerned were not able to derive full benefits from the technological advances that have taken place in the

recent past. Some GDPS centres in the Region still plot stations and product weather charts manually.

As regards the generation and dissemination of the GDPS products, Regional Specialized Meteorological Centre (RSMC) New Delhi produces a large number of products on a daily basis. The availability on the Internet of high-quality products from advanced high-resolution NWP systems operated by major GDPS centres within and outside the Region has opened up new opportunities for NMSs to enhance their capability in providing weather forecast service to the users. It is however noted that the only cost-effective solution for providing access to high quality products of major GDPS centres is to establish a regional database holding high-resolution NWP products of these centres. RSMC New Delhi and other NMSs in the Panel may consider to undertake this programme.

In responding to the requirement of several Members and of the United Nations Office for the Coordination of Humanitarian Affairs (UN/OCHA) for meteorological support services for chemical incidents and other non-nuclear emergencies with transboundary pollution, it would be desirable if RSMC New Delhi would develop and implement the necessary models.

Accompanying the remarkable development of numerical modelling techniques for long-range forecasting, including the ensemble forecasting technique, the requirements of Members in the Region for using long-range forecasts produced by numerical models are increasing.

The Panel may consider possible solutions to data-processing and forecasting issues

These include:

(*a*) Assisting NMCs which are not equipped with automated systems to acquire the minimum level of data-processing capability;

(*b*) Establishing a regional database to provide access to high-resolution NWP products from major GDPS centres such as the European Centre for Medium-Range Weather Forecasts (ECMWF), World Meteorological Centres (WMCs)-Moscow, Washington and Melbourne, and RSMCs-Bracknell, Tokyo and New Delhi, through the Internet or other cost-effective telecommunication means;

(c) Organizing regional training for the utilization of NWP products and for development of derived products from NWP model outputs, in particular a regional workshop on the use of Ensemble Prediction System (EPS) products;

(e) Providing technical assistance to developing countries of the Region to strengthen their NWP capability;

(*f*) Formulation of a regional project for NWP using PC clusters and establishment of a pilot project in one of the Panel Member country;

(g) Exchange of software for NWP on a regular basis;

(h) Sharing of knowledge and experience among NMSs on variational analysis which is becoming the mainstream technique for assimilating remote sensing and other asynoptic data in NWP;

(i) RSMC New Delhi and highly equipped and more capable NMCs providing assistance to other NMCs in the Panel region to improve their operational capabilities;

(j) Exploring the development of low-cost turn-key systems to take advantage of the Internet as a cost-effective means for the exchange of meteorological data and products for the benefit of least developed Members;

(k) The possibility of developing tailor-made products for individual Panel Members especially the least developed countries should be explored;

(l) Expanding the products' provision system in the Region to include long-range forecast products, taking into account the methods of provision, the use of the products and the role of regional climate centres;

(m) Expanding the emergency response functions of RSMC New Delhi in the Region with regard to chemical spills, forest fires and other accidents, and

(*n*) Equipping NMSs with modern forecasting systems in order to improve services to users, including NMSs of neighbouring states, especially in regions with transboundary rivers.

3.4 Natural disasters

The Panel region is the most natural disaster prone region in the world. It has the highest incidence of natural disasters and suffers immense damage from all types of natural phenomena (tropical cyclones, storm surges, floods, landslides, drought, earthquakes, volcanic eruptions, tsunamis, etc.).

A large percentage of these disasters have occurred in many countries of the Region, where population densities are highest, resulting in heavy loss of life and property damage. As an example, a single cyclone in 1970 caused almost 300 000 deaths in Bangladesh while an earthquake in China in 1976 had nearly 300 000 casualties.

Climate and weather-related disasters

The climate and weather-related hazards which most frequently occur in the Panel Region are tropical cyclones and associated storm surges, floods, landslides, drought and, in some areas, heavy snowfall and avalanches, and yet in some other areas, extreme high temperature and heat waves. Heavy haze and sand/dust storms are a usual occurrence in Panel's arid and semi-arid areas. Drought often affects many countries in the Region, in particular the western part of the Panel. Recently, tsunamis hit and devastated coastal areas of most of the Panel Countries causing considerable loss of life and property.

In the Bay of Bengal, tropical cyclones usually form over the southern end then move either towards the east coast of India, or to Bangladesh. A few tropical cyclones form in the Arabian Sea and move to the north affecting the western part of India, southern Pakistan and Oman. These tropical cyclones can generate very heavy rainfall and cause severe flooding and landslides, and are often accompanied by devastating storm surges.

Regional coordination on tropical cyclones

Regional cooperation and coordination in disaster prevention and mitigation, particularly among neighbouring countries, are gaining importance in the Region. The Economic and Social Commission for Asia and the Pacific (ESCAP)/WMO Typhoon Committee and the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and the Arabia Sea are good examples of such cooperation and coordination.

These organizations were set up to strengthen efforts to coordinate tropical cyclone activities in the Region and work primarily towards reducing damage caused by tropical cyclones or typhoons and associated storm surges and floods. Both the Panel and the Committee promote regional cooperation and coordination in the field of forecasting, warning, disaster prevention and preparedness information exchange, research and training.

Two Regional Specialized Meteorological Centres (RSMCs) on tropical cyclones have been designated in the Region, namely RSMC-Tokyo-Typhoon Center and RSMC Tropical Cyclones New Delhi to monitor and forecast the track and intensity of all tropical cyclones within their area of responsibility, to provide the track and intensity information to the international community, and to provide real-time advisory information and guidance to NMSs in the Region.

The Fourteenth Congress has approved an Inter-Commission approach in formulating a strategy for natural disaster reduction "Marine Impacts on Lowland Agriculture and Coastal Resources (MILAC). JCOMM has initiated action in this matter. Accurate forecasting of storm surges due to tropical cyclones in the Bay of Bengal has been proposed to be undertaken as a demonstration project which on completion would lead to dramatic reduction in loss of life and property due to these tropical cyclones. The TCP in cooperation with JCOMM had also organized two workshops in 2002 and 2003 on the forecasting of tropical cyclones, storm surges and waves in the South China Sea. Steps have been taken to organize in China (July 2005) the Third Workshop on Storm Surges, Waves and Ocean Circulation Forecasting in the South China Sea and Bay of Bengal areas.

Disaster management

Recognizing the importance of these issues, much work still needs to be done now and in the future by relevant NMSs in Asia in the fields of observing, analyzing, forecasting, and issuing early warnings of tropical cyclones to mitigate the potential damage caused by them. There is the potential for substantial improvement in the accuracy and timelines of cyclone warnings with adequate infrastructure (e.g. weather surveillance radars, satellite receiving equipment) and appropriate forecasting skills. Prolonged severe flooding or drought related to climate variability often results in severe nationwide social and economic stress. Seasonal prediction of drought, high tropical cyclone activity, and prolonged heavy rainfall that the countries in the Region are prone to would be valuable information for planning purposes.

The Panel to consider possible solutions to disaster management issues

These include:

(*a*) Close collaboration to be carried out through the ESCAP/WMO Typhoon Committee, the WMO/ESCAP Panel on Tropical Cyclones whereby Members would improve the Operational Development Plans and implement the Regional Cooperation Programme Implementation Plans of the Committee and the Panel;

(*b*) Promoting activities in tropical cyclone disaster mitigation of mutual interest to the Typhoon Committee and the Panel on Tropical Cyclones;

(*c*) Strengthening and improving the functions and services of RSMCs and other Centres, in particular the RSMC Tokyo-Typhoon Center and the RSMC Tropical Cyclones-New Delhi;

(*d*) Close cooperation between the RSMC Tokyo and RSMC New Delhi and efforts to work on a more coordinated warning system within the Region;

(*e*) To encourage NMSs to support exchange of official warnings of severe weather by contributing to the WMO pilot project "Severe Weather Information Centre" and promulgating its use among members of the public and the media;

(*f*) Making the NMS the sole official national agency to make prediction of and to issue warnings/bulletins/advisories on tropical cyclones/typhoons and related hazards;

(*g*) Maintaining and strengthening of the links between the NMS and national disaster managers and ensuring close collaboration/interaction with other institutions, including affected communities;

(*h*) Improving the accuracy (timing and location), timeliness and overall usefulness of tropical cyclone/typhoon warnings and other severe weather warnings;

(*i*) Exploring the use of EPS products and probability forecasts for meteorological or hydrological hazards e.g. tropical cyclones, storm surges prediction and related decision making;

(*j*) Encouraging the organization of seminars, training courses, workshops for forecasters of Members of the Typhoon Committee and the Panel on Tropical Cyclones;

(*k*) NMSs making efforts to educate the public on and to promote its awareness of tropical cyclones/typhoons, to compile cyclone track maps, to improve translation of terminology used in warnings and to raise the understanding and awareness of local severe weather; and

(l) Promote research initiatives on tropical cyclones and archival of tropical cyclone data for research purposes.

3.8 Management, capacity building and transfer of technology

In considering the rapid changes in technology and the social, political, economic and legal framework in which the individual NMSs are operating in addition to the global environmental challenges, NMSs need to respond to these challenges in such a way as to enable them to properly manage their services, and to have qualified and trained manpower and adequate facilities. Therefore, proper management, continuing training and development are important for the advancement of the NMSs.

The Panel to consider the following strategy is to be pursued in respect of management:

(*a*) NMSs should ensure that they have long-term development plans, and policy and legal frameworks in place when introducing new services and/or marketing their specialized services. In this regard, NMSs should exchange relevant information and experience;

(*b*) NMSs should carry out regular review of and make improvement to the structure, working mechanism and skill of staff of the NMS to increase effectiveness, efficiency and flexibility to cope with changing circumstances;

(*c*) NMSs should establish proper salary scales and incentive schemes to retain high calibre and trained staff and to motivate them;

(*d*) NMSs should partner with relevant government agencies and institutions, and work closely with the media, private sector and the academia; and

(*e*) NMSs should ensure that they have adequate building(s) with modern facilities to enable them to execute and advance their services in a suitable work environment.

While the Panel may consider the following strategy is to be pursued in respect of capacity building and transfer of technology:

(*a*) NMSs should have a commitment to human resources development in all meteorological categories through the implementation of human resources development plans and the adoption of a lifelong learning culture;

(*b*) NMSs should take continuing education and training as an investment to help improve the creativity and productivity of staff;

(*c*) NMSs should undertake planning, implementation and evaluation of continuing education and training activities in a structured and comprehensive way. They should encourage their staff to take actions for professional certification and, in the long run, consider the adoption of auditing system for the assessment of their staff;

(*d*) Regional exchange of technology and management skill among NMSs should be enhanced.

RSMC New Delhi, Regional Instrument Centres (RIC) at Calicut and the Regional Meteorological Training Centre (RMTC) in Poone, India should be more active in supporting the plans and requirements related to capacity building and transfer of technology in close cooperation with the Members.

Capacity building is to be underpinned by training and technology transfer in the areas of:

(*a*) Observing and processing data and interpretation of outputs from regional centres;

(*b*) Information and communication technology (ICT);

(*c*) Equipment maintenance;

(*d*) Provision of weather services for the public, including service-oriented media/communication skills;

(*e*) Provision of weather services for aviation and shipping, including marketing of services and liaison with clients;

(*f*) Provision of climate information services;

(*g*) Application of NWP products;

(*h*) Nowcasting of severe weather; and

(*i*) High level and middle management skills.

Training through fellowships, seminars and workshops with assistance from outside the Region needs to be also intensified.

3.9 Water resources

Freshwater is a natural resource vital to the survival of all living things; however, it is limited. The sources of freshwater are river basins, groundwater reserves, lakes and manmade reservoirs. These are increasingly under pressure to meet increased domestic needs as well as demands from agriculture, industry and other human activities.

Weather is the most important factor in water availability as it determines the timing and the location of precipitation and the amount lost to evaporation. Some arid countries in the Region like Oman, Southern Pakistan and Northwestern India have such low precipitation (as little as a few millimetres per year) and high evaporation, that only a small amount of freshwater can be captured for human use. By contrast, some countries receive abundant rainfall each year (thousands of millimetres). Seasonality is particularly pronounced throughout the Region and, in most cases, plays a major role in water availability; those countries which receive high rainfall - Bangladesh and India for example - are inundated with rainfall during the monsoon season, but lack rainfall the rest of the year.

This seasonality problem can be tackled by preventing the precipitation during the wet season from running off into the sea. The traditional method of rain harvesting, that is, retaining water through construction of ponds/lakes etc in individual villages or towns could ensure the optimum use of precipitation. Many demonstration projects have established that with proper storage techniques, rainfall during a season could be utilized throughout the year for agriculture and other human activities. It is such mini projects, rather than big dams, that are most cost-effective in conserving fresh water resources.

At the other end, for countries suffering from rain shortage, the conduct of cloud physics and precipitation enhancement projects should be encouraged, if feasible, in a collaborative basis.

The decline of hydrological networks in the Region is a challenge at a time when more high quality hydrological data are required, often in near real time. Hydrological networks need to be improved together with the capacity of Hydrological Services to provide relevant information to a variety of users of hydrological data. In this respect, the need for improving forecasting systems particularly to predict floods and droughts that could lead to disasters is a high priority in the Region. The management of international rivers in the Region is a most challenging problem as well. In the context of integrated water resources management, the joint management of river basins opens a window of opportunity for transnational collaboration in hydrology. The potential extension of several HYCOS projects into the Region are expected to foster this process and contribute to the capacity building of National Hydrological Services as well as integrated water resources management on the basis of timely, reliable hydrological data. Especially for prediction and forecasting of extreme events, the data collection and forecasting capacities of the meteorological and hydrological branches of national Services need to be integrated to provide the results required by the general public. Likewise, the introduction of rational water resources assessment methods, promoted by WMO and the United Nations Educational, Scientific and Cultural Organization (UNESCO), are expected to enhance the capacity of National Hydrological Services in the Region to act as service providers for planning, decision-making and implementation of water resources projects. A crucial issue for much needed regional collaboration between national Hydrological Services is the free exchange of hydrological data and information which has been documented in Resolution 25 of Thirteenth Congress.

4.3 Marine meteorology and oceanography

The economies and trade of many countries in the Region are strongly linked to the seas and oceans. Commercial shipping, port and harbour management, fisheries, offshore industry, tourism and recreation, coastal area and environmental protection and management, etc. are all very sensitive to marine weather and ocean conditions. In addition, marine meteorological and oceanographic data are essential to the improvement of seasonal and interannual predictions and to climate change research which are important for socio-economic activities in the Region.

According to the results of the monitoring survey of marine meteorological services undertaken by WMO during 2000, the usefulness of meteorological and oceanographic information in chart form was most favoured by users. While both information providers and users recognize the usefulness of the radiofacsimile broadcast, a concern over the high cost to maintain it arose. Migration to an economical modern communication means could be a solution.

