



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



WMO/ESCAP PANEL ON TROPICAL CYCLONES

THIRTY-NINTH SESSION

Nay Pyi Taw, Myanmar

(5 - 9 March 2012)

FINAL REPORT

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION

The thirty-ninth session of the WMO/ESCAP Panel on Tropical Cyclones hosted by Myanmar was held in Nay Pyi Taw, Myanmar from 5 to 9 March 2012. The session was attended by 44 participants from the eight Members of the Panel on Tropical Cyclones (PTC), namely, Bangladesh, India, Maldives, Myanmar, Oman, Pakistan, Sri Lanka and Thailand. It was also attended by observers from China, Indian Institute of Technology (IIT) Delhi, United Nations Educational Scientific and Cultural Organization (UNESCO)/Intergovernmental Oceanographic Commission (IOC), United Nations Development Programme (UNDP), International Civil Aviation Organization (ICAO), International Centre for Water-related Hazard Risk Management (ICHARM), Regional Integrated Multi-hazard Early Warning System (RIMES) and representatives from World Meteorological Organization (WMO), Economic and Social Commission for the Asia and the Pacific (ESCAP) and PTC Secretariat. The list of the participants as well as the capacities in which they attended is given in **Appendix I**.

1.1 Opening of the session

1.1.1 After the Technical Conference held in the morning, the opening ceremony of the thirty-ninth session was commenced at 1:00 p.m. on Monday, 5 March 2012 at Zabu Thiri Hotel in Nay Pyi Taw. Representing the Government of Myanmar, H.E U Nyan Htun Aung, Minister for Transport and H.E U Win Htun, Minister for Environmental Conservation and Forestry attended the opening ceremony.

1.1.2 On behalf of the Government of Myanmar, the Union Minister for Transport, H.E U Nyan Htun Aung extended his warmest welcome to all the delegations and participants. He said that he has a great pleasure and honour for having the opportunity of extending the welcome address at this auspicious occasion of the opening ceremony of the 39th Session of the WMO/ESCAP Panel on Tropical Cyclone organized by the Panel and the Department of Meteorology and Hydrology (DMH) in Nay Pyi Taw, the new capital of Myanmar. He thanked the Panel for giving the opportunity to host this meeting and providing the necessary guidance for the success of this Panel. He reviewed the history and main objectives of Panel on Tropical Cyclones and highlighted the natural disasters during 2011 not only those of regional scales but also to local events. He also pointed out technical and scientific supports on the basis of area-wise research activities are essential for effective planning and implementation of hazard mitigation scheme. He also mentioned that how the Panel benefits from further improvement of forecasting as well as risk management of tropical cyclone related disasters. Finally, he urged the Member countries to cooperate with each other in precautions and notifications about natural disasters on international strategy for natural disaster reduction.

1.1.3 Dr Qamar-uz-Zaman Chaudhry, Secretary of PTC and Vice president of WMO/RA-II (Asia) welcomed and extended his warmest greetings to the participants of thirty-ninth session of PTC. He also offered his sincere thanks to the Government of Myanmar for hosting this 39th Session of PTC and wished all the distinguished delegates a pleasant stay in Nay Pyi Taw, Myanmar. He stated that owing to the complex geomorphologic features and climatic conditions, the PTC region is prone to several types of natural disasters which range from earthquakes and tsunamis to droughts, floods and tropical cyclones. The impact of these natural disasters is also more pronounced in this region due to the socioeconomic conditions and limited resources. Though the average frequency of tropical cyclones over the Bay of Bengal and the Arabian Sea is just around 6 % of the total global average, the impact of these disasters is relatively very high in the region. The meteorological community of PTC region is fully aware of the challenges offered by the tropical cyclones and the PTC Members through their individual and collaborative efforts under agreed programmes of action of PTC

have done commendable job in improving their respective tropical cyclones forecasting services and in minimizing the loss of life and property from adverse impact of tropical cyclones. However, there is much more to be done through joint collaborative efforts in order to continue improving early warning systems and services. He further said that the present session of PTC is the first time in Myanmar after the cyclone NARGIS that struck the country in May, 2008 and caused severe loss of life and damage to the property and infrastructure making it one of the deadliest cyclones on record in the recent history. During this session, the representatives of PTC Member countries would have the opportunity to learn how Myanmar had restored its hydrometeorological network, enhanced its early warning system capacities and technical capabilities with regards to tropical cyclones forecasting and had rebuilt its infrastructure with its own resources and with assistance by the international community including WMO, ESCAP and PTC. Further, in wake of the extreme hydrometeorological events and floods of 2010 and 2011 in the PTC region, he renewed his last year's request to PTC for the establishment of a PTC Working Group on Hydrology (WGH) during 39th session of PTC. He envisaged that through the establishment of WGH, PTC Member countries could coordinate and contribute more effectively in Hydrological Component of Coordinated Technical Plan and could also share their experience in flood forecasts and best practices in flood management and suggest ways in adopting best water management practices for improved water security and hydrological disaster risk reduction in the PTC region.

1.1.4 Speaking on behalf of ESCAP, Dr. Yuichi Ono expressed his sincere gratitude to the Government of Myanmar. He reviewed the 2011 wet monsoon season which caused significant floods in the Southeast Asia and stressed the importance of investment in disaster risk reduction to keep up the rapid pace of economic development. He positively reviewed the progress made by the Government of Myanmar after the Cyclone Nargis. The Cyclone GIRI which hit Myanmar in 2010 but thanks to better early warning system and preparedness, many lives were saved. He expected that the 39th Session of PTC would need to be more action-oriented and the actions would be generated from two more newly developed working groups (meteorology and hydrology) towards the 40th PTC anniversary annual session next year. He also stressed the importance of developing measurable indicators. He encouraged the PTC members to report and review the previous years' cyclone-related disaster losses and damages at each PTC annual meeting.

1.1.5 Speaking on behalf of Mr Michel Jarraud, Secretary-General of WMO, Dr Geoff Love, Director, Weather and Disaster Risk Reduction Services Department, welcomed all the participants and expressed his appreciation to the Government of Myanmar for hosting the thirty-ninth session. Dr Love extended his gratitude to Dr Hrin Nei Thiam, Permanent Representative of Myanmar with WMO and her staff for the warm welcome and hospitality and for the excellent arrangements made to ensure the success of the session. In referring to the Panel's activities in the aftermath of Cyclone NARGIS, Dr Love commended their collaborative effort to improve regional early warning system for cyclone and storm surge forecasting and warning. Meanwhile, he urged the participants to renew their awareness that a series of unusual behaviors of cyclones including GONU and SIDR as well as the recent exceptionally serious flood in Pakistan have caused public anxiety about the increase of high impact weathers in this region. Referring to the WMO's provisional statement issued in November 2011 which showed that global temperatures in the year were the tenth highest on record, Dr Love emphasized that climate variability and change shall increasingly modify the relative magnitude of disaster risks, which will be especially critical in coastal areas on account of altered storm patterns and sea-level rise. In this regard, he stressed the necessity of establishing the multi-sectoral preparedness and prevention as part of overall national development programmes. Such development of the risk management of disasters emphasizes the increasing need for more reliable and longer lead-time hydro-meteorological information as well as for closer linkage between the disaster agencies and relevant sectors. Under these circumstances, Dr Love encourage the participants to renew their awareness that the Panel on Tropical Cyclones is expected to play an ever-greater role in the reduction of disaster risks for the people in the region and showed his expectation that the 39th

session would develop concrete actions to meet the requirement In ensuring WMO's continued support for the Panel's programmes, he wished the participants a very successful session and an enjoyable stay in Nay Pyi Taw.

1.1.6 At 01:50 p.m. H.E U Nyan Htun Aung, Minister for Transport declared the thirty-ninth session of the WMO/ESCAP Panel on Tropical Cyclones open.

1.2 Election of the Chairman and Vice-chairman

1.2.1 Dr Hrin Nei Thiam (Myanmar) and Mr Sunil H Kariyawasam (Sri Lanka) were unanimously elected as Chairperson and Vice-chairperson of the Panel, respectively, to hold their posts until the next session.

1.2.2 Mr Ali Shareef (Maldives) was elected as Chairperson of the drafting committee.

1.3 Adoption of the agenda

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

1.4 Working arrangements

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

2. FOLLOW-UP ACTION ON PTC-38

2.1 A detailed review of the follow-up actions taken to the recommendations of the thirty-eighth session was carried out based on the action sheet shown in **Appendix III**. The progress on the activities is incorporated into the relevant paragraphs below.

2.2 The representative of WMO offered its view that the Panel has been successful in implementing the Storm Surge Watch Scheme (SSWS) in the region. It achieved concrete results in that the SSWS was incorporated in the RSMC advisory arrangement through the collaborative effort of RSMC New Delhi and IIT and that all the Members achieved the skills of forecasting storm surges on operational bases through the capacity development activities with the support of IIT.

2.3 The representative of WMO informed the Panel that the update of the Global Guide to Tropical Cyclone Forecasting has been delayed. However, it was suggested that Mr Chip Guard, Primary Editor of the new Global Guide, expressed his views that the review of all chapters would start in June 2012 and the formatting for web version would be completed in 2012 (see para 4.3). The Panel requested WMO to complete the update as early as possible and share the draft version with the Members of the tropical cyclone regional bodies and other agencies concerned.

2.4 The representative of WMO also informed the Panel that prototype of the WMO Tropical Cyclone Forecaster Website has been established within the WMO/TCP website. In this regard, the Panel noted with pleasure that Hong Kong, China agreed to host the TC Forecaster Website in response to the request of WMO. The Website will be established in Hong Kong Observatory later in 2012 (see para 4.3).

2.5 As regards the national agreement of JCOMM/CHy Coastal Inundation Forecasting Demonstration Project (CIFDP) in Bangladesh, the Panel was informed that Bangladesh Meteorological Department (BMD) organized a National Stakeholders Workshop in Dhaka, from 28 November to 1 December 2011, and successfully launched the CIFDP Bangladesh sub-project (CIFDP-B). BMD is leading the national coordination of the CIFDP-B

and currently working to finalize the Definitive National Agreement (DNA) signed by all concerned Ministries. Expected completion of this phase is by June 2012 (see para 4.6–8).

2.6 The Panel noted with satisfaction that, for implementation of Tropical Cyclone Ensemble Forecast Project in the Panel region, ensemble products including strike probability have become available at the IMD website (www.imd.gov.in). It has been customized to display the products from major NWP centers including European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEP), United Kingdom National Weather Service (UKMO), Japan Meteorological Agency (JMA) and Meteorological Service of Canada (MSC). The present site needs some fine tuning and should be more user-friendly. It will be completed by the IMD experts and be fully operational in the next 2-3 months.