The Panel may consider the following strategy is to be pursued by NMSs:

(a) To strengthen the marine observing networks and marine data bases through establishing additional marine meteorological stations at ports with adequate equipment and instrument including tide gauges, sea surface temperature measurement; to recruit and operate more voluntary observing ships (VOS) for meteorological, oceanographic and upper-air observations; to deploy and operate more drifting and moored buoys; and where possible, to participate in the Argo Project of sub-surface floats;

(b) To provide, extend and improve the type, range, accuracy and time of validity of marine forecasts and warnings, for both meteorological and oceanographic variables;

(c) To carry out research to improve the forecasting and warning of storm surges, coastal inundation and related hazards;

(d) To improve the format and means of distribution of marine products, including user access via satellite and terrestrial broadcast facilities, Internet, facsimile, telephone, hard copy distribution, etc.;

(e) To form a forum of providers and users to explore the migration from the costly radiofacsimile broadcast of meteorological and oceanographic information in chart form to a more economical modern communication means;

(f) To establish and enhance links with the full range of marine user groups, including small boat owners, to assess their requirements and obtain feedback on the applications, value and accuracy of marine products;

(g) To provide specialized meteorological and oceanographic services to support environmental protection and management, marine pollution emergencies, search and rescue operations, etc;

(h) To educate users, including the general public and fishing communities, on the availability and use of marine weather and oceanographic information, forecasts and warnings for planning their activities;

(i) To participate actively in GOOS and to having close linkage with GOOS Regional Alliances, in coordination with national oceanographic institutes;

(j) To explore and develop the use of satellite remote sensing data and numerical products with a view to improving meteorological coverage over the oceans, in particular for search and rescue operations; and

(k) To make marine observations and provide data to support global and regional climate studies. In particular, to enhance sea level observation in close collaboration with the Global Sea Level Observing System (GLOSS) programme to monitor long-term sea level rise associated with global warming.

4.4 Public weather services

Society's expectations of the meteorological community have increased over the recent decades and NMSs are expected to deliver a set of traditional and new products and services with usefulness, timeliness, accuracy and quality higher than before. NMSs are in a position to benefit from many opportunities offered to them, in particular advances in science and technology to meet such expectations. At the same time, they should be prepared to face the challenges associated with the evolving economic and political situation on the global, regional and national levels. These could range from inadequate human and financial resources, to low national status and diminished visibility, and to increasing competition from private companies and the emergence of other external forces that may redefine the role

and operations of NMSs. The following strategy should be pursued by the NMSs in the Region:

(*a*) To provide appropriate quality information, products and services in a language that can be understood by the community;

(*b*) To make substantial effort in public education and in enhancing public awareness, through, among other things, close cooperation with the media, hazards mitigation community, government agencies and weather sensitive sectors;

(*c*) To gear toward a service-oriented NMS, putting emphasis on the training of forecasters as PWS frontline personnel, the enhancement of the forecast/warning/products dissemination systems to facilitate forecasters' new role in PWS and the design of PWS products in terms of media-friendliness, convenience in retrieval, readability and user-friendly layout;

(*d*) To contribute official forecasts to the WMO pilot project “World Weather Information Service” and promote its use to the public and media;

(*e*) To establish Websites and produce television weather programmes to disseminate weather forecasts, warnings, data and information to the general public and other users; and

(*f*) To make use of new developments in communication technology in providing “weather information any time any where” to better serve those on the “move”.

5. REGIONAL COOPERATION AND OTHER ACTIVITIES

5.1 Regional cooperation

The following strategy would be pursued in the Region:

(*a*) NMSs to make efforts to have adequate resources to support their activities and services in order to meet the increasing demands;

(*b*) NMSs to participate actively in the programmes and activities of RA II (Asia) as it provides for close cooperation between NMSs on regional activities of special interest;

(*c*) NMSs to contribute to, and learn from, as many technical commissions as practical and possible. The eight WMO technical commissions provide global cooperation in their fields and assist Members in keeping abreast of developments;

(*d*) Concerted efforts at the national, regional and global levels to be undertaken to provide NMSs with the assistance required to ensure adequate operations, maintenance activities and human resources. NMSs should strengthen their liaison with national authorities and various funding agencies, and regional and international development institutions to ensure that their inputs and requirements are taken into account in the formulation and funding of priority programmes;

(*e*) Necessary actions to be taken to strengthen and develop regional cooperation, especially with regard to inter-country projects and programmes such as those concerning natural disaster reduction and mitigation and environmental hazards, within the framework of subregional and regional intergovernmental organizations and economic groupings.

5.2 Regional projects

The following regional projects with significant potential benefits to Members especially the developing ones are worth pursuing:

(a) Establishment of an Early Warning System for Tsunamis

After the devastating tsunami which affected most of the countries of the Panel towards the end of December last year, there has been an urgent need to establish an Early Warning System for the Panel Region.

In this connection, WMO has for the past few months along with other International Organizations worked towards bringing the countries of the region to work together in identifying an ideal mechanism that will support an Early Warning System for the region.

The Panel should take advantage of this situation and participate in all the forums that are called upon by WMO in this regard.

It is important that the Panel collaborates with the adjacent regions in establishing this project. It should then draw up a plan for implementation having all the Members participate.

(b) Storm surge disaster reduction for the northern part of the Indian Ocean

A new initiative called the Marine Impacts on Lowlands Agriculture and Coastal Resources (MILAC) was endorsed by WMO Cg-XIV in 2003 and IOC EC-XXXVII in 2004. The aim of MILAC is to contribute to natural disaster reduction in coastal lowlands where marine impacts from tropical cyclones cause severe damage to population, agriculture, freshwater resources, environment and infrastructure, by developing a generic system for mitigating such impacts.

Partnership among the meteorological and oceanographic communities including WMO Technical Commissions, WMO Regional Associations and GOOS Regional Alliances is essential to the implementation of MILAC. It was agreed at WMO Cg-XIV that this new initiative be treated as a demonstration project to be implemented in one of the countries affected by tropical cyclones. Indian Ocean is considered to be the possible first MILAC site. NMSs in the Region should give support to the demonstration project for the northern part of the Indian Ocean.

(c) The WMO Programme for the Least Developed Countries (LDCs) was established by the Fourteenth Meteorological Congress in May 2003 to contribute efficiently and in a timely manner to the social and economic development efforts of LDCs through the enhancement of the capacities and capabilities of their NMHSs. A special WMO Trust Fund for the LDCs has been established for which contributions were expected from Members, bilateral and multilateral funding agencies including the World Bank, regional development banks and the private sector. Other strategies would be pursued for the successful implementation of the Programme, including:

- Developing specific projects for LDCs using strategic plans prepared for the rehabilitation and improvement of basic meteorological and hydrological infrastructure in various regions;
- Mobilizing resources through the establishment of strategic partnerships with regional/sub-regional organizations and economic groupings, public and private sectors, banks, UN agencies, multilateral organizations and bilateral arrangements; and

- Ensuring coordination with interested partners through periodic consultative processes.

Permanent Representatives of Members are encouraged to play an active role in the mobilization of resources for NMHSs of the LDCs.

6. WMO PROGRAMMES AND OTHER REGIONAL AND INTERNATIONAL PROGRAMMES IN SUPPORT OF NMSs IN THE REGION

6.1 WMO Programmes

The major WMO Programmes concerned are the World Weather Watch (WWW), the World Climate Programme (WCP), the Atmospheric Research and Environment Programme (AREP), the Applications of Meteorology Programme, the Hydrology and Water Resources Programme (HWRP), the Natural Disaster Prevention and Mitigation Programme (NDPMP), the Education and Training Programme (ETRP), the Technical Cooperation (TCO) Programme and the Regional Programme (RP).

6.2 Regional and international programmes

Programmes of the following organizations are of interest:

The ASEAN Subcommittee on Meteorology and Geophysics (ASCMG); ESCAP; the Interstate Council on Hydrometeorology of the Countries of the Commonwealth of Independent States (ICH CIS); the Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM); the UNESCO Intergovernmental Oceanographic Commission (IOC); the United Nations Environment Programme (UNEP); the Global Environment Facility (GEF); the Economic Cooperation Organization (ECO); ESCAP; the Economic and Social Commission for Western Asia (ESCWA); the South Asia Regional Cooperation (SARC); the League of Arab States (LAS); the Permanent Meteorological Committee; and the Regional Organization for the Protection of the Marine Environment (ROPME).

6.3 Agreements and conventions

NMSs are required to undertake national responsibilities or contribute to national obligations under many regional and international agreements and conventions. Some of the most important of these are the WMO Convention; Agenda 21 adopted at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992; the 1994 Global Conference which adopted the Barbados Programme of Action for Sustainable Development of Small Island Developing States; Resolution 40 of Twelfth Congress (1995) on the policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities; Resolution 25 of Thirteenth Congress (1999) on the exchange of hydrological data and products; the Geneva Declaration of Thirteenth Congress (1999); the United Nations Framework Convention on Climate Change (UNFCCC); the United Nations Convention to Combat Desertification (UNCCD); the International Strategy for Disaster Reduction (ISDR); the Convention of the International Civil Aviation Organization (ICAO); the Convention of the International Maritime Organization (IMO); the International Convention for the Safety of Life at Sea (SOLAS); and the Convention on the Protection of the Ozone Layer.

There are also a number of United Nations programmes and agencies having activities related specifically to meteorology, climate or hydrology or providing financial support to countries. These include UNEP, the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO) of the United Nations and others.

7. CONCLUSION

This Coordinated Technical Plan for the Enhancement of NMSs in the Panel Region (2005-2008) was developed taking into account the previous Plan for 2001-2004, the Sixth WMO Long-term Plan (6LTP) and suggestions from Members during the 31st Session which was held in Colombo, Srilanka, 01st March to 06th Match 2004. The important roles of the NMSs and their obligations have been described in this Plan. The Plan provides some information and proposals to help NMSs individually and collectively meet their national requirements and international commitments in relation to the provision of relevant services. Fundamental to the success of this Plan is that it is based on the National Five Year Development of each country in the Panel. It is expected that Members in the Panel will have to consider seriously whether the proposed Technical Coordinated Plan is practical and realistic to be implemented. And that it will lead to the strengthening of NMSs' capabilities to a high standard to meet the growing demands for improved weather and climate services and products.

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SURVEY ON THE BASIC CAPABILITY OF NATIONAL METEOROLOGICAL SERVICES IN THE PANEL REGION

Name of Member Panel:

	Actual	Planned status Included in National 5 Year development Plan		
Capability indicators	**Jan. 2005**	**Jan. 2006**	**Jan. 2007**	**Jan. 2008**
I. Management				
1. Legal basis for provision of meteorological services (Yes or No)				
2. Cost-recovery for services implemented (Yes or No)				
3. Has a structured training plan for professional, technical and supporting staff (Yes or No)				
4. Cooperates with academia (Yes or No)				
5. Cooperates with media (Yes or No)				
6. Cooperates with private sector (Yes or No)				
II. Observing systems				
1. Number of operational Regional Basic Synoptic Network surface stations				
2. Number of automatic weather stations				
3. Number of rainfall stations				
4. Number of operational Regional Basic Synoptic Network upper-air stations				
5. Number of operational Regional Basic Climatological Network stations				
6. Number of operational GCOS Surface Stations				
7. Number of operational GCOS Upper-Air Stations				
8. Number of operational weather radar stations				
9. Operates ground station(s) for high resolution images from geostationary meteorological satellites (Yes or No)				
10. Operates ground station(s) for high resolution images from polar-orbiting meteorological satellites (Yes or No)				
11. Number of operational wind profiler stations				
12. Operates a lightning location network (Yes or No)				
13. Number of Global Atmospheric Watch stations				
III. Telecommunication				
1. Speed of GTS connection to RTH(s) (Specify the highest speed among all circuits, in bps; No for no connection)				
2. Connected to Internet by broadband (Yes or No)				
3. Connected to Internet by telephone dial-up (Yes or No)				
IV. Data processing and forecasting systems				
1. Speed of the fastest computer system (GFLOPS)				
2. Automatic data reception and archival (Yes or No)				
3. Automatic data plotting (Yes or No)				
4. Automatic data processing (Yes or No)				
5. Runs NWP model(s) operationally (Yes or No)				
6. Access to NWP products from major centres operationally (Yes or No)				
7. Operates a nowcasting system for high impact weather warning (Yes or No)				
V. Natural disaster prevention and mitigation				

	Actual	Planned status Included in National 5 Year development Plan		
Capability indicators	**Jan. 2005**	**Jan. 2006**	**Jan. 2007**	**Jan. 2008**
1. Links with national disaster managers (Yes or No)				
2. Has a public education programme (Yes or No)				
3. Has a Natural Disaster Management Plan (Yes or No)				
VI. Climate, climate change and climate variability				
1. Provides monthly/seasonal climate predictions (Yes or No)				
2. Makes observations to monitor climate change and climate variability (Yes or No)				
IX. Marine meteorological services and oceanography				
1. Number of operational tide gauges				
2. Number of operational drifting and moored buoys				
3. Issues marine forecasts/warnings for coastal waters including sea state and wave/swell (Yes or No)				
4. Issues marine forecasts/warnings for high seas (Yes or No)				
5. Issues Tsunami forecast/warnings for coastal waters (Yes or No)				
6. Runs Tsunami model(s) operationally (Yes or No)				
7. Issues storm surge warnings (Yes or No)				
8. Runs storm surge model(s) operationally (Yes or No)				
9. Provides support for marine pollution (Yes or No)				
10. Provides support for search and rescue (Yes or No)				
X. Public weather services				
1. Provides nowcasting of high impact weather (0-6 hours ahead) (Yes or No)				
2. Issues short-range weather forecasts/warnings (6-24 hours ahead) (Yes or No)				
3. Issues medium-range weather forecasts/warnings (1 day - 2 weeks ahead) (Yes or No)				
4. Range of public weather forecasts (Days)				
5. Operates a Website for real-time weather information, forecasts and warnings (Yes or No)				
6. Operates an automatic telephone answering system for weather information, forecasts and warnings (Yes or No)				
7. Operates a TV weather programme (Yes or No)				
8. Verifies forecast accuracy (Yes or No)				
9. Obtains feedback from users through opinion surveys, user groups, etc (Yes or No)				

APPENDIX VI

SPECIFIC ISSUES IN THE OVERALL FRAMEWORK OF THE COORDINATED TECHNICAL PLAN (CTP) (2005-2009)

OVERALL FRAMEWORK

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

0.1 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.

0.2 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 (2005–2006) and by 20 percent during the five-year period (2005-2009).