2.7 With reference to the assessment of the impact of climate change on tropical cyclone activities in the Panel region, Dr Chaudhry, Chair of the Ad-hoc Group for the assessment, informed the Panel that, although some materials have been contributed by the Members during the past year, Members are invited to send further information and research outcomes available in their respective countries. In response to the inquiry about the substance of the assessment, the representative of WMO suggested that its primary objective is to provide the stakeholders and decision makers in the region with more detailed information which is tailored to the region-specific needs, based on the available operational and research results collected from the Members (see para 5.6.2).

2.8 PTC Secretariat informed the Panel that a complete list of the focal points/DPP experts for WGDPP has been prepared and was sent to all focal points including Chair and Vice-chair of WGDPP and the same has also been uploaded on PTC website. In this regard, work space for the WGDPP was also developed in the PTC website.

2.9 The Panel was informed that a joint project proposal developed by the Secretariats of the Panel on Tropical Cyclones and Typhoon Committee as well as Asian Disaster Reduction Center was submitted to the seventh round of ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness. The main objective is to develop a guideline on multi-hazard coastal hazards early warning system standard operational procedures, which covers issuance of warning, dissemination of warning, and reaction to warning. The result is likely to be announced around July 2012. The Panel while endorsing the submission of proposal to the ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness urged the Members to actively participate in the project if approved by the ESCAP. The Members showed their commitment for their participation in the project.

2.10 The Panel was pleased to note that the activities of Working Group on DPP would be introduced at the RA II meeting to make a link with RA II Working Group on DRR and Service Delivery at its next session to be held in Qatar in December 2012.

2.11 Regarding the AOP for DPP activities, the Panel was informed that Expert Group Meeting on Lessons Learnt from the Great East Japan Earthquake was jointly organized by ESCAP, the Cabinet Office of Japan, Japan International Cooperation Agency (JICA), Asian Disaster Reduction Center (ADRC). Some of the PTC Members joined this EGM to discuss lessons learnt from the tsunami and improved warning system. Myanmar, Sri Lanka and Thailand participated in the South-East Asia Flood Forum on 20 February organized by ESCAP, International Centre for Water-related Hazard Risk Management (ICHARM) and supported by Japan Aerospace Exploration Agency (JAXA).

2.12 The Panel was informed that, for capacity building in hydrology, a two-day workshop on Flood Risk Reduction through Space Applications was organized in Bangkok by ESCAP and ICHARM, 21-22 February 2012. This workshop provided a hands-on training in using the Integrated Flood Analysis System (IFAS) and introduced useful information on

space applications for flood monitoring and forecasting. Bangladesh, Sri Lanka, Myanmar and Thailand participated.

2.13 The Panel noted that AMDAR programmes in the Panel region have made little progress in the past year. Noting that AMDAR data is effective supplement to upper-air observation programme, the Panel encourage the Members to continue to promote collaboration with airlines for developing the regional AMDAR programmes.

3. REVIEW OF THE 2011 CYCLONE SEASON

3.1 Report of RSMC – Tropical Cyclones New Delhi

3.1.1 The RSMC New Delhi presented a detailed review of the 2011 cyclone season. The RSMC New Delhi informed the Panel that the north Indian and adjoining land surface Ocean witnessed the formation of ten cyclonic disturbances during the year 2011. Out of ten disturbances five cyclonic disturbances formed over the Bay of Bengal, four over the Arabian Sea and one over land. Out of the five cyclonic disturbances over the Bay of Bengal, one intensified to the stage of very severe cyclonic storm THANE, two to the stage of deep depression and rest two to the stage of depression. Out of four cyclonic disturbances formed over the Arabian Sea, one intensified to the stage of cyclonic storm KEILA, two to the stage of deep depression and one to the stage of depression.

3.1.2 The salient features of the cyclonic disturbances during 2011 were as follows:

- The number of total cyclonic disturbances (depression and above) during the year was below normal, as only 10 cyclonic disturbances formed during 2011 against the normal of 13. Similarly only two cyclones formed during the year against the normal of about 5.
- Both the cyclones made landfall .While cyclone KEILA made landfall over Oman, the very severe cyclonic storm THANE made landfall over Tamilnadu and Puducherry coast.
- The track of the cyclone KEILA was rare in nature as it made a loop after the landfall over Oman near Salalah.
- There were four cyclonic disturbances formed over the north Indian Ocean and adjoining land surface during monsoon season (June-Sep.) against the normal of 7 cyclonic disturbances. There were no cyclonic disturbances over the north Indian ocean during the main monsoon month of July and August 2011. However, one land depression formed during July.

3.1.3 The summary report on the 2011 cyclone season provided by the RSMC including tracks of the cyclonic disturbances formed over the north Indian Ocean during the period are shown in **Appendix IV**.

3.1.4 Concerning Cyclone KEILA, there was lot of discussion as the system was declared as Cyclone by RSMC, New Delhi whereas Deep Depression by Oman. Some Members viewed that this type of difference in category creates confusion. Situation is even critical when a cyclone is located in the vicinity and the NMHSs are pressed for a decision.

3.1.5 The Panel underlined that the primary objective of the RSMC advisories is to assist Members' forecasting services while the warnings to the public are under the responsibility of the respective countries. However, it was of the view that a solid linkage must be maintained between the RSMC and the Members and their regional services should be closely coordinated in order to provide reliable warnings and to avoid unnecessary confusion among the people at risk in the Panel region. In this respect, the Panel recognized the need to further enhance the communication in operational forecasting between the RSMC and the Members and therefore requested the PTC Secretariat and the rapporteur of the Operational

Plan to review and reestablish the list of the focal points which is given in the Annex V-A -1 of the Operational Plan.

3.1.6 Noting that RSMC New Delhi uses various tools and diverse data/information for monitoring cyclones, the Panel recommended that a workshop be organized and a case study be carried out jointly by the RSMC and the Members concerned to fully share the scientific bases and discuss how to address such issues raised as above.

3.1.7 In this connection, the representative of WMO advised the Panel that the TC Forecaster Website, which will be fully established in Hong Kong Observatory in 2012, and the Severe Weather Forecasting Demonstration Project, which has been implemented in the Panel region, will also provide effective tools and opportunities to facilitate the communication and data-sharing between the Panel Members.

3.1.8 The Panel expressed its appreciation to the RSMC New Delhi for its continued valuable support to the Members. It also expressed its hope that existing cooperation and collaboration between the Members' Early Warning Centres and RSMC New Delhi will be further strengthened through those activities.

3.2 Reports of Members on the impact of tropical cyclones

3.2.1 Oman reported that there were no significant tropical disturbances to affect Oman in the first tropical cyclone season last year. However, Oman was affected by a series of three tropical systems within one month time in the second season. Consequently, the Main Forecasting Center in cooperation with National Committee for Civil Defense NCCD has issued a series of warnings to the public and fishermen.

3.2.2 In Maldives, the most instance disturbance in January was on 31st of the month which brought 102 millimeters of rainfall to the Meteorological Office, Gan. It is reported that some islands of southern most atolls were flooded and household goods were damaged due to heavy rain. Almost fine weather prevailed in February except for 85mm of heavy rain that fell on 24th February over Fuaahmulaku. Another low pressure trough has formed over the Maldives and caused a down pour of 82 mm in Gan on 5th March. The pre-monsoon disturbances brought out thunderstorms and heavy showers in Addu City. Heavy falls were recorded as 86, 62 and 69 mm on 18, 25 and 27th of April respectively causing flash floods in some islands there with water seeping into the houses. Although the onset of SW monsoon was declared a week earlier on 9 May, the heavy rain and strong winds occurred during late May. In June, a weaker monsoon prevailed throughout until 28th a trough of low-pressure formed over southern atolls brought a heavy downpour of 178 mm causing flooding with extensive damage to property in Addu city. In November, the southward movement of the Inter-tropical Convergence Zone (ITCZ) over the Maldives brought widespread rain, heavy showers and thunderstorms to central and southern atolls. Most of the streets were flooded when heavy rain of 92 mm pounds capital city (Male') early hours of 21 November. While the unsettled weather continued, the ITCZ shifted southwards causing widespread rain over southern Maldives. The highest rainfall record for this period was 186 mm in Kaadehdhoo on 23 November. Due to this heavy downpour, some islands of Huvadhoo atoll have reported extensive damage to their households and property. Another session of severe weather approached Huvadhoo atoll once again in late December. Heavy rain accompanied with strong winds blew away roofs and uprooted trees in many islands in that area during 23 December.

3.2.3 There was no tropical cyclone affecting Sri Lanka in the year 2011. However, the northeast monsoon rain was very heavy due to cyclonic activity prevailed in the vicinity of the island triggered by strong La-Nina conditions. Over 1.1 million individuals were affected in the January floods, followed by 1. million people in the February phase. 62 deaths were reported mainly due to floods caused by heavy rain and heavy losses to housing, infrastructure, agriculture and livelihoods of people in flood affected areas. Squally conditions

prevailed off and along the southern coast associated with squall line developed in the southern sea, while a depression was forming to the west (southeast Arabian sea) on morning 25th November. 22 lives were lost and another six missing due to drowning in the sea and the strong winds damaged the properties and infrastructure facilities such as overhead power distribution lines and telephone cables in Matara and Galle districts. A disturbance appeared in 23rd December in the Bay of Bengal to the south east of the island and moved west northwest ward while deepening in to a tropical cyclone, named THANE by 27th and moved to Thamilnadu coast on 30th without crossing the island. Bad weather advisories were provided especially to the Naval and fishing communities. The island, however, experienced dry northerly continental cool air due to this system during 27-31st December with 9.80C lower than the monthly average night temperature at Badulla on 27th. In this year too, the reported lightning fatalities were quite high and it was totally 51, predominantly from March to 4th week of May and in September-November 2011.

3.2.4 The representatives of the Panel Members reported to the session a review of the 2011 cyclone season of their respective countries, summaries of which are given in **Appendix V**.

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

4.1 The Committee was informed that the 16th WMO Congress, which was held in May 2011, gave following guidance to the Tropical Cyclone Programme (TCP):

- To assist Members in their efforts to implement Tropical Cyclone Programme activities for the safeguard of life and property from tropical cyclones and related hazards to the maximum extent possible within the available budgetary resources;
- To continue to support the capacity building programmes for developing countries, especially for Least Developed Countries and Small Island Developing States;
- To maintain and further enhance the collaboration between the Tropical Cyclone Programme and relevant WMO Programmes and technical commissions, particularly in relation to the development of tropical cyclone forecasting competencies;
- To continue close cooperation with other international as well as relevant national organizations at the global and regional levels to promote a multidisciplinary and multi-hazard approach towards the attainment of the humanitarian goals of the Programme.