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 (2005-2006), 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 (2005–2006) 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

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1.5 To promote exchange of information 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 2005-2006;

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.

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 2005 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 programmes.

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.

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 and their application in Cyclone (track and intensity) and storm surge prediction;
- Media coordination during disasters and their effectiveness on “human response”;
- Use of Doppler Weather Radar products in Cyclone forecasting.

4.2 Arrange:

- Exchange visits of faculty members among Member countries to share their experiences and expertise on cyclone & related disaster management aspects;
- Enhance WMO's fellowship support on tropical cyclone related programmes;
- Introduction of "Disaster Management" in the High School carriculam.

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 (say Mahanadi) for coastal inundation and river flood forecast;
- R&D on various tropical cyclone and surge models, their evaluation and subsequent improvements / fine tuning etc. to suit the real time needs;
- Updating of vulnerability maps for various parameters like wind force/peak storm surge etc., based on latest available database.

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APPENDIX VII

METEOROLOGICAL ACTIVITIES OF MEMBERS

INDIA

Meteorological Observational Network (surface and upper-air):

- World Space Based Forecasting Centre at Pithrogarh was inaugurated and became functional in February 2004;
- Installation and commissioning of MKIV RS New Auto Computation System was completed at Meenambakkam, Karaikal, Visakhapatnam and Machilipatnam during January 2004;
- Met Observatory at National Institute of Technical Teacher's Training and Research Campus Chandigarh was inaugurated in March 2004;
- A Class III Aeronautical Meteorological Office started functioning at Hubli Airport from May 2004;
- MO Kanyakumari commissioned as Class I Observatory from March 2004;
- A new surface Observatory was commissioned at Bapatla during October 2004;
- MOU has been signed between MC Bangalore and University of Agricultural Sciences Dharwar for shifting of Met Observatories at Raichur and Bijapur;
- A proposal is under consideration for installation of 100 Automatic Raingauge stations over districts which are either not represented or have poor representation;
- Action was initiated to upgrade RS Kochi into RSRW station;
- AWS receiving stations installed at AWS Lab, Pashan, Pune and is functioning from July 2004;
- Tours were conducted to all 21 DCP sites in Tamilnadu and Andhra Pradesh to inspect their suitability to install new AWS system and action was taken to relocate some of the unfit sites;
- Under Meteorologically unrepresentative districts 10 stations were selected in phase I for the installation of new AWS systems in Tamilnadu, Andhra Pradesh, Kerala and Karnataka; and
- Sutron AWS system at Chennai and Karaikal are functioning satisfactorily.

Weather radar: Doppler weather Radars installed and commissioned at SHAR Sriharikota during April 2004 and at Machilipatnam during August 2004. IMD maintains a network of 11 high power S-Band radars located at Machilipatnam, Visakhapatnam, Paradip, Bhuj, Kochi, Karaikal, Mumbai, Goa, Chennai, Kolkata and Sriharikota along east and west coast of India for cyclone detection and tracking. Out of 11 radars, there are 3 Doppler Weather Radars located at Chennai, Kolkata and Sriharikota. The foouurth Doppler Weather Radar located at Machilipatnam has been installed and has become operational in December 2004. the fifth Doppler Weather Radar is to be installed in early 2005 at Visakhapatnam, after the construction of new Doppler Weathe Radar building is completed. Six Cyclone Detection Radars located at Paradip, Bhuj, Kochi, Mumbai and Karaikal have become very old and are proposed to be replaced by Doppler Weather Radars in phased manner. Further in order to bridge the gap regions between existing 11 Cyclone Detection Radars, 7 more radars are needed to be installed at Balasore, Gopalpur, Kavali, Ramanathapuram, Mangalore, Ratnagiri and Veraval. Thus, Department intends to procure, install and

operationalise 13 Dopler Weather Radars in next five years. Six of them will replace the old Cyclone Detection Radars and seven will be installed at new locations to fill the gap between existing network, subject to availability of funds.

Other Upper Observational Network: IMD's upper air observational network consists of 38 Radiosonde/Radiowind and 61 Pilot Balloon Observatories. The network has been expanded and being updated gradually for use in operational work of weather analysis and forecasting as per WMO standard. project of autocomputation is to be completed by March, 2005. The ground reception system used in the network is of mixed type such as 1680 MHz IMS-1500 Radiotheodolites and indigenously developed 401 MHz SAMEER tracking radiotheodolites. Radiosonde Ground Equipments (RSGEs) are used in association with Wind Finding Radars. Recently all the 7 Nos. of WBRT stations have been replaced with new IMD-1500 and also three new stations have been put on operation in the Himalayan mountain range. Radiosonde MK-III introduced in the network in early 70's is being further improved. Both the lithium chloride Hygrister and Baroswitches for the radiosonde are manufactured indigenously. A new radiosonde IMD MK-IV with automatic acquisition and processing system is being installed for improved performance.

Satellite Programme: Digital CWDS uplink equipment at RMC Chennai and 100 sets of receiving units at field stations in Coastal Andhra Pradesh under World Bank Project scheme.have been taken over from the supplier during August 2004. In another 4 to 5 years all the analogue CWDS receivers at 250 locations will be replaced by DCWDS technology and network shall be expaned to 50 more stations. Therefore, IMD's DCWDS network shall be about 400 stations by the year 2007. A scheme for digital Meteorological Data Dissemination (DMDD) is also being implemented to provide all the satellite imageries and Met. products to the users in digital form all over India. INSAT 3D will be launched in 2006, which will have imager as well as sounder as meteorological payloads. IMD is in the process of replacing old 100 Automatic Weather Stations (AWS) using latest AWS by 2005. At present 16 new AWS are operational and data is being received at New Delhi and Pune. Along with new AWS a AWS data reception earth station is also proposed to be established at Pune.

Telecommunication:

- New AMSS system was inaugurated at MO Pa1am in March 2004;
- 64 Kbps MLLN (Managed Leased Line Network) circuit between RTH New Delhi and MO Chennai commissioned in July 2004;
- 64 Kbps communication link has been established between MO Chennai and ACWC Chennai during June 2004;
- Action is in progress for the introduction of 64 Kbps data line between MO Chennai and MC Thiruvananthapuram and MC Thiruvananthapuram to MO Airport;
- Upgradation of Seismological communication system had been done by changing ODU / IOU equipments of the existing V-Sat system at Chennai, Visakhapatnam and Thiruvananthapuram and made operational from June 2004;
- Lease line Internet (SILL -Shared Internet Lease Line) facility from VSNL was commissioned at MO Chennai during May 2004;
- Internet facility was provided at RS RW Mangalore, CWDS Unit at RMC Chennai and at MO CIAL Kochi during 2004;
- IMD officers had discussion with NIOT Higher Officials for regular faxing of Buoy data to ACWC Chennai and through e-mail to NHAC New Delhi; and

- Fax on demand (FOD) facility of AMSS unit at MO Chennai commissioned during August 2004.

Present Operational Status of RTH, New Delhi is as under:

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.15th October, 2004.
2.	New Delhi – Tokyo	Upgraded via Frame Relay of RMDCN of RA VI of Equant w.e.f. 20th August, 2004.
3.	New Delhi – Cairo	Upgradation of 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.
3.	New Delhi – Jeddah	Upgraded to 64 Kbps w.e.f. 14th January, 2005.
C.	**Regional Circuits**	
1.	New Delhi – Colombo	50 baud.
2.	New Delhi – Dhaka	2400 bps.
3.	New Delhi – Karachi	64bps.
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 Circuits**	
1.	New Delhi – Melbourne	Through Internet.
E.	**Bilateral**	
1.	New Delhi – Beijing	9.6 Kbps – Upgradation via Frame Relay under progress.

Upgrading of New Delhi – Colombo and New Delhi – Yangon GTS circuit via Internet is in progress.

RTH New Delhi has plans to use internet VPN technique as replacement of circuits with National Centres.

India Meteorological Department has modernized the National Meteorological Telecom Centre (NMTC) with a new Switching Computer with effect from 1.1.2000. It has many advanced features like handling VSAT links, Dial-up Telex, Fax-in Fax-out facility, Data Modem-in, Data Modem-out facility, T4 Fax and handling sea bulletins under GMDSS broadcast system. The new system support TCP/IP, FTP and X.25 communication protocols for exchange of data/information. Many more advanced features have been incorporated in

the software like GTS socket communication using internet and data exchange through email and auto retrievals, frame relay connectivity.

IMD has started a new meteorological data and processed products broadcasting service from 1st July 2003 using World Space "Asia Star" satellite. This is a replacement of the H/F Broadcast System. The meteorological data presently being broadcasted are:

- Indian Satellite Images Visible, Infrared, Colour and Water Vapour Images.
- GTS data (SYNOP, PILOT, TEMP METAR, TAF etc.) of India and its neighbouring countries.
- Weather charts and Model outputs.

The broadcast covers large area of Middle-east and South-East Asia at a download frequency of 1467-1492 MHz.

IMD's website contains information on all India Weather and forecast, special monsoon reports, satellite cloud pictures updated every three hours, Limited Area Model (LAM) generated products and prognostic charts, special weather warnings, tropical cyclone information and warnings, weekly and monthly rainfall distribution maps, earth-quake reports etc. The website also contains lots of other information about various activities and services rendered by IMD. This site can be accessed with the **URL: http/www.imd.ernet.in.** IMD's regional offices at Mumbai, Kolkata, Chennai and Guwahati have also their own websites.

The speed of Internet upgraded to 2048 Kbps w.e.f. 21st July 2004.

Message Switching Computers are operational at Major International Airports Delhi, Mumbai, Chennai, kolkata and Guwahati and are Linked with the NMTC in a network formation. Chennai, Mumbai, Delhi and kolkata are connected to RTH/NMTC. New Delhi system through 64 Kbps, Guwahati through 2400 bps X.25 on one hand and to a number of Sub-regional Meteorological centres through slow speed links on the other hand. Other circuits are shortly being replaced by new systems capable of operating at 64 Kbps and using TCP/IP Socket protocol.

Telecom Training Centre at New Delhi is a Training Centre recognized by WMO where training classes of different Telecom Courses are being conducted. This centre is equipped with all latest facilities for imparting trainings.

Another Public Weather Service of IMD is the Interactive Voice Response System (IVRS) which started by NMTC w.e.f. July 2000 and is very useful for getting information on Weather even for remote places without making an STD call.

Under the New 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.

The OPMET data received through SADIS (Satellite Distribution System) receive only terminal installed at RTH, New Delhi is being sent to AMSS Mumbai, kolkata and Delhi for Flight Planning Documentation.

At NMTC, current meteorological observational data is available on FTP server and can be accessed by authorized users.

Antarctic Monitoring results have been conducted at RTH New Delhi during 1 to 15th January 2005 and the result sent to WMO via Internet.

75 out of 77 RBSN stations in India have been provided with dedicated telecommunication links. Many stations have been provided with multiple telecommunication links.

All Cyclone Warning Centres/Cyclone Detection Radars have been provided with dedicated telecom facilities.

There are 65 Telefax stations and 14 VSAT stations installed at CDR/CWC/MC/Seismological Stations/Observatories. Fax and RTT broadcast are being replaced by Satellite data casting through World Space Satellite.

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.

RTH New Delhi has plans to use internet VPN technique as replacement of circuits with National Centres. The circuits viz. New Delhi – Jeddah, Colombo, Yangon, Bangkok, upgradation either through Internet or 64 Kbps is under progress. New Delhi – Kathmandu circuit is also proposed to upgrade through 64 Kbps.

RTH New Delhi is keeping India's GTS data on ftp server which are being accessed by all NMC's.

The upgrading of the National and International links in a phased manner is under process. There is plan for connecting Tokyo and Moscow through frame relay connectivity with RTH, New Delhi. There are also plans to connect NMC's:-Male, Colombo and Yangon through Internet/64 kbps and the project is under implementation.

New Delhi – Moscow circuit through Frame Relay is under testing and will become operational soon.

MALDIVES

Meteorological Observations: Maldives has five meteorological stations of which four are 24 hours operational. As these are based on airports all of them serve for synoptic and aviation purposes. Two of them are categorized additionally as upper-air stations.

Hanimaadhoo	WMO# 43533 – Synoptic + aviation (00 to 15UTC)
Malé	WMO# 43555 – Synoptic + aviation + u/wind (24 hours)
Kadhdhoo	WMO# 43577 – Synoptic + aviation (00 to 15UTC)
Kaadehdhoo	WMO# 43588 – Synoptic + aviation (24 hours)
Gan	WMO# 43599 – Synoptic + aviation + u/wind (24 hours)

The Radiosonde observation has started at the Meteorological Office, Gan Island (WMO # 43599) using Visala Radisonde RS92 on 14 September 2004 under the Global Upper-Air Network (GUAN). Since then a 1200UTC TEMP message is transmitted daily through GTS from this station. This project was a combined effort of WMO, GCOS and in particular The USA, NOAA and the UK Met. Office.
The remaining spares for the removed WF-33 wind-finding radar were donated to the Department of Meteorology, Sri Lanka.

No upper-air observations were made at Male' (WMO # 43555) last year. The WF100 wind finding radar with the hydrogen generator remained unserviceable for several years and need to be replaced.

Since the South Indian Ocean is a data sparse area, upper air observations from the south and central Maldives are very important to us as well as the entire meteorological community in the region. Hence, Maldives request assistance from WMO and Panel members to re-build our upper air network soon.

Meteorological satellites: The INSAT receiving system remains unserviceable since 2003. Discussions were held at the Indian High Commission in Malé to upgrade this system during late 2004. We hope that the India Meteorological Department look on to the matter urgently and solve the problem as soon as possible. Currently there is no appropriate satellite receiving facilities available at NMC Maldives.

Imageries and satellite winds from METEOSAT that are available in the internet were used daily for weather forecasting purpose.

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

The 75 baud GTS circuit between Malé and New Delhi was upgraded to an internet TCP/IP link during late May 2004. At the beginning this link remained silent for few months and is now working satisfactorily. The necessary hardware was obtained locally and software was purchased from 3A Corporation of Pakistan. However, NMC Malé still transmit their meteorological messages by email to RTH as a backup service.

Computer network: The **A**nalyzing, **F**orecasting, **D**ata-processing and **O**perating **S**ystem (AFDOS) remain unserviceable and needed to be upgraded soon. Negotiations on this are undergoing with Chinese authorities.

The official website of the Department of Meteorology www.meteorology.gov.mv which was launched on 2003 upgraded in 2004. Forecasts, warnings, meteorological reports and aviation weather charts are readily available on this webpage.