4.2. TCP activities during the inter-sessional period were highlighted as follows.

Training and Capacity Development

- Workshops on TC Forecasting and Public Weather Service in Miami, Florida, USA from 21 March to 1 April 2011 and in Melbourne, Australia from 5 to 23 September 2011
- RSMC attachment training in New Delhi, India from 28 February to 11 March 2011 and in Tokyo, Japan from 20 to 29 July 2011

Support to Operational Forecasting

4.3 The Global Guide to Tropical Cyclone Forecasting has been updated and now in the stage of expert review. It will be mainly web-based for widespread access by forecasters and researchers around the globe and a limited number of hard copies will be also distributed to the WMO Members. Collation of chapters will be completed by Jun 2011 and

the final version of the updated Global Guide will become available by the end of 2012. The new Guide will achieve synergetic effect with the TC Forecaster Website which is also under construction and will provide useful tools and data for operational forecasters. In this respect, the Committee noted with pleasure that Hong Kong, China agreed to host the TC Forecaster Website in response to the request of WMO. The Website will be established later in 2012.

Storm Surge Watch Scheme

4.4 TCP collaborated with WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) to organize the 6th Storm Surge Workshop in the Dominican Republic for the RA IV Hurricane Committee Members in February 2011. It also held the 7th Storm Surge Workshop in Macao, China for the Typhoon Committee Members in October 2011 in cooperation with Meteorological and Geophysical Bureau of Macao and the Committee. A panel discussion was conducted on the storm surge warning service and its collaboration with the Urban Flood Risk Management (UFRM) project.

Application of Research and Development (R&D)

4.5 The first WMO International Workshop on the Satellite Analysis of Tropical Cyclones (IWSATC) was organized in Honolulu, Hawaii, USA from 13 to 16 April 2011 in collaboration with the WMO World Weather Research Programme (WWRP) and the National Climatic Data Center of NOAA. It was held in conjunction with the 2nd workshop of the International Best Track Archive for Climate Stewardship (IBTrACS) which is run by the National Climatic Data Center of NOAA. Linking with the effort to produce a globally-unified best track dataset, IWSATC set out to promote the sharing of expertise in satellite analysis of tropical cyclones between forecasters and researchers and helped facilitate their discussions on its future improvement.

WMO Coastal Inundation Forecasting Demonstration Project (CIFDP)

4.6 *The Committee was informed by Prof. Shishir Dube of the development of the Coastal Inundation Forecasting Demonstration Project.*

4.7 The representative of Bangladesh provided supplementary remarks that CIFDP-B is being very much appreciated in Bangladesh. It is understood that Stakeholders, Decision Makers as well as general public will be able to receive science based information & warnings after the successful completion of the projects. More than 50 participants including participants from Bangladesh Water Development Board(BWDB), Cyclone Preparedness Program(CPP), Disaster Management Bureau(DMB), Bangladesh Coast Guard, RIMES, RSMC, NEW DELHI attended the stakeholders workshop held in the conference room of BMD in the last week of November 2011. Signing of MOU among members of National Co-ordination Committee is under process.

4.8 While noting with pleasure the solid progress of CIFDP-B, the Panel renewed its awareness that the project is highly relevant to the PTC's disaster mitigation activities in the coastal region. It agreed to include in its Annual Operating Plan (AOP) an action to develop a collaborative linkage with CIFDP-B (see para 5.0.6).

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

Consideration of CTP for 2012-2015

5.0.1 Dr Chaudhry, Secretary of PTC briefed the Panel on the expected results and strategic objectives of each of the components of Coordinated Technical Plan (CTP)

including the main five components of meteorology, hydrology, disaster prevention and preparedness, training and research as well as partnership, management and governance.

5.0.2 Members were informed that CTP is a live document and subject to revision and updating by the Panel every four years. The Panel while reviewing the CTP urged the Members to give their suggestions and feedback on the content of the CTP for adoption of the CTP for the next four years 2012-2015.

5.0.3 The Members were requested to give their suggestions and views during the session if any for consideration to be incorporated in the CTP. Members can also send their suggestions if any to the PTC Secretariat by 30 April 2012 for this purpose. However, if no suggestion is received from the Members the CTP 2012-2015 shall be considered to be finalized. In this regard, PTC Secretariat will send a letter to the Members to invite such suggestions.

Consideration of AOP for 2012

5.0.4 The Panel reviewed the progress of its activities at both national and regional levels in five components - meteorology, hydrology, DPP, research and education - based on the reports presented by the Members. The Panel also held an extensive discussion about the way to develop the Annual Operating Plan (AOP) for 2012 for the five components to achieve the goals and objectives of the Coordinated Technical Plan (CTP).

5.0.5 In order to draft the Annual Operating Plan (AOP) for 2012, participants were divided into three components – Meteorology, Hydrology and DPP – and discussions were made in parallel to formulate the AOP in the respective components.

5.0.6 In regard to the Meteorological component, it was decided to establish the Working Group on Meteorology (WGM) with Mr Shamsuddin Ahmed (Bangladesh) as Chair. Giving careful consideration to the issues raised over the review of Panel's activities during the inter-sessional period as well as the relevant projects of WMO that have been implemented in the Panel region, WGM developed its AOPs as presented in the **Appendix VI** and also included "Study on the impact of climate change on the cyclone activities in the North Indian Ocean" as an AOP for the Research component. Recognizing that to secure the closest coordination between RSMC and the Members is an urgent task to be taken by the Working Group, it emphasized the necessity of organizing a workshop for a case study during 2012 as the Panel recommended under the Item 3 (see para 3.1.6).

5.0.7 The interim Working Group on Hydrology was attended by Myanmar, Oman, Pakistan, Thailand, ICHARM, and ESCAP. The meeting agreed a proposal that Oman to chair and Thailand to co-chair the working group. The representative of Oman and Thailand will expect a letter from the PTC Secretariat upon the approval by the member states during the session. The meeting requested the PTC Secretariat identify a focal point from each member country to develop the working group well. The meeting agreed that the strategic goal could remain as it is, but it needs to be revised based on the current needs of member countries. The members seek a comprehensive review at the working group level discussion. Under the strategic goals, the activities shown in the **Appendix VII** are proposed as AOP of the Working Group on Hydrology.

5.0.8 The Working Group on Disaster Prevention and Preparedness (WGDPP) was attended by Oman, Thailand and ESCAP. The meeting agreed on a proposal that Thailand to chair and Oman to co-chair the working group. Recognising the need to establish a close working relationship between Members of the WGDPP, based on the list of WGDPP focal points to be provided by PTC, the working group agreed to set up online group and a mailing list to enhance communication frequency and effectiveness. The working group agreed that the strategic goals should remain and that activities for 2012 will need to be realistic. The

activities shown in the **Appendix VIII** are proposed as AOP of the Working Group on Disaster Prevention and Preparedness.

5.1 Meteorological component (agenda item 8.1)

Activities of the Members

5.1.1 India Meteorological Department has taken up an extensive modernization programme (2008-12) with the following objectives and expected outcomes.

1) Objectives

- Induction of advanced technology for observational systems with induction of automatic weather station (AWS), Doppler Weather Radar (DWR) etc
- Digital data communication and data base integration
- Assimilation of non-conventional data into NWP systems
- Improved data dissemination and better public access
- Induction of more objective forecasting system
- Improvement in public weather services (PWS) and early warning system

The detailed observational system upgradation taken up in the programme is as follows.

2) Radar :

- Enhancement of DWR network
- Assimilation of Radar data in NWP Models
- Utility of Radar in Nowcasting
- Mosaicing of Radar imagery

3) Automatic weather Stations / rain gauges

- Phase I : AWS 550 and automatic raingauge (ARG) 1350
- Phase II : AWS 400 and ARG 2000

4) Upper air systems

- GPS based Radiosonde - 10
- Optical Theodolites - 70

5) Forecast System

- Global Forecast System (GFS T-382): 7 days
- Regional Forecast System (WRF): 3 days
- Mesoscale Forecasting System (WRF, ARPS & HWRF-high resolution): 48 hours
- Nowcasting

6) Outcomes of the programme

- Improved Forecast Services at district level with more accuracy
- Nowcasting of severe weather events
- Extended range (10-20 days or a month) Forecast .
- Increased accuracy of short, medium and long range forecasts
- Multi hazard early warning
- Real Time Data Availability -
- Rapid updation of data,
- Quicker response time for management,
- Easy accessibility,
- Opportunities for value addition
- Spatial & Temporal Coverage
- Better Service Delivery

5.1.2 Representative of Maldives informed the Panel that a Doppler weather radar provided to the Maldives Meteorological Service (MMS) as part of the Multi-hazard Early Warning System was repaired in 2011. However, the radar is not usable as it needs to be calibrated. In this regard, Maldives requested PTC and WMO to explore the possibility to assist MMS to find ways to solve this problem taking into consideration MMS does not have

such expertise. Radio-Sonde observations at Gan (43599) were launched in 2011 with some discontinuity due to software problem in the system and hardware issues with the Hydrogen Generator. Beginning from 1st October 2011, 8 observations were made at Gan with the support of ongoing DYNAMO project. Additionally, 4 radio-sonde observations were made at Male' (WMO # 43555) under the same project from 1 October till 15 December 2011. However, still there is no upper air sounding equipment in Male' and as the location of Maldives in the Indian Ocean happens to be a data sparse area in which, shifting of ITCZ and first phase of Madden-Julian Oscillation (MJO) takes place. Therefore, upper air observations from Male' are very important to entire meteorological community in the region and globe. Maldives urge assistance from donors and Panel members to consider rebuilding our upper air observation network. Maldives has 5 meteorological stations all are manned 24 hours, both synoptic and aviation reports are made on all five stations. Only one of them is categorized additionally as upper-air station. Total of 23 Automatic Weather Stations (AWS) has been installed and are in operation. Digital Meteorological Data Dissemination (DMDD) system donated by India Meteorological Department (IMD) has been malfunctioning and assistance from IMD is required to fully functioning of the system. Doppler Weather Radar needs further calibration of equipment by a professional and local technicians are unable to do the job. The system which runs WRF model had problem most of 2011 however, the issue has been resolved now. Maldives Meteorological Service continues to use NWP output provided by RIMES, ECMWF, IMD and other web based NWP products. For, NMC's Global Telecommunications System (GTS) and Message Switching System (MSS). the 10mbps internet service and the computer based telecommunication system between the local Meteorological Offices and the National Meteorological Centre (NMC), functioned very well. MESSIR-COMM message switching system is in operation throughout 2011. However, Maldives received many complains that many others are not receiving radio-sonde observation (TEMP) message through GTS. Likewise, the monthly CLIMAT report sent via GTS is also reported not received by users. Maldives is in need of assistance in strengthening its observational network, especially upper air observation and radar meteorology.

5.1.3 Representative of Myanmar introduced summary of 2011 weather events and extreme weather elements and unusual weather events, types of weather forecast and warning products, Improvement of meteorological services. Improvement of meteorological facilities under the project with JICA's development of cyclone forecasting project. Project of Reducing risks of Tsunami, storm surges, large wave and other natural hazards in low elevation zone currently progress with RIMES. DMH acknowledged WMO and ECMWF for providing (10) location specific EPS forecast starting from last week of February 2012. Also presented the high performance NWP products by various centers including RSMC New Delhi, NOAA, GFS, CIMSS, ECMWF, RIMES, JTWC, BMD, TMD, SATAID. Recent cyclones with rapid intensification character was observed and situation is challenges for Early warning providing agency without and extremely vulnerable to the coastal areas. DMH also highlight early warning dissemination system, warning users and feedback from stakeholders, emphasized WMO Early Warning guidance and National Standing Order. DMF informed to contribute to WMO about (10) more WWW observation stations to the RBSN via GTS. In summary DMH requested to WMO to enhance Upper Air Observation Network and WMO/ICAO for upgrading Aeronautical Meteorological Services in Myanmar. And International and Regional center were acknowledged providing for warning, products and technical cooperation and capacity development.

5.1.4 The representative of Oman informed the Panel that the Directorate General of Meteorology and Air Navigation (DGMAN) continued the efforts to improve and upgrade its meteorological facilities. During 2011, the network of surface weather stations was expanded through the installation of several new stations across the country. DGMAN continued to improve its numerical weather prediction capabilities by introducing new models with enhanced resolutions. The following NWP tools are now available:

- High Resolution Model HRM which is a Hydrostatic limited-area numerical weather with 14x14 km resolution. It covers a large area of the middle east and the Indian Ocean. It produces up to 120-h forecast at 00 and 12 UTC.
- COSMO which is a non-Hydrostatic limited-area numerical weather prediction with the same area of coverage and resolution.
- 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 Sea. WAM model run of 14km resolution and nested into 3.5km resolution.
- Tsunami Model for the Gulf of Oman and India Ocean: Comit Model from IOC is used to develop some hypothetical experiments to simulate tsunami waves propagation and indentation.

In addition, A Model Output Statistic Package (MOS) was installed to eliminate systematic errors in the direct model output. The Meteorology Department also installed Second Generation Satellite ground receiving station and the ground-receiving stations for intercepting High Resolution images from Polar Orbiting satellites operated by NOAA as well as from geostationary satellites operated by EUMETSAT. Several training and research activities continued during 2011 in order to improve the skills and knowledge of the Met personal. In addition, more forecaster were recruited to overcome the staff shortage. There are several goals that the Met Department aims to achieve in the near future. A network of 5 doppler radars is expected to be installed by the end of 2012. In addition, more land weather stations are planed to be installed across the Sultanate. Moreover, recruitment of new staff is going on to overcome the shortage of forecasters and observers in the department. DGMAN also plans to implement a Quality Management System (QMS) in the near future in order to comply with ICAO aviation requirements. Progress is also going on in establishing a multi-hazard early warning center that will be responsible to issue warnings for natural disasters such as Tsunamis and Tropical Cyclone.

5.1.5 The representative of Pakistan informed the Panel that Pakistan Meteorological Department (PMD) has installed two Automatic Weather Stations (AWSs) for Glacier Monitoring in 2011. The first AWS was erected on 16th June, 2011 for recording ground based observation at an elevation of 4500m above mean sea level (a.m.s.l.) on the top of Passu and Batura Glaciers. The second AWS was installed in August, 2011 in collaboration with Italian research organization EV-K2-CNR Committee near Concordia (at 4700 a.m.s.l.) at Baltoro glacier located in Shigar basin. It has mean length of 62 km and an area of around 640 square kilometers. He further informed that PMD has recently installed an Integrated CMACast System at PMD Islamabad with Chinese support. The Integrated CMACast System includes CMACast Reception Station, CMACast Geo-system (Satellite Data Quick Viewing Program and Automatically Processing Program), and MICAPS (Meteorological Information Comprehensive Analysis and Process System). The second such system will be installed at Karachi. The Panel was also informed that PMD has been using High resolution Regional Model (HRM) of DWD (the National Meteorological Service of Germany) as an operational model for numerical weather prediction (NWP) since January, 2007. Initially, the model was run with 28 Km resolution which was improved to 22 Km in March 2008 and to 11 Km in September, 2010. Now, PMD is planning to also implement COSMO (COnsortium for Small-scale MOdelling) with higher resolution for NWP. In this regard, two scientists of PMD attended a training workshop on NWP using HRM and COSMO models during 2011.

5.1.6 The representative of Thailand informed the Panel that Thailand focused on the improvement of the last year satellite signal receiving station being in validity process. Regarding the national early warning and data storing, the TMD enhanced the control systems of telecommunication networks across the country, linked the GTS and the AFTN with the Digital system, and connected GTS Circuit with the TMD and the NDWC for DART BUOY spread to WMO's members. Also, the Forecast Service adjusted the storm's course and intensity by data of the JMA and the JTWC accessed through the Internet. Improved the data service for aviation in accordance with ICAO regulation, the TMD received ISO9001:2008 Quality Management System (QMS), applied the service with receiver's

satisfaction seminar, and enhanced the Low Level Windshear Alert System (LLWAS) covering area of Suvarnabhumi International Airport. To enhance upper-air observatory, the TMD established two sets of Rawinsonde and purchased Radiosonde. In cooperation with the Ministry of Foreign Affairs, weather observing instruments were successfully installed in Myanmar by the TMD.

Activities of WMO

5.1.7 The representative of WMO reported that, according to the Integrated WWW Monitoring (IWM) carried out on a quarterly basis from July 2010 to April 2011, the average availability of SYNOP reports ranged from 9% to 96% during this period in the Panel region. The availability of SYNOP reports continued to be more than 70% for all countries, except for the Maldives, which continued to show a negative trend decreasing further to 9% of availability. Overall, the total availability of reports increased to 88% during this period from 86% in the previous year.

5.1.8 Average availability of TEMP reports ranged from zero to 49% with decreased availability in most countries. As during the previous period, the availability is around 11% for the Maldives with Myanmar not reporting TEMP. Overall, with the reduction in the number of reports received from a majority of Panel Members, the average percentage of the total number of TEMP reports received declined from 45% in the previous year to 38% during this period.

5.1.9 In reference to the results of IWM, the representative of Myanmar advised WMO that there should be no upper-air station registered as a RBSN station.

5.1.10 Regarding the space-based observing system, the Panel was informed that among the R&D or other environmental missions that provide a valuable contribution to operational tropical cyclone activities, one should note in particular: NASA's Aqua and Terra missions; NASA-CNES Jason-1 mission; NASA-JAXA's TRMM (with precipitation radar, microwave imager and lightning mapper); ESA's Envisat mission (namely with SAR and radar altimeter), China's HY-2A ocean monitoring satellite (with scatterometer, altimeter and microwave radiometer), ISRO's Oceansat-2 (with scatterometer, ocean colour monitor and radio-occultation) and CNES-ISRO's Megha-Tropiques (with microwave imager and sounder for precipitation estimation). Missions planned for launch in 2012 include: the ISRO-CNES SARAL (with an altimeter) and JAXA's GCOM-W1 missions (with microwave imager providing all-weather sea surface temperature measurements). As concerns the Global Precipitation Measurement (GPM) programme, the launch of its core satellite is now planned for early 2014.

5.1.11 The Panel noted that WIS has been operational from January 2012, with an initial three GISCs (Beijing, Offenbach and Tokyo) offering the initial service. More GISCs are planned, including one in New Delhi. These are supported by Data Collection or Production Centres. The Manual on WIS (WMO No. 1060) and amendments to include WIS in the Technical Regulations (WMO No. 49) have been published. These combined with a Guideline to WIS and guidelines for WMO Metadata for WIS (<http://wis.wmo.int>) will allow all Members to begin to implement the new WIS functionality. It is expected that GISC New Delhi will take the leading role in ensuring Members of the Panel on Tropical Cyclones also implement and benefit from the new functionality of WIS.

5.1.12 The representative of WMO stressed the usefulness of Common Alerting Protocol (CAP, ITU Recommendation X.1303) as a content standard designed for all-hazards and all-media public alerting. CAP is used in the disaster response community for delivering information about a large variety of events, and it is suitable for the dissemination of weather, climate and water related alerts and warnings. Thus CAP will now be supported in the virtual all hazards network within the WIS-GTS. The Panel Members were encouraged to consider early implementation of CAP for their warning services.

5.1.13 The WMO Secretariat briefed the meeting on the SWFDP, including its overall framework, the experience of developing other SWFDP regional projects.

The Panel was informed of the WMO SWFDP framework, including guidance from the Commission for Basic Systems (CBS) which is described in the basic documents: “SWFDP Overall Project Plan (2010)”, and “SWFDP Guidebook for Planning Regional Subprojects (2010)” that have been developed by the CBS Steering Group on the SWFDP.

5.1.14 The Panel noted that SWFDP aims to contribute to capacity-building and to help developing countries in particular to have available existing NWP products and make the best possible use of those products for improving warnings of hazardous weather conditions and weather-related hazards. Global-scale products, as well as data and information provided by other regional centres, are integrated and synthesized by a designated Regional Specialized Meteorological Centre (RSMC), which, in turn, provides daily guidance for short-range (days 1 and 2) and medium-range (out to day-5) on specified hazardous meteorological phenomena (e.g. heavy rain, strong winds, etc) to participating National Meteorological Centres (NMCs) of the region. This is a “Cascading” concept of the forecasting process, which is further discussed under item 7.

5.1.15 The meeting recalled that the SWFDP had been implemented successfully in Southern Africa and other three projects are in progress for the South Pacific Islands, Eastern Africa and for the Southeast Asia.