MYANMAR

Meteorological satellies: There are two ground receiving systems for meteorological satellite namely skyceiver for WEFAX and APT from GOES 9 (via GMS 5) and NOAA. Second receiving system is donated from china which can receive GMS 5 (at the present GMS 5 VISSR is silent due to replacement of GMS 5 with MTSAT). We learnt that IMD disseminated Meteorological Product via World space satellite based broadcast system. In this regards we are looking for (encription-or licence) to receive Digital Satellite broadcast from IMD.

Climate Data Rescue Project: All the meteorological, hydrological and seismological data of the DMH are stored in DOS Version GO6 Software and Microsoft Excel. The volume of data entry is low compared to the data in the hard copy, which have been collected since pre-war period. It is urgently necessary to implement the project to rescue and save the data in the very old hard copy. Therefore, the CLICOM Software Version 3.1 has been installed and Climate Data Rescue Project VCP (4/1/1) has been successfully completed in DMH from 14 to 25 May 2001, under the VCP of WMO.

ASEAN Project: Record Section of Department of Meteorology and Hydrology is solely responsible section of DMH for partial implementing the ASEAN Project on "Updating of the ASEAN Climate Atlas and Compendium of Climate Statistics". In the case of Myanmar, this will involve the preparation of the data set for the period commencing January 1965 to December 2000 with (30) stations including WWW stations has been chosen for this project.

Upper-air observations: Fourteen stations are listed as pilot balloon stations in Myanmar. However, due to the shortage of consumables, only half of the listed stations can take observations at 0000 UTC. Although six stations of Myanmar are listed in WMO as Radiosonde/ Radio wind stations, five stations are not operational due to the shortage of airborne transmitter from the factory. DIGI CORA II at Mandalay in the Central Myanmar is partially operational, it is meant that no wind data can be obtained due to the ceased OMEGA Signal world wide. Myanmar is eager to carry out regular observation for the benefit of the region, if equipment and consumables are available under VCP/ Bilateral Programme. WMO monitoring result showed that Myanmar TEMP report to GTS percentage is zero.

Storm detection radar: A storm detection radar is located at Kyaukpyu and now it fairly operational due to the absence of preamplifier and DVIP (Digital Video Integrator Processor) function. Although the lack of above mentioned units, the radar can detect storm position except for true intensity and amount of rainfall. Since Kyaukpyu radar is the only radar in Myanmar, there is a gap of storm detection radar coverage in the region of Deltaic- Mon, Taninthayi coast and it is necessary to implement a storm detection radar at Yangon (48097) to fill the gap of radar coverage for better tracking and warning of the tropical cyclone in the region.

Present status: Myanmar is taking care of 27 WWW stations (details in Annex 1) and all of them are equipped with HF SSB (High Frequency Single Side Band) transceiver for national data collection. On the other hand, other 13 meteorological and hydrological stations are also equipped with SSB for local use. Since 1990, NMC (Yangon) is connected to GTS through RTH Newdelhi and RTH Bangkok working with 50 baud, Async ITA2.

Aviation Meteorological Office located at Yangon International Airport is receiving necessary observational data through UHF (Ultra High Frequency) data link connected between NMC Yangon headquarter and Aviation Met Office. The charts prepared by Aviation Met Office are being sent regular basis to the selected airports within Myanmar by Telefax.

The existing facilities at DMH are as follows:

(a) 40 SSB station including 27 WWW stations are working properly;

(b) Storm detection radar at Kyaukpyu is fairly operational due to the absence of preamplifier and DVIP functions;

(c) The only one AWOS (Automatic Weather Observation System) at DMH headquarter is operating well;

(d) Four numbers of wind and solar data loggers at DMH headquarter (48097), Nyaung-U (48048), Pyay (48077), Tharrawaddy (48088) are well operating for wind and solar energy measurements.

Essential requirement to meet future international agreed telecommunication procedures and technologies: After review of above existing telecommunication facilities in DMH, Myanmar, it can be noted that most of the telecommunication and electronic related instruments are more than 10 and 25 years old. Although they are aged, current implementation of those equipments can fairly fulfill the national, regional and WWW requirement. Thus, DMH Myanmar is proud of our strength to maintain those equipments

provided by WMO / VCP and related nations. Nowadays technologies in various field are growing up in high rate. Conventional Telecommunication equipments are facing mismatch to the updated equipment and protocol.

It is learnt that number of changes in Meteorological telecommunication and dissemination method of data and product, in order to get cost effective, more reliable and high volume of information transfer in short period using modern technologies such as:

(a) Number of GTS centers (NMCs and RTHs) implemented TCP/ IP for international and national purposes and that the migration towards TCP/ IP has also facilitated the replacement and upgrading of GTS systems as well as the introduction of PC based system for GTS / GDPS operation in NMCs of several developing countries;

(b) Several members have already discontinued the operation of HF broadcast, which have high recurrent operational cost and a limited efficiency, in some instances replaceing them by satellite distribution systems. At the present 33 VSAT receiving stations of SADIS operated by the UK, were implement in 22 RA II countries. JMA has been considered the possibility of discontinuation of JMH broadcast and seeking the move cost effective and modern alternative since 1997.

Above example indicating that telecommunication such as GTS-ITA2 50 baud and HF Radio Fax Receiver currently implemented in DMH will not be fulfill our requirement in near future. In this regards, DMH is already submitted VCP request, project indicator TE/4/1/1 upgrading of GTS communication between NMC Yangon and RTH Bangkok and Project indicator OB/1/2/5 upgrading of OMEGA Upper Air Observation system to GPS capability the status is not yet supported. DMH has a plan to install MTSAT receiving system within our budget allotment. Alternatively NMC Yangon is within the coverage of VSAT / MDD system operated by India, China and Thailand. These member countries are invited to suggest the possibilities of cooperation activities with NMC Yangon.

OMAN

Meteorological facilities

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.

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.

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).

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.

Telecommunication

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.

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

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.

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.

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

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.

Computer workstations

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 78.0E, 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.

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.

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 Permanent Representative to WMO.

Aeronautical services

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. 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

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 Miister, 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.

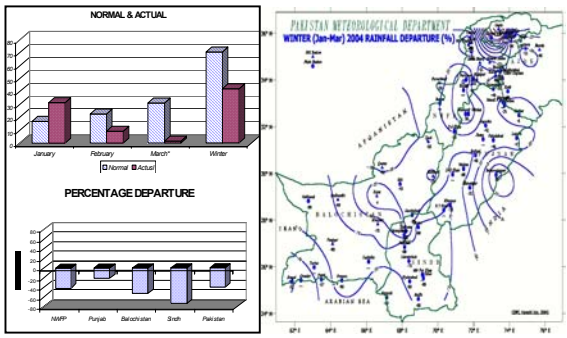
(ii) Technical advancement

For speedy transmission of data, V-Sat facility was provided to eleven 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.

(iii) Rainfall during 2004

(a) Winter rainfall

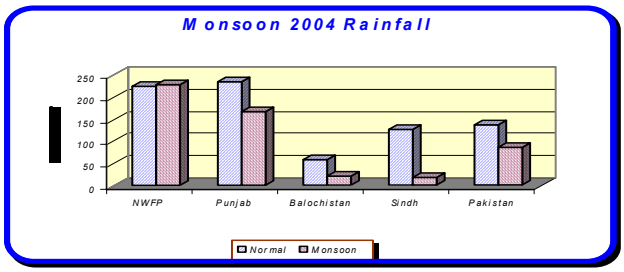
Abnormal variation of rainfall has been observed in Pakistan's winter rainfall 2004. Heavy downpour was witnessed in almost whole of the country during the month of January, when rainfall was 84% above normal. However, very little rainfall occurred in the two subsequent months, i.e. -59% & -96% respectively. March 2004 was one of the driest months of March in the history of Pakistan. Overall 41% below normal rainfall was recorded during the winter season. Seasonal rainfall distribution has been observed to be largely below normal, on

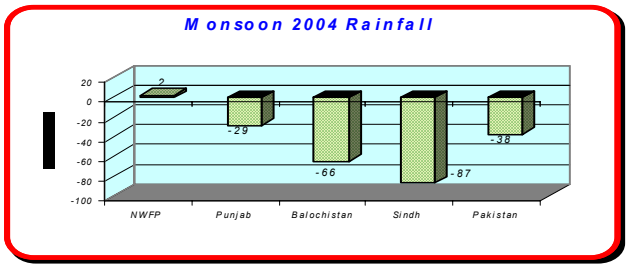


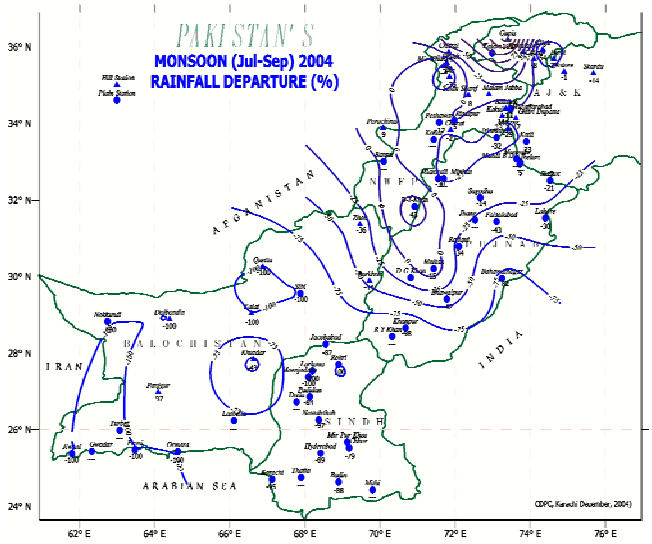
provincial and national basis. Bar diagrams show normal, actual and percentage departures from normal while map shows seasonal distribution of rainfall over Pakistan.

(b) Monsoon rainfall

Pakistan received 38% deficit rainfall during the recent 2004 monsoon season. Province-wise distribution of the rainfall has also been observed to be below normal except NWFP (Sindh –87%, Balochistan –66%, Punjab –29% & NWFP +2%). Bar diagrams show normal, actual and percentage departure from normal while map shows seasonal distribution of rainfall over Pakistan.







(iv) Extreme weather events

- ***Heavy snowfall*** occurred in and around Quetta valley on 30 January 2004 after a period of 10 years.

- ***Lowest minimum temperatures*** of -14.0°C on 22 December 2003 and -15.8°C on 4 January 2004 were recorded at Astore and Kalam respectively.

❖ ***Fog phenomena*** was observed at Lahore from 19 December 2003; lowest visibility of 30 meters was observed at Lahore Airport on 21 December 2003. Fog frequencies over major cities during January 2004 have been shown in the table.

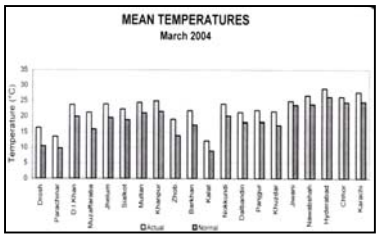
Fog Frequencies	
Station	**No. of days**
Lahore Airport	12
Faisalabad	17
Multan	16
Sialkot	22
Sargodha	09
Bahawalpur	13

❖ ***Some new climatic records*** were formed during the period January-May 2004 which are detailed below:-

Month	***Station***	***New record of highest maximum temperature***	***Old record of highest maximum temperature***
January	Barkhan	30.0 / 15-01-2004	25.0 / 27-01-1987
	Nawabshah	33.7 / 12-01-2004	33.5 / 27-01-1990
February	Zhob	26.5 / 25-02-2004	26.0 / 11-02-1998
	Khuzdar	33.5 / 27-02-2004	30.0 / 29-02-2000
March	Jhelum	36.8 / 16-03-2004	36.7 / 31-03-1971
	Zhob	32.5 / 08-03-2004	32.0 / 21-03-1974
	Barkhan	33.2 / 16-03-2004	33.1 / 29-03-1999
	Kalat	29.0 / 08-03-2004	26.7 / 22-03-1959
	Punjgur	36.5 / 22-03-2004	35.6 / 31-03-1942
	Khuzdar	33.5 / 07-03-2004	33.0 / 03-03-1999
	Nawabshah	44.5 / 21-03-2004	44.0 / 31-03-2002
	Karachi	41.5 / twice in March 2004	41.0 / 28-03-1998
	Quetta	31.0 / 08-03-2004	30.3 / 28-03-1999
April	Kalat	37.3 / 28-04-2004	32.8 / 24-04-1958
May	Zhob	45.0 / 20-05-2004	40.4 / 24-05-1998
	Sialkot	47.5 / 19-05-2004	47.3 / 26-05-1984
Month	***Station***	***New record of lowest minimum temperature***	***Old record of lowest minimum temperature***
April	Jiwani	12.5 / 30-04-2004	12.8 / 01-04-1945
May	D.I. Khan	12.5 / 01-05-2004	14.0 / 14-05-1997
	Muzaffarabad	05.9 / 02-05-2004	07.0 / 09-05-1997
	Sargodha	13.0 / 01-05-2004	14.0 / 08-05-1998
	Lahore	11.1 / 04-05-2004	14.0 / 14-05-1977
	Barkhan	12.0 / 01-05-2004	13.0 / 08-05-1981
Month	***Station***	***New record of heaviest rainfall in 24 hours***	***Old record of heaviest rainfall in 24 hours***
May	Jhelum	49.5 / 01-05-2004	48.5 / 31-05-1951

(v) Heat wave during March 2004

March 2004 heat wave over Pakistan, particularly over Sindh and Balochistan provinces, has broken many previous stations' records. Temperature analysis of 21 stations, based on real-time data, showed that monthly mean temperatures during March 2004 were 2–6°C above normal.



New Recorded Highest Maximum Temperatures		
Stations	***New Record***	***Old Record***
Jhelum	36.8 °C on 16	36.7 °C on 31/1971
Zhob	32.5 °C on 8	32.0 °C on 21/1974
Barkhan	33.2 °C on 16	33.1 °C on 29/1999
Kalat	29.0 °C on 8	26.7 °C on 22/1959
Panjgur	36.5 °C on 22	35.6 °C on 31/1942
Khuzdar	33.5 °C on 7	33.0 °C on 31/1984 & 3 days in 1999
Nawabshah	44.5 °C on 21	44.0 °C on 31/2002
Karachi	41.5 °C on 2 days	41.0 °C on 28/1998

SRI LANKA

Upper-air observations: Radiosonde observations at Colombo were conducted three times a week at 1200 UTC satisfactorily except during events of shortage or defective Radiosonde parts. The Government of India generously continued to supply Radiosonde transmitters, accessories and consumables for these observations.

Radar wind observations were done at 0600 UTC and 1200 UTC using 100g balloons and 350g balloons at Colombo throughout the year.