5.1.16 The meeting noted that the “SWFDP Overall Project Plan (2010)” is a high-level document targeting senior managers, which describes the SWFDP technical aspects related to weather forecasting (GDPFS) and public weather services (PWS) programmes; and general principles and conceptual framework for guiding project planning; while the “SWFDP Guidebook for Planning Regional Subprojects (2010)” provides a “template” and procedures for developing a Regional Subproject Implementation Plan (RSIP). The meeting noted that the development of an Implementation Plan for an SWFDP for the Bay of Bengal (South Asia) should follow the procedures as described in the Guidebook, with the required adjustments to address particular aspects of the region. The meeting further noted that the Implementation Plan, when developed, is required to be reviewed by the Steering Group for the SWFDP, and approved by the Regional Association, prior to its implementation to ensure that the required procedures had been properly addressed.

5.1.17 The Panel was pleased to note that a WMO/RIMES joint regional project for “Reducing risks of tsunami, storm surges, large waves and other natural hazards in low elevation coastal zones” has been implemented within the UNESCAP Tsunami Regional Trust Fund. Within this project, the Technical-Planning Workshop on Severe Weather Forecasting Demonstration Project (SWFDP) for the Bay of Bengal (South Asia) was held in New Delhi, India, from 23 to 27 January 2012. Participants included representatives (forecasters) of Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand, representatives from global products centres (JMA, NOAA/NCEP and IMD/NCMRWF), and the WMO Secretariat within this project. The objective of the workshop was to develop a series of conclusions and recommendations on how the SWFDP-Bay of Bengal should be designed and developed for its first demonstration period, including the following aspects:

- which participating centres (global, regional, national)
- what geographical window (latitude-longitudes) should be adopted for the project
- which hazards, i.e. where warnings are issued by the NMHSs, and are the most important in this region (should at least include heavy rainfall and strong winds)
- what RSMC daily guidance hazard thresholds should be adopted (e.g. heavy precipitation at 100 mm/24-hr)
- what is the period of the season for each of the hazards
- what products should be requested from the global and regional centres (including locations for EPSgrams to be supplied)

- what forecasting guidance products from other RA II related projects could be included or linked to the SWFDP
- timetable and milestones

5.1.18 The Panel believed that the SWFDP had a vital role to contribute to the visibility and credibility of the NMHSs of the region as the authoritative sources for the provision and delivery of reliable, timely, accurate and useful severe weather warnings and forecasts. WMO expends considerable resources and effort to highlight the role of NMHSs in this regard and assists them with the delivery of user focused and relevant services.

5.1.19 The Panel welcomed the initiation of the SWFDP for the Bay of Bengal and some Members currently not included in the SWFDP expressed its interest to be associated with the project when the target countries will be increased. In this regard, the Panel requested WMO to explore the possibility to mobilize resources contacting donors. The Panel felt that it would be worthwhile to consider developing a link with SWFDP as an AOP for 2012.

5.2 Hydrological Component

Activities of the Members

5.2.1 The representative of India informed the Panel that the IMD is providing the necessary technical and operational support to various Central/State Govt. Organisations and other agencies in the field of Hydromet design flood forecasting, water management and agricultural planning purposes. Real time monitoring of district wise daily rainfall is one of the important functions of IMD. A network comprising a large number of raingauge stations is utilized under District wise Rainfall Monitoring Scheme (DRMS). Flood Meteorological Service of IMD provides the inputs to Central Water Commission through their 10 FMO established in different parts of India for operational flood forecasting. This unit is mainly engaged in developing Quantitative Precipitation Forecast (QPF) model using different dynamical models for river basins during flood season. Design Storm Studies are being conducted to evaluate design storm estimates (rainfall magnitude and time distribution) for various river catchments/projects in the country, for use as main input for design engineers in estimating design flood for hydraulic structures, irrigation projects, dams etc. on various rivers. Central Water Commission is charged with the general responsibility of initiating, coordinating and furthering in consultation with the State Governments concerned, schemes for the control, conservation and utilization of water resources in the respective State for the purpose of flood management, irrigation, drinking water supply and water power generation. The Commission, if so required, can undertake the construction and execution of any such scheme.

5.2.2 The representative of Myanmar informed the Panel that, Hydrological Division of Department of Meteorology and Hydrology (DMH) is responsible for issuing daily river forecast and flood forecast for 30 selected stations along 8 major rivers: Ayeyarwady, Chindwin, Sittaung, Thanlwin, Dokehtawady, Bago, Shwegyin and Ngawun. Whenever warnings and bulletins are issued from River Forecasting Section (RFS) of D.M.H, the message is sent to higher authorities, concerned ministries/departments and the respective stations of DMH by telephone or Single Side Band (SSB) transceiver. As soon as head of the station receive the message of warning, he or she immediately inform the local authorities and other related departments in order to carry out the necessary action. At the same time the warnings are disseminated through the radio and television as well as through the Newspaper for general public. During the year 2011, there were floods at downstream of Ayeyarwady river, Chindwin river, Thanlwin river, Sittoung river, Dokhtawady river, Bago river, Shwegyin river and Ngawun river. In August, the big flood occurred at Bago of Bago river and this flood was the highest record during last 47 years. Similarly, the flood occurred six times at Hpaan of Thanlwin in 2011 and the third flood wave exceeded the danger level by 6 feet and stayed about 26 days. This flood was the second highest flood by historical record (1966-2011). During the year 2011, DMH has issued (34) flood warnings and (136) flood

bulletins during 2011 flood season. Apart from river flood, flash flood and severe landslide occurred at Pakokku district of Magway Region, due to the continuous heavy rain which amounted (6.65) inches at Pakokku, (5.95) inches at Gangaw and (9.34) inches at Nyaung Oo during 18-20 October 2011 while the depression was crossing to Myanmar area. It caused (161) death toll, lost 3384 livestock, affected (102) wards and villages, 9523 houses, 29751 population, and damaged 2535 houses, 15 government building, 33 religious building, 7 bridges, 5378 acres croplands in Pakokku District. In order to provide runoff data, discharge and sediment discharge measurements are carried out every year at three sites in the selected three rivers. At the year 2011, measurements of discharge, sediment discharge and bed profile were implemented at Nyaung U and Thabeikkyin for Ayeyarwady river and Mawlaik for Chindwin River. In order to enhance meteorological and hydrological monitoring capacities for the generation of long-lead location-specific flood forecasts and flood early warning system, the requirements are: to improve the advance and effective flood forecasting techniques and advance model/software for large catchments as well as flash flood forecast for small catchments, to install Automatic Telemetric Hydromet stations at remote area, to install more Automatic Weather Stations, to install the siren at flash flood area. The short term training for advance flood forecasting technology and GIS application in Hydrology and the long term fellowship for M. Sc and Ph. D degree for Hydrology are required for human resources and capacity building.

5.2.3 The representative of Oman informed the Panel that the Ministry of Regional Municipalities and Water Resources is responsible for the hydrological measurements and the management of the water resources for the Country. During the year 2011, all hydrological parameters were measured through a network of 4681 monitoring stations. This network includes rain gauges, wadi gauges, flow peaks, aflaj, springs and water level in addition to 36 dams distributed all over the Sultanate. There are 362 rain gauges, of which 277 Automatic and 85 of standard type. About 47 of these rainfall stations are fitted with telemetry using GSM modems. During the year 2011, the coastal areas of the country were exposed with exceptional rainfall as a result of Tropical depressions that affected Oman during the second tropical cyclone season in October and November. The maximum annual accumulated rainfall was 378 mm in Dhofar while in the east (Sharqiyah) 124 mm. The highest recorded in Muscat was 176 mm and in the Interior region 256 mm was recorded at Nizwa. There are 167 wadi gauge stations to measure wadi flow and to compute flood volumes. In addition, there are 25 stations to measure the peak height of the wadi flows. The year 2011 is considered one of the years where low discharge rates were recorded. The total flood volumes during 2011 was estimated (190 Mm³) which is below the annual average (220 Mm³). The highest recorded was (284 Mm³) in Dhofar region in the southern part of the country. The Ministry of Regional Municipalities & Water resources operate a network of 2107 groundwater wells measured for water levels, 1644 of them are measured every month and the rest are measured every three months. Analysis of data showed that as a result of the decrease in the recharge, there is a gradual decrease in water levels in most areas of the Sultanate, except Muscat and South Sharqiyah regions where recharge as a result of Cyclone Phet is still in progress. There are 3 types of Dams in Oman: 70 surface retention dams, 32 recharge dams and 12 Flood protection dams. On the 32 recharge dams stations for measuring flow and sedimentation, a total of 42 Mm³ was retained by recharge dams during 2011. In addition, the Wadi Dayqah sdam in Muscat regions stored a total of 14.6 Mm³. The Ministry arranged 3 main water resources related workshops and conferences during 2011:

- International Workshop on Hydrology, Nature and Engineering at the Sultan Qaboos University on 20th to 21st March 2011.
- World Water Day Seminar, 20-22 March, 2011 at the Sultan Qaboos University.
- International Conference on Drought Management Strategies in Arid and Semi-Arid Regions 11-14 December, 2011 Muscat - Sultanate of Oman.

Some of the main Ministry achievements are listed below:

- The Ministry has completed 9 dams for groundwater recharge, flood protection and storage. In addition to that, there are 7 other dams under construction during this year.
- Several studies have been completed during last year that include the topics of dams construction, study of the increase groundwater level in some part of the country, study the water situation, drilling of exploration wells, rehabilitation of monitoring wells at Muscat area, wadi gauges and rain gauges affected by cyclone.

5.2.4 The representative of Pakistan informed the Panel that an initial version of Flash Flood Guidance System (FFGS) has been installed at PMD to help provide warnings about the imminence of potential flash-flooding. The development of FFGS for Pakistan was conceived during WMO fact-finding and needs- assessment Expert Mission that visited Pakistan in early November, 2010 in wake of 2010 super floods in Pakistan. The FFGS for Pakistan has been developed by Hydrologic Research Center (HRC), USA with the assistance by USAID through joint collaboration between the WMO, U.S. NOAA NWS, and the PMD at a cost of US \$ 99,000. The main objective of the FFGS is to provide near real-time guidance products pertaining to the imminence of potential small-scale flash flooding throughout Pakistan. The system will provide the necessary products to support the development of warnings for flash floods from intense rainfall events through the use of satellite-based rainfall estimates. The FFGS outputs will be a diagnostic tool for the meteorologists to analyze weather-related events that can initiate flash floods and then to make a rapid evaluation of the potential for a flash flood at a location. For the implementation of the initial version of FFGS and for imparting FFGS training to PMD officials, two scientists from HRC, USA visited PMD, Islamabad in August 2011. The FFGS will be improved towards finer version during next 2-3 years through joint efforts of HRC and PMD. The Panel was also informed that UNESCO, the Government of Pakistan and the JICA have launched a US\$3.5 million project funded by the Japanese government to upgrade early flood warning in Pakistan. The project is part of UNESCO's wider effort to help Pakistan to tackle natural disasters in wake of 2010 floods. The project aims to address the following three inter-related focus areas: Strategic Augmenting of Flood Forecasting and Hazard Mapping Capacity; Knowledge Platforms for Sharing Transboundary and Community Data; Capacity Development for Flood Forecasting and Hazard Mapping. The project will benefit from the technical expertise of the ICHARM, Japan under the auspices of UNESCO. ICHARM has developed an Integrated Flood Analysis System (IFAS) using data provided by satellites. The development of Indus-IFAS (i.e. IFAS for the Indus River system in Pakistan) is also part of the project. At national level, the main beneficiaries of the project are FFC, NDMA, SUPARCO and PMD.

5.2.5 Representative of ICHARM informed the Panel that ICHARM aims at contributing to the prevention and mitigation of water-related disasters in the world. Initial efforts are focused on flood-related disaster management. ICHARM has developed Integrated Flood Analysis System (IFAS), a concise flood-runoff analysis system as a toolkit for more effective and efficient flood forecasting in developing countries. IFAS provides interfaces to input not only satellite-based but also ground-based rainfall data, as well as GIS functions to create river channel network and to estimate parameters of a default runoff analysis engine and interfaces to display output results. The IFAS has been already applied in many river basins of Asia such as Solo River basin of Indonesia, Kabul River basin of Pakistan, Chindwin River basin of Myanmar, Sendai River and Kikuchi River basins of Japan and other river basins of Asia. Besides IFAS application in flood forecasting, RRI (Rainfall-Runoff-Inundation) model has been applied in Chaophraya River of Thailand to understand and predict flood in 2011 and also has been applied in the Kabul River basin of Pakistan to simulate flood in 2010. ICHARM has been also engaged in assessment of the impact of climate change on flood disaster risk and its reduction measures over the globe and specific vulnerable areas. ICHARM is also working on a collaborative project with Asian Development Bank (ADB) to help prepare and implement flood management projects through knowledge and capacity development services for reducing vulnerability to water-related disasters with national and

regional level assistance. Under this project, a National Road Map for flood early warning system in Bangladesh has been prepared. The integrated approach of IFAS application and community based flood disaster management for the flood early warning system has been implemented in Bengawan Solo River basin in Indonesia. Also, flood vulnerability indices in Mekong Basin area in Cambodia are prepared. In addition to the implementation of flood forecasting and warning system and research activities, the Centre is also providing practical training to develop local engineers' capacity to cope with water-related disasters. ICHARM organized many IFAS workshop in Indonesia, India and Bangkok. Recently ICHARM organized two knowledge sharing workshop in Nepal on January 15-18, 2012 and in Cambodia on February 9-10, 2012. ICHARM also offers one year master course and three years Phd study.

Activities of WMO

Flood Forecasting Initiative

5.2.6 With regard to the WMO Flood Forecasting Initiative (FFI), progress was achieved with regard to establishing Flash Flood Guidance Systems as outlined in item 5.2.3.2 below. Further activities under WMO-FFI implemented in 2011 include:

- Workshop on the Intercomparison of flood forecasting models currently in use in the various WMO Regions, to help the countries in identifying the most suitable models to serve their requirements (Koblenz, Germany September 2011);
- Workshop on the development of a framework for the assessment of service delivery capabilities of hydrological services in flood forecasting (Geneva, October 2011);
- Regional workshop cum training in flood forecasting in Nanjing, China in October 2011

5.2.7 With the aim to make best use of meteorological forecasting products for hydrological purposes it is generally recognized in RA-II that QPE/QPF products are very important to improve hydrological service delivery. However, QPE/QPF has not been extensively used in real-time hydrological modeling maybe because: its uncertainty issues and because QPE/QPF products were developed for meteorological, not hydrologic purposes. QPE and QPF could be strengthened through enhanced coupled modeling and an end-to-end evaluation on QPE/QPF quality and impacts on flood and streamflow products for basins of diverse size and topography. To improve QPE and QPF, hydrologists could be encouraged to work with QPE/QPF groups to ensure that hydrological requirements for precipitation (QPE/QPF) can be considered.

5.2.8 The Associated Programme on Flood Management (APFM) that promotes the concept of Integrated Flood Management practices has progressed largely and in particular the development of Tools on a wide variety of flood management issues and the HelpDesk established under the programme since June 2009. A regional training workshops had been held in Hanoi in April 2011 in cooperation with the Mekong River Commission Secretariat; workshops to establish a National Integrated Flood Management Strategy has been held in January 2011 in Pakistan and tow of these national workshops are scheduled for Thailand in March 2012 and Laos PDR in April 2012. A considerable number of tools have been developed under the APFM that can be downloaded from www.FloodManagement.info.

5.2.9 Efforts are underway to establish an Integrated Drought Management Programme which was seen as highly relevant for the region.

Commission for Hydrology (CHy)

5.2.10 With regard to activities of the Commission for Hydrology, the following achievements and on-going activities of the Commission are reported:

- *Quality Management Framework (QMF)*

The QMF – Hydrology aims at improving all aspects of operations and activities of NHSs/NMHSs. The WMO Quality Management Framework guidance will be finalized as a draft by March 2012 put up for review on the e-Board to have ready for CHy-XIV.

Two stages of activities are envisaged:

- Produce Guides and Manuals to improve operations of NHSs/NMHSs;
- Encourage NHSs/NMHSs to adopt and implement Quality Management Systems (QMS) and finally obtain ISO certification.

- *Publications*

The Manual on Flood Forecasting and Warning has been published in 2011 and currently being distributed. Likewise, under the guidance of JCOMM, the Guide to Storm Surge Forecasting has been published in 2011.

- *Capacity Building*

In Capacity Building the following achievements have been made and a number of activities are on-going including:

- *Distance Learning (DL)*

In accordance to the recommendation of the Strategy on Education and Training in HWR to promote distance learning activities, WMO, in collaboration with COMET and NOAA, delivered a first International Basic Hydrological Sciences Distance Learning Course in 2009. In 2011 two regional courses were held: an advanced one for Eastern Europe in March and a basic one for RA V in October. In July 2011, an invitation to interested institutions to participate in this DL initiative was issued, and a Training of Trainers Workshop on Distance Learning Delivery of Hydrology Courses was held in COMET's headquarters in Boulder, USA, from 29 November to 9 December 2011, with participants covering all WMO regions.

- *Roving Seminars on Manuals of Stream Gauging and Flood Forecasting*

In cooperation with International Association for Hydro-Environment Engineering and Research (IAHR), two versions of a course on stream gauging based on the second edition of the WMO Manual have been designed: a short one (3 class days plus one field day) for the IAHR audience and a two-week one for WMO's audience (staff of NMHSs). The first course in the IAHR version was held in Brescia, Italy in September 2011, while the first course in the WMO version is tentatively scheduled in the second quarter of 2012 in Ghana. A first version of training material on Flood Forecasting and Warning has also been prepared and used in the training course on the subject, held in Nanjing, China in October 2011.

Regional activities

5.2.11 Progress has been made in the implementation of WHYCOS projects and in particular the Mekong-HYCOS that will end by November 2012 and the Hindu Kush Himalayan (HKH) HYCOS projects that is currently being implemented. The objective of both HYCOS projects is the establishment of regional flood information systems.

5.2.12 Together with NOAA/National Weather Service, the Hydrologic Research Center (HRC), San Diego, USA as technical partner, and funding from USAID, elements of the Flash Flood Guidance System with Global Coverage have been established in the region: The Mekong FFGS is being operational and likewise, an advanced proto-type FFGS has been established in Pakistan. With further funding become available from USAID, a kick-off meeting will be held later in 2012 in Kathmandu, Nepal for the establishment of a FFGS in the Hindu Kush Himalayan region and – in extension to the system existing at the Mekong River Commission (MRC), an FFGS is planned to be established in Myanmar, starting in 2012.

Current and proposed Theme Areas of the RA-II WGH

5.2.13 With regard to achieving the objectives of the RA-II WGH, the following theme areas are currently under implementation and advanced draft reports for each of these areas are expected by end of April 2012. The active theme areas are:

- Improving Institutional Capacity including the implementation of the RA II Strategic Plan for NHSS
- Disaster Mitigation – Implementation of the WMO Flood Forecasting Initiative including Flash Flood Forecasting Capabilities
- Hydrological responses to climate variability and change and promotion of the use of climate information by water managers,

The priority activities suggested for consideration from the RA II- WGH session in November 2010 were:

- Flood forecasting and warning;
- Hydrological aspects of drought;
- Hydrological response to climate variability and change;
- Hydrological observations, including from satellites;
- Water resources assessment.

These will be discussed during the upcoming RA-II session in December 2012.

Regional Cooperation

5.2.14 As a major step forward, the WGH during its session in November 2010 had decided to establish close links to the WGH of the Typhoon Committee. It was agreed that the RA-II WGH would nominate its chair to represent activities of the WGH and likewise that the results of the proposed joint working areas be communicated during the 43rd session of the TC in January 2011. The four areas where joint activities are envisaged are documented below.

- Urban Flood Risk Management (UFRM)
- Flash Flood/Debris Flow/landslide Forecasting/Warning
- Assessment of the Variability of Water Resources in a Changing Climate
- Drought Monitoring and Forecasting based on Space-based Information

Cooperation between the RA-II WGH, the WGH of the Typhoon Committee and the Hydrology and Water Resources Branch of the Department on Climate and Water (CLW) at WMO Secretariat are in full swing, especially – at this moment - in the areas of urban flood risk management and flash flood warnings. The TC-WGH had also noted with interest regional activities related to the intercomparison of flood forecasting models and training courses in flood forecasting envisaged for RA-II, probably in close cooperation with the Bureau of hydrology, Ministry of Water resources P.R China.