Pilot balloon observations were conducted as usual at Colombo at 0001 UTC and at 0600 UTC, and also at 1200 UTC when the radar system was defective. The pilot balloon observations at Hambantota, Puttalam and Trincomalee were continued at 0001, 0600 and 1200 UTC very good.
Cyclone detection radar (WSR74) at Trincomalee is not in good working order but requires refurbishing, probably at a very exorbitant price.

Meteorological satellites: HRPT receiver of NOAA imageries was defective at times and corrected, but at present working well.

SADIS WAFS data system has been working well but non-operational now; repairing is underway. Funds for up-gradation to second generation has been requested from the Government of Sri Lanka.

Ships and aircraft reports: Ship reports are not received as used to be, due to the communication shortcomings. Crew-members are apparently reluctant to pass on messages to the shore the old way, as latest INMARSAT capabilities are not present in Colombo.

AIREPs are transmitted to the WAFS centers, although the delivery to the Met office is not regular.

One Meteorological station in the South-east (Pottuvil - 43475) was completely washed away due to the Tsunami waves, and discussions are taking place, to house temporary equipment and continue observations.

Improvement of facilities

The British Government donated all the equipment for a media studio at the Department of Meteorology in November 2004; forecasters both from Maldives and Sri Lanka were also trained on making presentations by a British expert, under the same project.

Sites are selected and work progresses to re-locate two Synoptic observation stations Galle (43495) and Badulla (43479), due to increasing environmental changes and possible unrealistic values.

A committee has been set up with sub-committees, in September 2004, to handle different issues related, when a cyclone threat is imminent (Awareness, issuance of warnings, media handling etc are dealt with). This committee was in effect during two such periods.

Initial steps are taken to set-up a team of meteorologists and graduate trainees to promote seasonal forecasting in the Department.

Technical advancements

Spare parts for Radar upper-wind ground equipment WF33 were received from the Maldives Government in April 2004, under the WMO/VCP Project, costs involved totally born by the British Government.

Observing and telecommunications: The Internet is being used extensively in daily forecasting, especially during bad weather situations. Local Area Network is established in the Department in November 2004, but had to abandon temporarily due to a Virus problem; it is being attended now.

It is vital that the point-to- point link with Delhi be upgraded with TCP/IP as a bilateral issue with the IMD, as they are already assisting SLMD in this area.

THAILAND

Improvement of facilities

Three additional C-band radars were purchased by the Thai Meteorological Department (TMD). One of them is being set up together with a radar tower and related equipment at the Krabi Airport in Krabi Province. For the other two, they are assigned to replace the old ones in two provinces: Phuket and Rayong. Besides, an S-band radar in Klystron system was also put into position together with a set of satellite workstation in Khao Khiew District, Nakhon Nayok Province. Furthermore, a portable Doppler C-band weather radar was purchased for the Department's mission as well.

The speed of the TMD' Internet link has been upgraded from 256 Kbps to 2 Mbps since November 2003 in order that the needed information and services can be provided to the users with the higher efficiency.

A new Automatic Weather Observation System (AWOS) has been assembled at a meteorological station in Mae Hong Son Province whereas another device of this kind at the Hat Yai Airport was upgraded recently.

A new Wind Shear Alert System (WSAS) is being set up to replace an old one at the Southern Meteorological Center (West Coast).
A meteorological project has been being established at the second International Airport in Bangkok (the Suvarnabhumi Airport). This project is planned to comprise four main components: Main Meteorological Operation Office, Aeronautical Meteorological Station, Meteorological Field Station in Runway, and Meteorological Briefing Office.

Main Meteorological Operation Office is located on the 6th floor at the ATC Complex building. The staffs here are responsible to follow the weather conditions, issue the warning whenever necessary, and provide weather maps as well as documents concerning aeronautical meteorological information before distributing them to other internal units and organizations. The meteorological data will be recorded and stored here too.

Aeronautical Meteorological Station is fixed to be in the southeastern part of the airport. It will be the site where weather observation can be conducted on the regular basis as well as when severe weather takes place. The observation will be practiced by means of the Automatic Weather Observation System (AWOS) together with conventional meteorological instruments and the Doppler S-Band Weather Radar.

Meteorological Field Station in Runway is the area where automatic weather equipment and Low Level Wind Shear Alert System (LLWAS) will be installed.

Meteorological Briefing Office will be available on the 4th floor at the Passenger Terminal Complex the Main Terminal Building. It is designed to be the place where weather briefing activities will be held and flight documentation will be distributed to airline companies.

A radar tower had been constructed before a weather radar was installed at the Hat Yai International Airport in Hat Yai, Songkhla.

Technical advancement

The Fifth-Generation NCAR/Penn State Mesoscale Model or the MM5 software has been applied in both the medium-ranged and the long-ranged weather forecasting tasks of the TMD. Such model is run by the Linux cluster and can generate the weather forecast to cover the period of next 10 days.

A set of software had been developed to use for data management in METAR and TAFOR gathering task of the Bureau of Meteorology for Transportation of the TMD.

Three sets of software have been developed and used in the data base of the marine meteorological tasks of the TMD:

1. “MGDR” for accessing the wave height as well as other relevant data from the TOPEX Satellite;
2. “GTS_SHIP Translation” for conversing synoptic raw data observed from the sea surrounding Thailand (collected by the GTS_SHIP) into the literate form of the data; and
3. “Platform Program” for conversing synoptic raw data (obtained from the UNOCAL) into the literate form of the marine meteorological data.

Two computer programmes have been being on the test at the TMD in 2004 with the hope to be used as the tools to record the meteorological elements observed at the synoptic, the agrometeorological, and the hydrometeorological stations countrywide. Both programmes also contain a mode that allows them to automatically print the report in the weekly, 10 days, or the monthly interval. They are expected to save time in data recording, processing, and reporting procedure. Moreover, they are believed to help the Department to reduce the expenses for printing materials as well as distributing them to the users. They both are planned to be officially operated in 2005.

NWP Model has been run at the TMD with 3 models: Global Model (100 km resolution), Southeast Asia Model (48 km resolution), and Thailand Model (17 km resolution). All of them are used in the Department's operation (to supply the outputs to the weather forecasting procedure).

The communication systems at all regional meteorological centers have been changed from the IP system into the Virtual Public Network (VPN) with the speed of 256 Mb.

A marine meteorological research using soft computing technique was introduced at the TMD.

The data base of marine meteorology has been created in a certain format in which the users can pick any grids in their interests (with the grid system of 0.25 degree x 0.25 degree) to access the marine meteorological data in the chosen grids.

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 2 websites: www.tmd.go.th/~marine and www.marinemet.com.

Two websites (www.tmd.go.th/~marine and www.marinemet.com) have been provided to convey the knowledge about marine meteorology and ocean wave forecasts in both Thai and English to the users.

The Thai language version in the website: www.aeromet.tmd.go.th, provided by the Bureau of Meteorology for Transportation has made available. In addition, the weather prediction, satellite images as well as radar and any relevant data have been added in the website. The users can access all needed information from either personal computers at their offices or workstations provided at the Bureau of Meteorology for Transportation.

The Southern Meteorological Center (East Coast) has improved its website (www.songkhla-met.org) by adding the GIS in it and updating the data as well as information all the time.

APPENDIX VIII

HYDROLOGICAL ACTIVITIES OF MEMBERS

INDIA

Flood meteorological services

Flood prone areas of India issued about 1500 QPF (Quantitative Precipitation Forecast) during the flood season. These QPF have been issued for flood forecasting by FFD (Flood Forecasting Division) of Central Water Commission.

Rainfall monitoring

Real time monitoring of districtwise daily rainfall of the country is one of the important functions of IMD. A network comprising of about 2500 raingauge stations under the Districtwise Rainfall Monitoring (DRMS) to collect real time daily rainfall on real time basis.

Weekly districtwise, sub-divisionwise and statewise rainfall distribution summaries are prepared as a routine throughout the year by Rainfall Monitoring Units (RMU) of IMD. These reports are used for water management purposes. Maps showing weekly and cumulative rainfall give in 36 met. sub-divisions of India are prepared to present a pictorial distribution of rainfall over the country and these are distributed to various concerned ministries/departments.

Design storm studies

Design storm studies are being conducted by IMD to study rainfall magnitude and its time distribution for use as a main input for the design engineers in estimating flood for hydraulic structure, irrigation projects, dams etc. on various rivers. The probable maximum precipitation values are also evaluated for optimum utilization of water resources.

Storm analysis studies

Storm Analysis Unit of IMD provides design estimates of short duration rainfall in different sub-zones of the country for the purpose of construction of railways and road bridges, culverts, drainage etc. The hydromet studies for subzone – 2(c), Barak Basin is in progress.

The work for the preparation of All India Atlas of isopluvial maps of different return periods has been taken up. These maps can be used to derive 24-hour rainfall for specific return periods at any desired location throughout India. the isopluvial maps for the states of Kerala and Tamil Nadu have been prepared for 24-hr., 2-years, 5-years, 10-years, 50-years and 100-years, return period.

MYANMAR

Floods in Myanmar

The peculiar feature of 2004 floods is the occurrences of serve flood twice along almost all Myanmar rivers. Along Ayeyarwady river, the observed peaks at Bhamo, Mandalay, Sagaing, Nyaung U And Magway were noted as the highest ever recorded and peaks occurred at Myitkyina, Katha, Minbu, Pyay and Henzada were recorded as second highest since 1965. DMH had issued (6) sharp-rise warnings, (49) flood warnings and (28) flood bulletins during the year 2004.

Water quality management

In order to identify the water quality situation of Myanmar rivers, water quality tests have been done at 19 sites along Chindwin, Ayeyarwady, Thanlwin, Sittaung,Bago,Bilin, Dokehtawady,Nanpon and Thaungyin rivers in 2004 during wet season (May and July). Apart from these,earliest rainfall for the month throughout the year were collected from (8) cities of different states and divisions and carried out pH measurement to analyse acid deposition.

Discharge measurement

In order to provide runoff data discharge measurement are carried out at Magway (Ayeyarwady), Pyay (Ayeyarwady) Thabeikkyin (Ayeyarwady), Shwesayan (Dokethawady) and Tazone- Homalin (Chindwin) since the year 2003 upto 2004.

Hydrologic Annual

Hydrological data of full time stations are published annually as Hydrologic Annual Volume I and II since 1956 up to this year, except an 11 years gap between 1976 and 1986. During 2004, the Hydrologic Annual for the year 2003 was issued.

Installation of tide gauge

In March 2004, National Institute of Ocean Technology (NIOT) of India had established acoustic tide gauge at Yangon and Pathein according to the International Corporation Programme of the India Government. In October 2004, DMH has designated danger level of Pathein and installed one staff gauge at Pathein (Nga Won river). By application of the observed continuous data of tide gauge, it is hopeful to issue accurate and timely forecast for Pathein in flood times.

OMAN

One of the roles of the Ministry of Water Resources (MWR) is to act as the flood information authority of Oman. As well as collecting storm and flood data in its nation wide hydrological network, it provides a service of information on historic storms and floods, flood risk maps, flood frequencies, design storm rainfall intensities and frequencies, design floods and drainage rates. It is also involved in tidal flooding aspects.

These services are used by various Ministries and the public in the course of planning any housing infrastructure and other developments that may involve wadis in any way, either as wadi crossings, or any structures within wadis or flood plains. They are also used for general drainage design.

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:-

1. 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.

2. 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 then 100,000 cusecs at Tarbela and 23,000 cusecs at Jassar respectively.

3. 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 performs collection, archival and analysis of hydrological data on island-wide basis.

Hydrological 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. These 17 river basins account for over 60% of the total basin area in the island. The hydrological data thus collected is made available for water resource planning and research work. In addition to the above, the division collects daily rainfall records from 33 rain gauges out of which 28 gauges are established, mostly in conjunction with stream gauging stations. It also maintains 10 evaporation pans to collect daily evaporation records.

The Hydrology division makes use of the daily weather reports in the Meteorology Department Web site, to monitor the prevailing weather condition.

Improvement of facilities

Under Water Resources Management Project Part–A (WRMPA), following improvements to River Gauging Stations and Offices were carried out:

1. Construction of camp at Bopagoda 95 % completed;
2. Construction of camp at Padiyatalawa completed;
3. Bopagoda, Thawalama, Moragaswewa, Ellagawa, Siyambalanduwa and Laggala - Pallegama cableways completed;
4. Pitabeddara cableway 80 % completed.

Technical advancements, flood forecasting and warning

The division also operates a flood warning system for Kelani river for the safety of city of Colombo, which continued to function well throughout the year. For this purpose several upstream river gauging and rainfall stations are connected to the Hydrology division through a UHF radio network. These stations provide real-time data enabling the division to operate the flood model and forecast the river level during a flood, to protect low lying areas. This warning system has been improved.

For hydrologic modeling and data processing, latest versions of the following computer application packages are used:

1. MIKE II hydraulic model
2. HEC HMS

3. HEC RAS
4. HEC DSSVue
5. MIKE BASIN

Development of flood warning systems for Kalu river is being studied.

Comprehensive flood loss prevention and management

As the tsunami generated seawater intrusion rose to miner flood level, effect propagated upstream of Kelani river. The Electricity Board was advised to continue operating the hydropower generator located in this proximity. This release of water to the river restricted the salt-water intrusion. Colombo water supply was safeguarded.

The areas affected by the tsunami were inspected. It was observed that sand bars in the tsunami-affected areas have been washed away by the wave action and sand was filled at river mouth interiors. Subsequently the sea action naturally restored the sand bars.

Areas where mangroves and sand bars are, beaches were much protective against extensive damages especially in Southern Sri Lanka and Hambantota areas.

THAILAND

Improvement of facilities

The second phase of the Telemetering System Project (which was firstly established by the TMD in late September 1999) was complete on 23 March 2004 when all 43 automatic rainfall/hydro-meteorological stations had been constructed in three main river basins in the Southern Region of Thailand. The 3rd phase has been carried out since 23 August 2004. Under this phase, another 53 automatic rainfall/hydro-meteorological stations must be constructed in five main river basins in the upper part of Thailand. It is expected to be complete by the end of September 2006.

In case of the Royal Irrigation Department (RID), its two telemetering projects, located in two provinces (Chumporn and Songkhla) in the Southern Region of Thailand, were completely established this year. The real-time in situ and remotely sensed data collection is conducted on the hourly basis. In these two projects, the “NAM-Model” has been employed to simulate the hydrological behavior in the upstream areas and create the inputs for the “MIKE 11” Model to proceed further in order to produce the channel routing which gives flood forecasting and warning.

Technical advancement

Since the telemetering systems had been installed in the two river basins in the Southern Region of Thailand, detailed data have been being collected by the RID until now. Hopefully, some fruitful results can be achieved in the future.

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.

Flood forecasting and warning

In the past few years, RID has installed many telemetering 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:

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.

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 LBGI/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 since last year. According to the plan, this system is to be ready for the operation in 2006. The collected data from it will be shared to the CIDA's Project as well.

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.

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 no severe storms over this area last year. Therefore, the accuracy of the system has not been examined by the presence of a big flood yet.

Flood forecasts in the Pasak River Basin

The telemetering system was completely assembled and has been implemented since 2001. In 2004, three rainfall periods cast their effects over the area during June 5 – July 10, July 24 - August 31, and August 31 - October 9. These events filled the Pasak Reservoir with the inflow volumes of 456, 646, and 744 million cubic meters, respectively. 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.

Comprehensive flood loss prevention and management

All of the telemetering systems have been operated with the aim to spare leading time in forecasting activities and allow enough time for the people in the flood prone areas to be warned and prepare themselves prior to the 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 IX

DISASTER PREVENTION AND PREPAREDNESS ACTIVITIES OF MEMBERS

INDIA

As a pre-cyclone measure 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 non-governmental organisations and explain the salient features and disastrous effect of the storm and precautions to be taken during the storm season. IMD conducts Annual Cyclone Review' meeting in the month of January /February. The tropical cyclone warnings are issued through satellite based CWDS to various state government agencies in local regional languages in a simple user-friendly form so that it is easily understood by common man. These warnings are also broadcast through AIR Doordharshan and telecast by private TV channel network in simple form so that the general public can easily understand the warnings. Before every cyclone season officers from IMD deliver talks in AIR and Doordharshan about the cyclone warnings and precautions to be taken by the people during the cyclone period. Every effort is made to augment the observational network better forecast techniques to minimize the loss to property and life.

India Meteorological Department issued timely and accurate tropical cyclone warnings and disseminates them to the public through mass media. 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. These warnings were greatly appreciated by the community.

MALDIVES

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

Due to late December 2004 devastating tsunami, His Excellency the President formed a high level committee to cope with the disaster and to carry out relief work. The DMM is also a member of this disaster management team.

It is strongly felt that apart from tropical cyclone warnings, tsunami early warning system also has to be installed in this region as well.

MYANMAR

Seismological Activities

Loss of Lives, property in Myanmar by Tsunami on 26 December 2004

Tsunami caused by earthquake at sea west of North Sumatra on 26 December 2004. On 26 December 2004, an earthquake with magnitude of 9.0 Richter Scale jolted at the bottom of the Sea about 155 miles southeast of Banda Aceh in North Sumatra. Tremors from the earthquake off Sumatra Island were felt in Myanmar at 7:30 am MST. The aftershocks and Tsunami were felt some regions along the coast of Myanmar. Tsunami arrived in Myanmar only the height of 3 to 7 feet.

According to the data collected, the death toll due to the earthquake were 61, while 42 were left injured, 601 homes damaged, and 2,592 persons homeless, with a total loss of property valued at about 1,585.56 millions kyats.

Activities of the Relief and Resettlement Department

Introduction

The Relief and Resettlement is responsible for welfare, assistance and rehousing of those who fall victim to such disasters as fires, flood, storm, earthquake and others common in the Union of Myanmar. When the State gets developed, there will be less losses due to natural disasters, and so will the loss and wastage in nation-building endeavours by taking early preventive measures.

Disaster that occur in Myanmar

In spite of Myanmar suffering natural disasters less seriously than neighbouring countries, the following may break out occasionally.

(a) Flood
(b) Storm
(c) Earthquake

The situation and causes of the disasters are as follows:

(a) **Flood:** The peak monsoon may cause floods in July and August as most parts of Myanmar enjoy rains. However, it usually returns to normal in a few days. As the State is giving priority to endeavours to prevent floods by constructing dams and reservoirs, it has now become a rare occurrence.

(b) **Storm:** Myanmar is sometimes hit by storm which originate in the Bay of Bengal. However, Myanmar does not face the danger of storms every year like her neighbouring countries. If any, the losses are not heavy Storms are frequent in Rakhine State and rare in Ayeyarwady Division, Mon State and Taninthari Division.

(c) **Earthquake:** Earthquake hardly strike in Myanmar, but mostly in hilly regions and border areas – sparsely populated regions.

Providing relief for disaster victims

Relief such as rice, clothes, blankets, kitchen utensils and building materials are made for victims. A total of K69.73 million was spent on it in 2004.

Storage of relief supplies

To help victims in case of disaster, relief supplies are stored at the central warehouse in Yangon in rediness for 10,000 households, and likewise, in 18 townships of other states and divisions relief supplies are kept ready for households ranging from 1,000 to 2,000. Also in store are generators, water-pumps, water tanks and tarpaulins. In a state of emergency, they can be distributed to victims for their immediate comfort.

Report on condition of disasters in Myanmar

In spite of a temperate climate, Myanmar suffers from natural disasters. In the year 2004, there happened 18 floods, 23 storm related occurrences and 12 others totalling 53 cases in Myanmar.

Preventive measures for natural disasters

The Relief and Resettlement Department has taken the preventive measure for the natural disasters as follows:

(a) At the central level of the subcommittee for prevention of natural disasters, relief and resettlement, the Deputy Minister for Social Welfare, Relief and Resettlement formed a 27-member team with heads from the Department of Defence Services Representatives as chairman and members including representatives from voluntary staff organizations. In line with the directives of the committee, committees at state / division / district / township levels also been founded.

(b) Courses on management for prevention of natural disasters are being conducted in states and divisions yearly in order to educate the public in how to make preparations before the disaster, escape during the disaster, and carry out rescue works after the disaster. Courses had been conducted for 40 times beginning from 1988 to 2004 and a total of 1718 trainees had attended them. Together with the Relief and Resettlement Department, the Fire Service Department, the Department of Meteorology and Hydrology, the Health Department, the Irrigation department, the Myanmar Police Force and the Myanmar Red Cross Society have joined in giving lectures.

International cooperation

Being a member nation of the United Nations Organization, Myanmar always took her active part in international natural disasters deduction activities which were lunched from 1990 to 2004. Moreover, under the leadership of United Nations Organization, Myanmar is still cooperating with other members nations in these ongoing activities. Myanmar, as also a member nation of the Association of South-East Asian Nations (ASEAN), is actively participating in carrying out the activities for natural disasters within regions.

In order to share the knowledge and experience of disasters, Myanmar is working together joining hands with international and regional organizations by sending delegates abroad to attend the world conference, regional seminars and workshops as well courses.

In case of catastrophe in Myanmar, assistance rendered of their own volition by the United Nations Representative Office of the United Nations Development Programme (UNDP) to Myanmar, embassies and other organizations, are accepted and they are sent to places where the disaster occurs and are handed round to victims. The Relief and Resettlement Department disburses cash and provisions to victims in accord with the instructions of the State.

Natural disasters are not only economically but also socially harmful. The loss of lives and properties of the people owing to them can be reduced by implementing the works to lessen the risk of them and to make advance preparations for them as a responsibility.

Requirements for courses

It will be more effective if worldwide experiences and classroom aids are used at the courses on natural disaster prevention management. Being the case, following classroom aids, references and video tapes are required.

(a) references on disasters
(b) video tapes on occurrences of disasters, managements and lectures
(c) charts and maps on lectures
(d) other necessary material for classroom use

In sending departmental staff and service personnel to international training centers to gain worldwide experience and techniques, it will be more appropriate if they have an opportunity to attend the courses and the seminars with the supply of expense assistance by training centers and organizations. The permission to send trainees to following centers can benefit the Relief and Resettlement Department.

(a) courses lectured by ADPC of Thailand
(b) courses lectured by NRCDP of Japan
(c) courses lectured by Integrated Security Systems Group (JSSG) of Israel
(d) courses lectured by JCDO of Singapore
(e) courses conducted by UN

OMAN

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.

SRI LANKA

The increasing trend of natural and man-made disasters is demanding combating strategy to counter measure ill effects to the economy and social aspects of the country. Therefore, the National Disaster Management Centre was established in 1996 under the purview of the Ministry of Social Welfare, fulfilling a long felt need of the country. The Mission is to protect human life, property and environment from natural disaster through awareness, prevention, preparedness, mitigation and coordination. The Centre has prepared a Disaster Counter Measures Act and National Disaster Management Plan for Sri Lanka in collaboration with International disaster related organizations.

DPP Activities

Disaster mitigation programmes

- Tube wells have been constructed to provide drinking water at the alternative lands given to the displaced people of 2003-May floods;
- Construction of model rain water tanks in the drought stricken areas under the drought mitigation program was undertaken as pilot projects in the Siyambalanduwa and Thanamalwila Divisional Secretariat Divisions in the South;
- Construction of rain water tanks model projects have been completed in the Wellawaya and Thanamalwila Divisions under the patronage of World Food Program food mitigation of drought impact.

Relief, rehabilitation and construction work

Relief measures, rehabilitation and construction work began immediately with much dedication and the victims of May 2003 floods and landslides were given alternative lands, developed infrastructure facilities and constructed houses. The Disaster Management Centre has coordinated relief work in respect of the 2004 drought.

Legislation and a National Plan on Disaster

Disaster Management Counter Measures Bill has been submitted to Parliament. Five District Preparedness Plans have been prepared and submitted to the Hon. Prime Minister in respect of the five districts severely affected by 2003 floods.

Data-bank for collection of information on disasters

Disaster Management -Information System (DMIS) is in the process of collecting information on disasters monthly since 2001 at Divisional Secretariat Division level and these information are being computerized.

Propaganda and Awareness Programmes on Disaster Management

International Day for Natural Disaster Reduction which fell on October 13th 2004 was commemorated at the BMICH. Island-wide Inter-School art and essay competitions were held earlier and presents were awarded to winners at this occasion.

International support for disaster management

Disaster mitigation plans have been prepared and submitted to the concerned authorities in respect of severely devastated 05 Divisional Secretariat Divisions selected one each from the 5 provinces affected by May 2003 Floods with the initiative of UNDP. UNDP has granted provisions for the reconstruction of 178 minor irrigation work in 10 Divisional Secretariat Divisions in the Matara District affected by May 2003 floods. Agreement was signed with SIDA to obtain financial assistance to the 109 million rupees in respect of housing and infrastructure facilities in the flood affected districts

Awareness and educational programmes

Three National Courses have been conducted for 20 Divisional Secretaries, 19 Assistant Divisional Secretaries and 27 Social service Officers since January 2004.

Two-day workshops for media personnel have been conducted on two occasions for which 79 participated.

Five Workshops were conducted with the participation and representation of officials from Departments, Boards and Corporations, Armed Forces, Foreign Agencies, Voluntary Organizations, Non-governmental Organizations and Community Leaders on "Lessons Learnt from Disasters" of Ratnapura, Kalutara, Galle, Matara and Hambantota. This was as an activity for co-ordination of disaster related public institutions, foreign agencies and non-governmental organizations. Views, observations and suggestions put forward by the participants were taken into account in formulating counter measure strategies.

Disaster statistics

The Government of Sri Lanka has spent nearly Rupees 2.7 Billion on disasters during the year 2004 and up to mid-February 2005, out of which Rupees 1.43 Billion has been spent on Tsunami related issues. Certain allocations were made for disasters occurred in 2003. Droughts claimed a big slice of about Rupees 751 Million, with floods in the country costing about 505 Million, at two extreme events.

THAILAND

DPP activities

The Department of Disaster Prevention and Mitigation (DDPM) has installed more simple rain gauges and hand-spin warning sirens in flood-prone villages all over the country. This has brought about the total of 3,000 pieces of necessary equipment for observing, notifying, forecasting, and warning about local flood conditions.

Temporary shelters for evacuees have been designed and manufactured by the technicians of the DDPM. Each of them approximately costed US$ 250 for the building materials and can accommodate four persons. Last fiscal year, the Department has mobilized the central fund to manufacture 21 temporary shelters and the private sector has funded for four more. It is expected that apart from the government budget, more funds from private sectors and NGO will be mobilized in this project as well.

The National Civil Defence Committee assigned the DDPM to set up “Flood Vigilance Clusters” to monitor potential floods in flood-prone areas throughout the country. According to their locations, the “Flood Vigilance Clusters” can be grouped into five areas namely:

- Lower Northern Region area;
- The Chao Phraya basin;
- Bangkok Metropolis and peripheral provinces area;
- Eastern Region area;
- Lower Central Region area.

The provinces under each area have to collaboratively prepare flood prevention action plan and implement the exercise or drilling accordingly.

Besides launching community-based disaster management to enhance the participation from the people in the community, the DDPM has also organized and trained the Civil Defence Volunteers to become the disaster tackling network. These Civil Defence Volunteers are community-based volunteers who will work closely with government officials in managing disasters. At present, there are 407,382 Civil Defence Volunteers throughout

the country and the Department has the plan to annually increase their number at the rate of 1% of total number of the country population.

Since the adoption of the community-based disaster management approach with the aims to generate the awareness, strengthen disaster preparedness, and enhance disaster prevention capacity of the community, the DDPM has launched the community-based training course in 51 communities countrywide. The findings achieved from having monitored and evaluated this programme revealed its success. Thus, the Department will continue launching this training course in order to cover more communities, particularly those located in vulnerable areas, in this fiscal year. Moreover, the workshops on Disaster Prevention and Mitigation Network at Village Level will be carried out to equip villagers with new disaster prevention and mitigation methodology and to enhance their efficiency in collaboration.

Since the DDPM launched its website: www.disaster.go.th for disseminating DPP information via Internet a couple of years ago, the number of its visitors has increased very rapidly. This website has been recognized as one of the best source of the official information dissemination service too.

Having introduced the Information and Communication Technology for disaster management since last year, the DDPM has succeeded in designing data-base structure of water-related disasters. For the time being, all relevant data, including those on flood-prone areas; repeated flooded areas; and flood potentiality of the said areas, have been compiled and analyzed. All data will be applied for disaster impact assessment and for the decision-makers to use both applied data and the results from such assessment as the tools in managing water-related disasters.

The Natural Disaster Warning Center has been established at the Southern Meteorological Center (East Coast) by the TMD's in the town of Songkhla District with the responsibility to distribute the warning for natural disasters in Songkhla Province and its vicinity.

The Southern Meteorological Center (East Coast) of the TMD and the Asian Disaster Preparedness Center had hosted the Public Disaster Preparedness and Mitigation Training Workshop in Hat Yai District twice.

To maintain effective working relationship and communications with the mass media, the DDPM has continuously disseminated disaster-related information for public notification. Enhancement of the level of awareness and preparedness of the people in the risk areas is another purpose of such practice as well.