Recommendations

Recognizing the importance of hydrological forecasting in connection to activities of the PTC it is recommended that the PTC

- Considers the establishment of a Working Group Hydrology (WGH) in analogy to the highly successful WGH of the ESCAP/WMO Typhoon Committee (TC) with active involvement of hydrologists and seeks to enhance full collaboration with the TC;
- Establishes closer links with the RA-II WGH on the working level and with individual experts;
- Develops a Requirements Document for hydrological services in support of current and planned PTC activities;
- Makes use of services provided through CHy and the WMO Flood Forecasting Initiative in particular as well as proposals for new HYCOS components;

- Further provides suggestions for activities to be carried out in support of PTC needs in hydrology;
- Makes use of the services provided by the APFM in the area of Integrated Flood Management

5.3 Disaster Prevention and Preparedness (DPP) Component

Activities of the Members

5.3.1 The representative of India informed the Panel that meetings related to cyclone preparedness and disaster management conducted by the State Govt. departments are regularly attended by IMD officers to provide necessary briefings and inputs. Frequent lectures on Disaster Preparedness and Mitigation are delivered to educate the State Govt. officials and NGOs. Exhibits on Statistics on frequencies of landfalling Tropical Cyclones over the coastal belts of North Indian Ocean, Cyclone Warning procedures employed by IMD, Damages caused due to landfalling cyclones etc. are prepared every year with updated data and displayed in the meteorological exhibition conducted during the WMO Day and National Science Day. Exhibits are also supplied to schools and other academic/ govt. institutions for display during scientific programmes. IMD officials also participate in such exhibitions.

5.3.2 The representative of Maldives informed the Panel that Maldives Meteorological Service is the authoritative organization in the country for issuing advisories and warnings related to meteorological, hydrological, tectonic and oceanographic disasters. To accomplish these tasks, MMS has prepared the Standard Operating Procedures (SOP) to act upon any likely event of such disasters. MMS acquired broadband and short-period seismometers within the framework of establishing a National Early Warning System. Maldives' sea level network comprises of 3 tide gauges to monitor low frequency changes in sea level associated with global sea level rise or decadal climate variations like other gauges in GLOSS network. After the 26 December 2004 Tsunami, these 3 tide gauges have been upgraded with more sensors such as radar/ pressure/ float based water level sensors, and the reference level float switch sensors. With these improvements, it shall even detect any slight variations in sea level due to a tsunami wave. The National Meteorological Centre issued timely and accurate warnings and advisories, disseminated them to the public through mass media and through its website. Apart from severe weather or tropical cyclone warnings, earthquake or tsunami warning reports received from Pacific Tsunami Warning Centre, Japan Meteorological Agency, Regional Tsunami Service Provider (RTSP) India, Indonesia, Australia and the Regional Integrated Multi-hazard Early Warning System (RIMES), through internet and GTS were also disseminated to public satisfactorily in time.

5.3.3 Oman is experiencing a major restructure and development in its Emergency management system. More emphasis is on disaster risk reduction especially in the areas of early warning and public awareness programs. In addition, a national emergency information management system is now being developed which will not only enhance decision making during emergencies, but also will assist different government and NGOs and private sector in risk analysis and mitigation activities by providing essential data to carry vulnerability assessment. Moreover, an emphasis is put in enhancing community capabilities in preparing for and responding to emergencies. Enhancing local (first) responding capabilities is an objective that authorities are thriving to achieve in the next three years. An important development in emergency and risk management in Oman is the restructuring of the emergency management system which is now based on functional multi hazard sectors system rather than institutional based response system. Oman DPP representative recommended that an effective communication and coordination system should be implement between member countries in better enhancing disaster prevention and preparedness exchange of knowledge and experiences and promoting international standards specially that pertaining to search and rescue and relief operations.

5.4 Training component

Activities of the Members

5.4.1 The representative of Oman informed the Panel that Oman hosts WMO 7th center of excellence for satellite training in cooperation with EUMETSAT. Panel Members are welcome to participate in satellite training courses that will be held in the future. A list of other workshops, seminars, research and training courses attended by the Met personnel during the year 2011 is presented in **Appendix IX**.

5.4.2 The representative of Maldives informed the Panel that to build the capacity of MMS further and in accordance with the mandate and action plan, Maldives urgently needs to train their personnel. Coordination is required in Meteorology, Aviation, and Satellite Met, WRF/WAM, climate, tsunami propagation and storm-surge modeling.

5.4.3 The representative of India informed the Panel that the seminars/workshops were conducted for cyclone forecasters in India during March and September, 2011 regularly. A National Conference on Bay of Bengal Tropical Cyclone Experiments (BOBTEx-2011) was organized during 1-2 November, 2011. Many scientists participated and presented their papers in this conference. One official each from Myanmar, Bangladesh and two from Oman had received training on Tropical Cyclones monitoring and forecasting at RSMC, New Delhi during 28 February to 11 March, 2011. Eight IMD officers were sent abroad for various components of forecasting system, for technical training in software Code, operation and maintenance of C-Band DWRs system under IMDs modernizing its observational facilities and infrastructure during 2011. National Conference on Satellite Meteorology- I (NCSM-2011) New Delhi on Utilization of MODIS/NOAA/METOP satellite data and products in weather analysis and forecasting was held in New Delhi during 8-9 December, 2011. The following regular courses are running at Central Training Institute Pune;

- i) Advanced Meteorological Training Course in General Meteorology with one foreign candidate from Maldives.
- ii) Forecasters Training Course in General Meteorology
- iii) Intermediate Training Course in General Meteorology

In addition to these courses, the refresher courses on the thematic topics are also being conducted. Under World Bank aided Hydrology Project Phase II, the following regular courses are running;

- a) Basic Hydromet Observer Course
- b) Hydromet Supervisor's Course

5.4.4 The representative of Pakistan informed the Panel that PMD has been putting maximum efforts for human resource development at PMD. For this purpose, PMD has been seeking higher education and training opportunities abroad for the scientists in the fields of meteorology, seismology and climate sciences for the capacity building PMD since 2006. So far, nineteen (19) officers have completed their higher studies and joined back to PMD after completion of MS/PhD from United Kingdom, Canada, Norway, China and Thailand. In 2011, eleven (11) scientists joined back to PMD after completion of their higher studies in Meteorology from abroad. One scientist has completed his PhD (Meteorology) from Stockholm University, Sweden on scholarship award by Higher Education Commission of Pakistan, while the other ten scientists have done their MS (Meteorology) from Nanjing University of Science and Information Technology (NUIST), China with partial financial support by the China Meteorological Administration (CMA) and NUIST and remaining support by the government of Pakistan. While, three (3) scientists are still going through their PhD studies in Meteorology, two scientists in China and one in Germany. They are expected to join back at PMD in 2012 after completion of their PhD. During 2011, two (2) more scientists have proceeded abroad for their PhD studies in Republic of Korea and China, while five (5) scientists have proceeded abroad for MS in Hydrology. One of these scientists has been awarded scholarship by the WMO for doing 3-years MSc (Hydrology) at Russian Institute, at St. Petersburg, Russian Federation and the remaining four scientists have been sponsored by JICA for doing MS in Hydrology and Flood related Disaster Management at

International Centre for Water Hazard and Risk Management (ICHARM), Japan with two scientists under the auspices of JICA and the other two under the auspices of UNESCO with Japanese support under a UNESCO project which aim to improve flood alerts in Pakistan.

5.4.5 The representative of Myanmar informed the Panel that training programs were undertaken on storm surge modeling, RS-GIS, meteorological, hydrological, seismological and environmental fields which organized by IIT, JICA, TICA, MOFCOM and JMA, etc. DMH has sent approximately 22 staff for foreign trainings and about 65 staff and officer for workshops and meetings during 2011. A degree offering program in the field of Meteorology and Hydrology has been carried-out by DMH since 1996 in collaboration with Dagon and Yangon Universities. Instructors from DMH has been conducted Disaster Management Course for Disaster Managers in collaboration with the Department of Relief and Resettlement. Trainings are held for DMH' staff on Meteorological Grade I, II, III Courses , Hydrological Grade III Course in regular and for Navy and Air Force as their request. DMH is needed Short-term Fellowship / Training such as;- Numerical Weather Prediction, Weather Forecasting for Aviation, Satellite Meteorology, Radar Meteorology, Advanced River Forecasting Technique, RS/GIS Application for Flood Hazard/Plain Mapping; Coastal Zone Monitoring & Watershed / Water Resources Management, Crop Weather Modelling, Maintenance and Instrumentation for Meteorological and Electronic Equipments, Disaster Management and Mitigation Course, Teaching techniques in international training centre and Long-term Fellowship as;- M.Sc / Ph.D (Meteorology), Diploma / M.Tech /Ph.D (Hydrology) and Diploma (Agro-met).

5.4.6 RSMC New Delhi reported that the Annual Cyclone Forecasters Training was successfully conducted during 20 February to 02 March 2012 as presented in **Appendix X**. Also, the representative of IIT reported that the storm surge training and technology transfer was conducted for the experts of Myanmar and Thailand during 12-23 December 2011. Details are given in **Appendix XI**.

5.4.7 The Panel expressed its deep gratitude to RSMC New Delhi and IIT Delhi for their great effort for building capacity in tropical cyclone and storm surge forecasting. It requested the RSMC and IIT to continue to host the training for the coming years.

Activities of WMO

5.4.8 The Panel noted the training events and workshops which were organized in 2011 for the benefit of its Members. Since its last session, the Panel had benefited from WMO's education and training activities through the provision of fellowships, attachments, relevant training courses, workshops, seminars, and the provision of advice and assistance to Members.

5.4.9 The Panel noted the forthcoming training events planned for 2012, and the Members were encouraged to make maximum benefit of the training seminars, workshops and courses to be organized or co-sponsored by WMO.

5.4.10 The Panel also noted the available training resources produced by the Cooperative Program for Operational Meteorology, Education and Training (COMET). The Members were encouraged to make maximum benefit of the available training resources in English and Spanish languages, especially the online Tropical Textbook – a comprehensive guide to understanding tropical weather.

5.4.11 The Panel noted that WMO fellowships for long-term and short-term training continued to be granted to the Member countries of the Panel under the various WMO programmes. More information on WMO Fellowship programme is available on the ETRP Website.

5.4.12 The Panel also noted that the WMO Regional Training Centres (RTCs) and national training institutions offer training courses time-to-time and they are made available on ERTTP Website.

5.4.13 The training activities offered by the Members are extremely valuable. To assist WMO better support the education and training needs of ESCAP members it was recommended that ESCAP develop and refine their training needs over the intersessional period. ESCAP were encouraged to consider reviewing and adapting the competency approach being used by Tropical Cyclone centres outside of ESCAP (for example the Bureau of Meteorology in Australia) and then identifying regional and national training requirements based around the competencies. The Panel were encouraged to develop a prioritized list of training needs and opportunities and advise WMO for reporting, planning and implementation purposes.