Initiation of the orientation for the journalists has been put in practice so as to better their understanding and knowledge on disaster prevention and mitigation. Another aim of this activity is to establish the disaster prevention and mitigation network.

The DDPM has joined ADPC and UNESCAP as the judging committee in the ADPC-UNCESCAP Journalism Award. This award aims at building up partnerships and emphasizing the vital role of mass media in promoting the awareness of disaster management issues in the mainstream press.

Several computer-based and internet-based training had been conducted by the DDPM last fiscal year (2004). The participants of these course were from administrative level, computer technician and other related staffs. For this fiscal year, more internet-based and computer-based training are on the way, for examples, "GIS Application" training course, "Adoption of GIS System for Disaster Management" workshop etc.

Many other disaster management related training courses and workshops will be carried out such as, “Disaster Victim Relief Operation” Workshop, “Early Warning System and Emergency Management” training, “Telecommunication System and Emergency Management” training, etc.

The DDPM has sent their staffs to attend various international workshops and conferences. This provides our staffs’ good opportunities to exchange the experience and information and to enhance their capability and know-how.

Disaster statistics

Statistical data of disasters and damages in Thailand during 2000-2003

Year	Types of Disasters	Frequency	Affected Provinces	Damages		
				Injuries (Persons)	Fatality (persons)	Losses (Million Baht)
2000	Floods	12	62	-	120	10,032.94
	Storms	960	62	81	9	271.48
	Drought	-	59	-	-	641.71
	Earthquakes	-	-	-	-	-
	Fires	1,814	-	91	46	722.59
	Road Accidents	73,737	-	53,111	11,493	1,242.20
	Chemical Hazards	6	-	57	2	Na
2001	Floods	14	60	-	244	3,666.28
	Storms	1,061	-	-	6	501.01
	Droughts	-	51	-	-	71,962.97
	Earthquakes	4	-	-	-	-
	Fires	1,498	-	-	-	1,529.28
	Road Accidents	17,616	-	53,960	11,652	1,240.80
	Chemical Hazards	20	-	160	32	na
2002	Floods	-	72	-	216	13,385.31
	Storms	594	-	11	18	213.37
	Droughts	-	68	-	-	330.37
	Earthquakes	12	-	-	-	-
	Fires	1,135	-	150	24	805.81
	Road Accidents	88,390	-	62,054	13,398	1,560.50
	Chemical Hazards	24	-	-		40.50
2003	Floods	17	66	10	53	2,066.08
	Storms	3,213	76	434	74	457.43
	Droughts	-	63	-	-	174.33
	Earthquakes	1	-	-	-	-
	Fires	2,267	-	167	56	565.54
	Road Accidents	na	-	952,238	13,290	na
	Chemical Hazards	15	10	56	5	na

Note: 1 US. Dollar ≈ 40 Baht

Source: Civil Defence Secretariat, Royal Thai Police, Department of Pollution Control

APPENDIX X

TRAINING ACTIVITIES OF MEMBERS

BANGLADESH

Training During 2004

Participant	Training Tittle	Funding	Host Country	Duration
1	Workshop on satellite Data Utilization for water cyclone in Asia GPM Asian Workshop and IGOS International Workshop.	Japan Govt.	Japan	02 - 06 February/04
1	Application of Simulation Models for Assessment of Climate Change	APN Project	Pakistan	16 - 27 February/04
1	Training Course Weather Forecasting for operational Meteorologists.	WMO	Korea	05 - 30 April/04
1	2nd Regional Technical conference and International Conference on Tropical Cyclones and Storm Surge.	WMO	Brisbane Australia	01 - 09 July/04
2	4th Post Graduate course in Meteorology and Global Climate	India Govt.	India	01 August - 09 Month
1	CLIPS Training Workshop for Regional Association- II	WMO	Qutar, Doha	26 September- 07 October/04
1	Workshop MSN -VII and IWM-III	WMO	China	26 October to 6 November/04
1	Meeting of the CAgM Expert Team on Weather, Climate and Farmers.	WMO	Switzerland	15-18 November/04
1	GCOS Regional workshop for South and South west Asia	WMO	New Delhi	11-13 October/04
1	Meeting of the CAgM Expert Team on weather, Climate and Farmers.	WMO	Switzerland	15-18 November/04
1	Training Course on Aviation Meteorological Services	China Govt.	China	22-26 November/04
1	Ninth GAME International Science Panel meeting (GAME ISP) and the Sixth International study conference on GEMEX in Asia and GAME.	WMO	Japan	01-05 December/04
1	Second Regional Seminar on cost Recovery and administration in Regional Association-II (Asia) and 13th Session of Regional Association-II (Asia).	WMO	China	04-08 December/04

Training Programmes Conducted by BMD'2004

01. Inspector's Course, Batch No. 07/2004.
Duration : 10-04-2004 to 03-06-2004 (2 months)

02. Class- II forecaster's Refresher Course, Batch No. 02/2004.
Duration : 01-06-04 to 30-11-04 (Six months)

03. Class- II forecaster's Course, Batch No. 10/2004 - 2005.
Duration : 16-04-04 to 15-04-05 (one year)

04. Package Course on Meteorology, Batch No. 02/2004 (Bangladesh- Navy).
Duration : 21-08-04 to 26-08-04 (one week)

05. Industrial Training Course on Meteorology, Meteorological Instruments, Electronics and Communication Systems.
(Students of level-4, Term-1, Department-Electrical and Electronic Engineering, BUET.
Duration : 02-10-04 to 21-10-04.

06. Industrial Attachment course on Meteorology, Meteorological Instruments, Electronics and Communication Systems.
(Students of B.Sc. in Electronics and Communication Engineering Discipline, Khulna University).
Duration : 15-06-04 to 28-06-04.

07. Short Class-III Assistant course, Batch No. 01/2005 to

08. Industrial Attachment Course (Different trades) Mirpur Technical Training Centre.
Duration : 24-03-04 to 18-05-04.

09. Industrial Attachment Course (Different trades)
Duration : 28-03-04 to 22-05-04.

10. Industrial Attachment Course (Different trades) Mirpur Technical Training Centre.
Duration : 28-03-04 to 22-05-04.

11. Industrial Attachment Course (Different trades) Bangladesh German Technical Centre. Duration : 05-12-04 to 29-01-05.

12. Two month's training of the Forecasters in Storm Surge model (Dubey Model)
Duration : January- February 2005.

INDIA

India has been providing training facilities at its RMTC to foreign candidates under various programmes including VCP of WMO.

On the Job Training schedule in Doppler Weather Radar to be conducted at DWR Chennai is as follows:

Year Proposed duration of Training/Date of commencement

2005 Two weeks(2 Monday of September 2005)
2006 Two weeks(2 Monday of September 2006)
2007 Two weeks(2 Monday of September 2007)

Training requirements are considered/processed after receipt of formal request from WMO, concerned Country/ Department. India has been providing training facilities at its RMTC to foreign candidates from ESCAP Panel members under VCP/ITEC, Bilateral Cooperation,WMO Fellowship etc.

Two IMD officers have undergone training in S-Band Doppler Weather Radar System at the premises of M/S Gematronik, Neuss, Germany for 8 weeks during February to April 2004.

Shri M.C. Rastogi, Director attended WMO/ RAII/ RAV Training Seminar on Table Driven Code Forms in Kaula Lumpur, Malaysia from 28 June to 2 July 2004.

Dr. A.K. Shukla, Director attended Study visit and discussion in the areas of Seismology and Earthquake Engineering as part of Indian delegation to Beijing, China from 26 to 30 July 2004.

Shri V.K. Rajeev, Meteorologist Grade-I, M.O. Mumbai and Ms.S. Stella, Meteorologist Grade-II, M.O. Chennai attended the Training Workshop on ISCS and SADIS Workstation Operation and Display of WAFS products using GRIB and BUFR Code Forms held in Bangkok, Thailand from 24 to 27 January 2005.

MALDIVES

The Department of Meteorology has participated in some training events abroad with the support of WMO, IMD, CMA, UK Met. Office and the Panel.

For 2005/ 2006, the Department of Meteorology urgently needs to train staff in the field of oceanography /marine, aviation and synoptic meteorology. Training of technicians and or computer personnel are also highly important for a smooth functioning of our National Met. Service.

Subject	**Level**	**Desired Venue**	**Number of Trainees**
Marine Meteorology	Deg	Singapore/ Malaysia	3
Geology B.Sc.	Deg	India / UK /Australia	1
Synoptic and Aeronautical Forecasting	Cert	India / China	4
Meteorology Class III	Cert	India / China	3
Information technology/ Networking	Cert	Singapore/ Malaysia	3
Climate Data Application & Maintenance	Cert	Malaysia/ Hong Kong	3
Equipment / instrument Maintenance	Cert	India/ China/ Egypt	2

Therefore, we call upon WMO and Panel members for their cooperation and considerations.

Storm surge model training

Mr. Ahmed Rasheed, the Assistant Meteorological Forecaster of the Department of Meteorology, Maldives has attended the 2 week training course on Ocean State Forecasting Model (WAM) held at the Indian Institute of Technology, Kharagpur, India during October 2004. The Department is grateful to the Panel, India and Professor S.K Dube for their contribution to this important event. DMM wish to get similar opportunities in the future as well.

MYANMAR

The Department of Meteorology and Hydrology has attended to the meetings and training courses shown in Tables (1) and (2).

Table 1: WMO and related meeting attended

1.(a) (b) (c)	The Workshop on the Satellite Data Utilization for water cycle in Asia The GPM (Global Precipitation Monitoring) Asia Workshop Integrated Glocal Observation Strategy (IGOS), Japan	Dr. San Hla Thaw (Director General)	From 2-2-2004 to 6.2.2004
2.	Regional Training Workshop on the ASEAN Compendium of Climate Statistics, Malaysia	Daw Khin Cho Cho Shein (Assistance Director) Daw May Khin Chaw (Staff Officer)	From 26-2-2004 to 28-2-2004
3.	RAII/V Training Seminar on Table Driven Code forms, Malaysia	U Chit Kyaw (Staff Officer)	From 26-6-2004 to 2-7-2004
4.	Myanmar Delegation to Yunnan Earthquake Administration (YEA) to study Seismological Stations in Yunnan Province, China	U Thein Tun (Director)	From 3-6-2004 to 13-6-2004
5.	Advanced Program on Meteorological Technology and Policy, Korea	U Tun Lwin (Deputy Director General)	From 12-9-2004 to 18-9-2004
6.	Remote Sensing and GIS Based Training for a mini-Project, Thailand	U Tin Aung (3) (Assistance Director)	From 12-7-2004 to 13-8-2004
7.	Regional Training Workshop on Soil Erosion Information System, China	U Zin Aung U Than Myint (Staff Officers)	From 6-7-2004 to 16-7-2004
8.	Regional Workshop on Climate and Media Building Partnerships, Thailand	Daw Yi Ye Nyein (Assistance Director)	From 26-9-2004 to 27-9-2004
9.	Invitation for the fifth Senior Technical Managers' Meeting, Japan	U Tin Ngwe (Deputy Director)	From 28-9-2004 to 30-9-2004

10.	The 26th ASCMG (ASEAN Sub-committee on Meteorology & Geophysics, Thailand	U Khin Than (Director)	From 22-9-2004 to 23-9-2004
11.	Twenty second Session of the Intergovernmental Panel on Climate Change, India	U Htay Oo Kyi (Assistance Director)	From 9-11-2004 to 11-11-2004
12.	The Ninth GAME International Science Panel Meeting and the Sixth International Study Conference on GEWEX in Asia and GAME, Japan	U Aung Kyi (Assistance Director)	From 1-12-2004 to 5-12-2004
13.	Second Regional Seminar on Cost Recovery and Administration RA II, China	Dr. San Hla Thaw (Director General)	From 4-12-2004 to 15-12-2004
14.	International Conference; Advances in Integrated Mekong River Management, Lao PDR	U Thein Tun (Director)	From 25-10-2004 to 27-10-2004
15.	The 4th Session of the Scientific Advisory Committee and the 6th Session of the Intergovernmental Meeting on the Acid Deposition Monitoring Network in East Asia (EANET), Cambodia	Daw Hrin Neithian (Assistance Director)	From 3-11-2004 to 8-11-2004

Table 2: WMO and related training attended

1.	Training Course on Application of Remote Sensing and Geographic Information System Technologies for Integrated Water and Land Resources, Indonesia	Daw Kyu Kyu Sein (Senior Observer)	From 14-7-2004 to 11-9-2004
2.	M.Sc. Meteorology, Philippines	U Sein Maw Oo (Staff Offier)	From 3-11-2004
3.	Training Course on Aviation Meteorological Services, China	U Tint Wai (Staff Officer)	From 22-11-2004 to 26-11-2004
4.	GIS and Remote Sensing Disaster Risk Assessment, Thailand	U Sein Lin (Staff Officer)	From 13-9-2004 to 24-9-2004

The Department of Meteorology and Hydrology needs to send the candidates abroad for long-term and short-term fellowships on various specialized fields to fulfill the requirements of our service. The needs are shown in Table (3).

Table 3: Training and workshop requirement during the next 5 years

Sr. No.	Fields of specialization	No. of

		candidates
1	**Long-term fellowships leading to M. Sc./Ph.D.** (Meteorology/ Hydrology)	2
2	**Short-term courses and workshops**	
	(a) Weather forecasting	2
	(b) Tropical storm forecasting	5
	(c) Storm surge prediction	5
	(d) Extreme weather events prediction	6
	(e) Limited area numerical modeling	2
	(f) Long/Medium – range weather forecasting	2
	(g) Aviation meteorology	5
	(h) Satellite meteorology	3
	(i) Radar meteorology	3
	(j) Remote sensing and GIS	5
	(k) Flood forecasting	6
	(l) Flood risk mapping	5
	(m) Water resources management	5
	(n) Water quality monitoring	6
	(0) Maintenance of non-conventional meteorological instrument	3
	(p) Maintenance of conventional meteorological instrument	2
	(q) Estimation of loss and damage due to disasters	4

OMAN

Workshops, Seminars and Training Courses attended by the Met personnel during the year 2004 were as follows:

Workshop/Seminar/Training Course	**Country**	**No. of Persons**
Ph.D. in NWP	UK	1
NWP Training for Scientists and Programmers	Germany	1
Satellite Meteorology	China	3
Seasonal Forecast	China	2
Storm Surge/ Wave Modeling	India	1
EUMETSAT Satellite Applications	Oman	6
NWP Seminar	Brazil	2
Climate change Monitoring and indexes	Turkey	1
Data Base	Lebanon	1
CLIPS	Qatar	1
WMO Class III and II	Qatar	2
Master in Computer programming (NWP)	Oman	1
Computer (Net Work)	UAE	1
Cloud Seeding Experiment Project	UAE	1
Cloud Seeding	South Africa	1
Fundamental Meteorological Courses for three government Agencies	Oman	24
Tropical Cyclones and Local Storms	Australia	2
Aviation Meteorology	UK	1

PAKISTAN

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.

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.

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.

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 six meteorologists and one technical officer from the Department of Meteorology attended conferences/seminars/workshops/trainings sponsored by the WMO. They are:

1. Training Seminar on Table Driven Code Forms, Kuala Lampur, Malaysia (28th June to 02nd July)
2. Second Regional Technical Conference and International Conference on Storms, Brisbane, Australia (1st July to 9th July 2004) – two nos.
3. Training Workshop on Climate Information and Prediction Services, Doha, Qatar (26th Sept to 07th Oct 2004)
4. M.Sc Training Programme in Meteorology, University of the Philippines, Philippines (27th Oct 2004 to 15th May 2006)
5. Intermediate Training Course in General Meteorology, Pune, India (8th November 2004 to 7th March 2005)
6. Second Regional Seminar on Cost Recovery, Hong Kong, China (4th to 6th December 2004)

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.

We especially thank 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

Local Training

Since 1 October 2003 till 30 September 2004, the TMD has provided training courses to its staffs on the regularly 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 courses had been available are show in the table below:

The list of the local training course provided by the TMD for its staffs:

No.	Course Title	Duration	No. of Participants
1	Workshop on Aeronautical Meteorology	24-28 Nov. 2003	30
2	Workshop on MM5	15-19, 22-26 Dec. 2003	30
3	Workshop on Meteorological Strategy in ICT Age.	7 Jan. 2004	296
4	English for Communication	10 Feb.-23 Mar. 2004	20
5	Workshop on Meteorological Services in New Millennium	11 Mar. 2004	71
6	Webpage Design	7-11, 14-18 Jun. 2004	60
7	Meteorological Database Construction	20-24 Sep. 2004	29

Besides, the Southern Meteorological Center (East Coast) had provided temporary exhibitions, training courses, and special lecture sessions to deliver correct meteorological knowledge to the public members, students, and the staffs of other related organizations.

Overseas training

During 1 Oct 2003 – 30 September 2004, the staffs of the TMD had joined oversea training as shown in the table below:

The oversea training courses which the staffs of the TMD had joined:

No.	Course Title (s)	Duration	Country	No. of participant(s)
1	EANET Training on Acid Deposition Monitoring	6 – 13 Oct 2003	Japan	1
2	The 2nd Training Course on Space Technology and Remote Sensing Applications of AP-MCSTA	18 Oct – 16 Nov 2003	China	1
3	Training Workshop on Climate System Monitoring, Diagnosis and Prediction in the Asia-Pacific Region	25 – 28 Nov 2003	Japan	1
4	RA V/RAII Regional Training Seminar on Data Processing and Forecasting System and Improvement of Public Weather Services (PWS)	8 – 19 Dec 2003	Brunei Darussalam	1
5	International Training Seminar on Typhoon Monitoring and Forecasting in the Western North Pacific	12 – 27 Feb 2004	Japan	1

No.	Course Title (s)	Duration	Country	No. of participant(s)
6	Regional Training Workshop on the ASEAN Compendium of Climate Statistics	26 – 28 Feb 2004	Malaysia	2
7	Training Course on Provision of Weather Services via Internet	8 – 12 Mar 2004	Hong Kong, China	1
8	RA II/V Training Seminar on Table Driven Code Forms	28 Jun – 2 Jul 2004	Malaysia	1
9	Training Class for GSN/IRIS Station Operators	13 – 17 Sep 2004	U.S.A.	1

Hydrology

The training in flood risk map is carried out by the RID. But, none of the results have yet been produced this year since it takes time to collect data and analyze. However, some of the outcome is expected in the future. At present, training programmes are set only for the concerned local staffs of the RID and will be provided to the others in the future.

DPP

Several computer-based and internet-based training had been conducted by the DDPM last fiscal year (2004). The participants of these courses were from the administrative level, the computer technicians, and other related staffs. For this fiscal year, more internet-based and computer-based training are on the way, for example, “GIS Application” training course, “Adoption of GIS System for Disaster Management” workshop, etc.

Many other disaster management related training courses and workshops will be carried out such as, “Disaster Victim Relief Operation” workshop, “Early Warning System and Emergency Management” training, and “Telecommunication System and Emergency Management” training, etc.

The DPPM has sent its staffs to attend various international workshops and conferences. This provides its staffs’ good opportunities to exchange the experience and information and to enhance their capability and know-how.

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APPENDIX XI

RESEARCH ACTIVITIES OF MEMBERS

BANGLADESH

There exists a small scale research cell in the BMD, where Met. scientists of the Department find time to devote themselves in research work on various Meteorological aspects borne out of their experience. They carry on these work outside their normal official duties. the have already completed some of these research works which have been published in the national and regional scientific journals.

The SAARC " young scientists Award" 1987, 1995 and 1996 in Meteorology were won by two Meteorologist in BMD.

SMRC is a Meteorological Research centre which was established by SAARC. This centre is to carry out on research works on various meteorological aspect within south Asian countries.

INDIA

Research on topics related to Tropical Cyclone is being taken by different offices/officers as a routine

A proposal for generation of Electronic version of Cyclone has been taken up. The following features could be included to the Electronic version in addition to the features avai1able in the existing Atlas.

- User friendly menu driven features;
- Easy and ready display of tracks;
- Provision of any number *of* choices in the display or tracks;
- Provision for viewing, saving and retrieving;
- Generating any type *of storm* statistics; and
- Comparison of storm tracks with different years and periods for any given month/season.

The following projects have been completed:

i) A comprehensive data base of statistics of Depressions, Cyclonic storms and Severe Cyclonic storms over North Indian Ocean alongwith the program to retrieve relevant cyclone information has been developed. Any statistics on cyclones and depression for Indian seas can be readily generated in respect of formation (basins and Lat/Long squares), dissipation (basins and (Lat/Long squares), coastal crossing, life of each system. for any given period (years and months);

ii) A case study of May 2004 cyclonic storm in North Indian Ocean;

iii) Weakening of cyclonic storms over the seas due to shearing;

iv) Decadal trends in the frequency of cyclonic disturbances over Indian seas.

3. The following projects have already been taken up and are progressing:

i) Probable causes of intensification and weakening of cyclonic storms emerging from NW Pacific lo North Indian Ocean;

ii) A study on northward transportation of energy and momentum flux over Indian land mass and North Indian Ocean in northward and westward moving storms;

iii) Estimation of Cyclone Risk Index based on Met. Parameters and the Socio Economic conditions in different coastal belt;

iv) Directional variability of rainfall distribution in a Cyclonic storm;

v) A study on relation between structure of cyclonic systems and their rainfall contribution has been initiated.

The following research papers were published in Mausam during 2004:

i) "Climatology of cyclonic disturbances over Lakshadweep" by Shri S.Natrajan, Director, B. Ramakrishanan, AM-I, Smt. Santosh Arora and Smt. P.A. Subadra, AM-II.

ii) "Satellite analysis of tropical cyclones using NOAA-16 AMSU measurements over Indian Region" by Singh. D, Bhatia R.C. & Srivastava S.K.

iii) "Comments on periodicities in the frequency of Indian Monsoonal Cyclonic disturbances and storms "by Kumar J.R.

iv) "Tropical cyclones-statistical perspectives" by Chaudhiri S, Chattopadhynhay S.

v) " Identification of coasts vulnerable for Severe Tropical cyclones -statistical elucidation" by Chaudhiri S, Chattapadhayay S.

vi) "Cyclones and Depressions over North Indian Ocean during 2003.

A research paper on 'Role of Cyclonic systems in excess and deficit monsoon years in India' by *S/Shri* S.Sridharan and A. Muthuchami has hcen accepted for publication in MAUSAM.

A paper "Relation between Size of the storm and eye' by Shri A.Muthuchami was published in the proceeding of the Seminar on 'Prediction of Meteorological events a mathematical approach' held at Birla Institute of Technology, Ranchi.

Published scientific reports on “Storm Surge Height in Orissa Super Cyclone” and “Orissa Super Cyclone – A Review” by S.R.Kalsi.

“A review of different storm surge models and estimated storm surge height in respect of Orissa Super Cyclonic Storm of 29 October 1999” by S.R.Kalsi, N.Jayanthi and S.K.Roy Bhowmik – Published as Meteorological Monograph No 1/2004, January 2004.

A research work on “Relation between size of the storm and eye” published in the proceeding of Seminar.

A paper entitled “Climatology of cyclone disturbance over Lakshadweep” has been completed.

A paper entitled “Indian monsoon activity and the contrasting EL-Niño events” was presented in International symposium on Natural hazards INTROMET) held at Hyderabad during 24-27 February, 2004.

Two days conference on "Natural Disaster Institutional building for mitigating the impact on vulnerable section" was held during 25th to 26th March, 2004 at Chandigarh.

Paper entitled "Behaviour of recurring cyclone storm in Arabia Sea as a response to atmospheric interactions" by Dr. (Mrs.) B. Shyamala, Sudevan, S. Shinde G.M., Burte, M.D., published in Mausam 2001, 52,3, 469-478.

PAKISTAN

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.

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.

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

Meteorology

The research program titled Assessment of Impact and Adaptation of Climate Change in Tea and Coconut sectors in Sri Lanka funded by GEF continued successfully throughout 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.

DPP

Action has been taken to collect and computerize information on disasters that occurred at least during the past 30 years with the full patronage of UNDP under Disinventor Programme.

THAILAND

Meteorology

The topics of the researches had been conducted by the staffs of the Thai Meteorological Department can be listed as below:

- Jet Streams and Jets
- The Basic Analysis and Interpretation of Radar Image from Doppler Radar
- The Satellite Image Analysis by ENVI Program
- Correlation between Tropical Storms in the South China Sea and Wind Speed in the Gulf of Thailand
- Assessment of Radiation for Potential Evapotranspiration
- Track of Tropical Storms move across the Southern Thailand
- Factor of High Waves behind Samui Island
- Prediction of Rainfalls by Relative Vorticity
- The Comparison of Studying and Analysis Result for Forecasting the Dense Fog
- The Comparison of Studying and Analysis Result for Forecasting the Thunderstorm
- Study of Location of Peak Rainfall Intensity in Bangkok
- Education Relation of Cold Air Penetrate with Thunderstorms at Donmuang Airport
- Occasions of Poor Visibility at Donmuang Airport

- Influence of Southwest Monsoon on Rain Developed Over the Upper Part of Thailand
- Minimum Temperature Forecasting in the Northern Part of Thailand
- A Statistical Analysis on the Occurrence of Fog at Donmuang Airport
- Verification of Route Forecasts
- Intensity of Drought in Thailand
- The Variations of Rainfall and Temperature over Thailand
- The Analysis of the Parameters Causing Hailstones over Northern and Central Thailand during 11 to 14 January 2002

Additionally, a research concerning an ocean wave model has been being conducted with the aim to use it for both statistical and numerical ocean wave forecasts.

Hydrology

The topics of the researches had been conducted by the staffs of the Thai Meteorological Department can be listed as below:

- Statistics Analysis Flood Magnitude in Yom River Basin
- Study of Rainfall Intensity-Duration-Frequency Relationship for Hydrometeorological Station

In addition, a research is being run in the Pasak river basin by the RID. Instead of using “MIKE 11” as main engine, the unit hydrograph is employed. The results are impressive, but time is still needed to verify this methodology. More information will be provided in the future.

DPP

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

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APPENDIX XII

STATEMENT OF TSU ACCOUNTS

1.	Balance after 31st Session	Pak. Rs. 30,070.00
2.	Receipts during the inter-sessional period (US$ 8,000)	Pak. Rs. 451,840.00
	Non-disbursement of running cost of TSU website claimed in the statement of TSU accounts for the Year 2003	Pak. Rs. 10,000.00
	Total	**Pak. Rs. 491,910.00**

EXPENDITURE

1. (a)	Re-hosting and running cost of TSU website for one year	Pak. Rs. 17,470.00
(b)	Honorarium to TSU-Meteorologist	Pak. Rs. 51,000.00
2. (a)	Expenses incurred on the printing of 20th and 21st Issue of the Panel News	Pak. Rs. 49,500.00
(b)	Honorarium to technical staff	Pak. Rs. 10,000.00
3. (a)	Purchase of stationery for TSU use	Pak. Rs. 5,500.00
(b)	Expenditure on postage etc.	Pak. Rs. 6,400.00
	Total	**Pak. Rs. 139,870.00**
	Balance in hand	**Pak. Rs. 352,040.00**

APPENDIX XIII

INTERIM STATEMENT OF ACCOUNT OF THE PANEL'S TRUST FUND

(hard copy only)

APPENDIX XIV

PROGRAMME OF TECHNICAL CONFERENCE ON:

"WATER RELATED DISASTERS WITH SPECIAL REFERENCE TO STORM SURGES AND TSUNAMIS AND THEIR EARLY WARNING SYSTEMS"

Title of Presentation	Name
Early Warning System for Oceanographic Disasters in Indian Ocean (Tsunami and Storm Surge) – The Indian Initiative	Dr. Harsh K. Gupta, Secretary, DOD, Govt of India
Tsunamis effect on Aviation	Mr. Dimitar H. Ivanov, ICAO
Integrated Tsunami Early Warning System	Dr. Avinash Tyagi, WMO
Tsunami & Cyclone Storm Surge Warning and Contingency planning	Dr. Karsten Havnö, DHI
The impacts of "RANAMIM" – Typhoon in Southeast China	Dr. Xiaodong Ye, China
Case Study of a low pressure area affecting Oman	Mr. BADAR AL-RUMHI, OMAN
Track and Intensity Prediction of Tropical Cyclones by Numerical Models	Dr. H.R. Hatwar, IMD
Storm Surge Prediction in IMD	Dr. S.K. Roy Bhowmik
Recent Experiences of Assessment of Socio-economic Impacts of Disasters in Asia	Mr. Le Huu Ti, ESCAP
Tsunamis – Relief & Rehabilitation – Initiatives by NDM, MHA	MHA, India
Some Observations on Early Warning Systems for Tropical Cyclones in India	S.R. Kalsi, IMD
Earthquake Monitoring in IMD and some Observation on Sumatra Earthquake of 26th December 2004	Dr. A.K. Shukla, Director, IMD
The International Early Warning Programme	ISDR presented by Ms E. Tsunozaki, ADRC
Promoting Disaster Reduction through multi-national Cooperation in Asia	Ms. Etsuko Tsunozaki, ADRC
Some aspects of the Monsoon depression – a case study of depression September 2004	Md. Akram Hossain, Bangladesh