5.5 Research component

Activities of the Members

5.5.1 The representative of India informed the Panel that Forecast Demonstration Project (FDP) on landfalling tropical cyclones over the Bay of Bengal has been taken up. It will help us in minimizing the error in prediction of tropical cyclone track and intensity forecasts. Quadrant wind forecast has been introduced for scientific community during this year. Research is on to improve the product. The major objective the CTCZ programme of the Indian Climate Research Programme is to understand the mechanisms leading to space-time variation of the CTCZ and the embedded monsoon disturbances during the summer monsoon. A multi-year programme with multiscale approach aiming at study of the major interacting scales viz. planetary, regional, synoptic and mesoscale has been taken up since 2009 with adequate observations on all important time-scales from diurnal to intraseasonal and interannual, is required. Forecasting Demonstration Project(FDP) on – fog was carried out for first time at IGI airport, New Delhi to demonstrate the capability of various fog Models available in India for fog prediction on real time basis during 2011 like previous years of 2009-10. A software supplied by JMA have been implemented in IMD to customise display of products from ECMWF, NCEP, UKMO, MSC and ALL plots of 1. Ensemble 2. Deterministic 3. Strike Probability 4. Station Forecasts up to 36 hours based on 00, 06, 12 and 18 UTC forecasts based on the available of data. The present site needs some fine tuning and user friendly. The same will be completed in the next 2-3 months to make it fully operational by the IMD experts. A National monsoon mission has been set up by Govt of India. It is multi-institutional programme. The objective of this programme is to improve medium and long range prediction of monsoon. National mission will help in developing dynamic model with better skill for monsoon prediction than the existing models/ techniques. The grid point analysis and forecast of the genesis parameter up to seven days has been generated on real time (available at <http://www.imd.gov.in/section/nhac/dynamic/Analysis.htm>). Higher value of the GPP over a region indicates higher potential of genesis over the region. Region with GPP value equal or greater than 30 is found to be high potential zone for cyclogenesis. The analysis of the parameter and its effectiveness during cyclonic disturbances in 2011 affirm its usefulness as a predictive signal (4-5 days in advance) for cyclogenesis over the North Indian Ocean. A study has been undertaken to predict the rapid intensification based on a dynamical and statistical model. A review of the characteristics of the best track parameters over the north Indian Ocean has been published in the natural hazards. It has brought out the salient features of best tracks, problems and limitations and future scope for reanalysis. A study on the comparison of the satellite estimated track and intensity with the best track and intensity published by RSMC, New Delhi. A study of comparison of best track and intensity prepared by RSMC, New Delhi and JTWC for the disturbances over the north Indian Ocean. They have highlighted the reasons for differences in location, intensity. The cause of missing storms by both the agencies is also presented.

5.5.2 The Panel was informed that PMD is committed in promoting research activities in the field of meteorology and related disciplines for improving meteorological services for the benefit of the people. As part of its efforts, PMD started publication of its biennial research journal namely “Pakistan Journal of Meteorology” in 2004. During 2011, PMD published two issues (No. 14 & 15) of “Pakistan Journal of Meteorology”. These issues contain 15 research papers which were mainly contributed by the scientists of PMD as well as some foreign researchers. Scientists of PMD also contributed (both as lead authors and co authors) in around ten (10) research papers which have been published in various international journals like Climate Dynamics, Science International, Atmospheric and Climate Sciences, Atmospheric Ocean and/or presented at international scientific conferences and have been published in the proceedings of the these conferences/ seminars. A number of research work / small projects related to forecasting techniques, climate change, climate modeling, downscaling for seasonal and monthly prediction, verification of High resolution Regional Model (HRM), were also carried out by the scientists of PMD and they presented their research work at various conferences/ symposia / workshops at national and international levels during 2011.

5.5.3 The representative of Maldives informed the Panel that Maldives is hosting a Collaborative Climate Research in its Addu City – A scientific Project in the Indian Ocean to better understand Global Climate & Weather Systems – Endorsed by World Climate Research Programme. The Madden-Julian Oscillation (MJO) is a 30 to 90 day tropical weather cycle that alternates between large, strong rain storms and relatively quiet periods, moving from the Indian Ocean eastward to the Pacific Ocean. The MJO not only plays an important role in local weather in the tropics, affecting regional monsoon rains, but also impacts weather and climate in other parts of the world. Improved understanding of this important event will help short- and long-term weather forecasting and climate predictions across the globe. Dynamics of the Madden-Julian Oscillation (DYNAMO) study is being conducted from October – March, which is the most frequent time for the onset of the MJO. DYNAMO will provide researchers with vital observations of the MJO, a poorly understood phenomenon, particularly during the initiation phase. The results will help researchers to more accurately forecast the weather and climate of the equatorial Indian Ocean and around the world. Large-scale weather events, such as the MJO, create pulses that have direct effects on regional weather patterns around the world. During the field campaign land, ocean and atmosphere based observations will simultaneously be taken by using various radars, balloon launches, research vessels and research airplanes.

5.5.4 The representative of Myanmar informed the Panel that Department of Meteorology and Hydrology reorganized “Research and Development Team (R and D Team)” with the purpose for building capacity of younger generation and enhancing research activities of DMH. A number of Research work and small projects related to tropical storms, Climate trend, Climate Change, drought events and other meteorological and hydrological hazards are carried out by scientists of DMH and they presented their research work at various conferences/ symposia / workshops at national and international levels during 2011. Research studies on SW Monsoon and NE Monsoon have been carried out with the emphasis on changing of onset/withdrawal phase, duration, intensity, monsoon rain, storm frequency and shiftment of their seasonal tracks, dry spell and wet spell, drought, extreme events etc; Research works on many aspects of agro-meteorology (evapotranspiration, water balance etc.), hydrology and their practical applications to respective sectors of the nation, are carried out in co-operation with responsible personnel from other agencies concerned. Climate Change activities like National Adaptation Programme on Action (NAPA) have been undertaken in DMH. Need and Requirements for Research and Development are listed as follows;

- The technical/ financial/ expertise support will be necessary from various international/ regional organizations to enhance research activities. Especially, the research programmes in DMH should also aim to maintain and develop international links that ensure collaboration with international research programmes and contribution to rapidly emerging new global technologies.

- The observational instruments must be replaced by automatic or computerized facilities to control quality of data and to provide quality information to regional/global climatic centre.
- The technology enhancement must be promoted by the usage of numerical models and data analysis.
- Workshop/Forum must be performed frequently to raise awareness and response strategies and to deliver opportunities to researchers

Activities of WMO

5.5.5 The Panel was informed of the activities of the WMO World Weather Research Programme (WWRP) in 2011 and its plan for the future. It noted with pleasure that the International Workshop on Rapid Change of Tropical Cyclone Intensity and Movement was successfully held in Xiamen, China from 18 to 20 October 2011. The workshop was attended by 53 tropical cyclone researchers and forecasters. The workshop highlighted recent advances in the theory and practice of forecasting rapid changes in tropical cyclone intensity and track.

5.5.6 The 3-day training session on Tropical Cyclone Ensemble Forecast was conducted from 14 to 16 December 2011 at the WMO Regional Training Centre in Nanjing, China. It was held in conjunction with the 2-week International Training Course on Tropical Cyclones organized by CMA (5-16 December 2011). The training session was co-sponsored by CMA, Typhoon Committee, WWRP (including THORPEX) and TCP and was targeted mainly at forecasters of the Typhoon Committee Member countries. It focused on the use of up-to-date ensemble forecast of tropical cyclones such as on maximum wind speeds, rainfall, and landfall timing and location.

5.5.7 The Panel noted that WWRP and TCP are jointly organizing the Second International Conference on Indian Ocean Tropical Cyclones and Climate Change (New Delhi, India, 14-17 February 2012). Major objectives of the Conference are to i) review and discuss current status of the operational tropical cyclone forecasting and warning system, ii) progress on the understanding of tropical cyclone genesis, iii) climate change and tropical cyclone activity, tropical cyclone risk and iv) vulnerability assessment and tropical cyclone disaster preparedness, management and reduction.

5.5.8 To be held in succession by WWRP in India is International Conference on "Opportunities and Challenges in Monsoon Prediction in a Changing Climate" (OCHAMP-2012) to be held from 21 to 25 February 2012 in Pune. The Conference will be dedicated to Monsoon prediction in a changing climate. Its aim is to give impetus to basic research and development and also to spread the salient features of the research pursuits in force throughout the world. It would bring together a panel of highly-accomplished and leading experts in the field of monsoon prediction coming from different research and operational meteorological environments.

5.5.9 WWRP and TCP also plan to organize the International Workshop on Unusual Tropical Cyclone Behaviour tentatively in Guangzhou, China in November 2012. The workshop will focus on unusual behavior of tropical cyclones, especially on motion, evolution, intensity, precipitation patterns and structure. A better understanding of such tropical cyclone behavior will lead to more accurate forecast and better guidance for disaster risk managers and thus contribute to mitigation of impacts of storms.

5.6 Publications

Panel News

5.6.1 As per schedule, two (2) issues of PTC newsletter "Panel News" (No.31 and 32) were published during 2011 for distribution among the PTC Members, WMO, ESCAP and

other concerned. The electronic versions of these issues have also been made available on the PTC website on the web link: <http://www.ptc-wmoescap.org/newsLetters.htm>. The publication of next issue of PTC newsletter has been scheduled in April 2012. The Panel therefore, requested the Members to kindly provide their contributions in the form news material related to development activities, science news, training workshops, research reports etc. in the respective countries to PTC Secretariat through their Panel News Correspondents for timely publication of the next issue. The Panel urged the Members to consider provision of news material for PTC newsletters in more pictographic format and having policy information and development activities in order to effectively target the policy makers and planners while making the PTC newsletters more informative and attractive. The Panel also requested the Members to please send updated information about their News Correspondents especially if there is any change.

5.6.2 While presenting his preliminary report as Chair of the Adhoc Group (established during PTC-38 last year) on collection of available knowledge and research papers on the impact of climate change on tropical cyclone activities in the Panel region, Dr Chaudhry informed the Panel that in response to PTC Secretariat request, only 4 out of 8 Panel Members sent their feedback on the issue to PTC Secretariat. The countries include Myanmar, Pakistan, Sri Lanka and Thailand. Most of the material sent by the Members relate to the frequency (intensity) and trend in the frequency (intensity) of tropical cyclones affecting the respective countries and/or the PTC region. In some of the studies, combined trend of tropical cyclones and the monsoon depressions are also discussed.

5.6.3 Though the feedback and studies as sent by the Members on the issue are interesting and useful, they do not solely cover the issue of the impact of climate change on tropical cyclone activities in the PTC region. In view of the importance of the issue and considering growing concern about this issue in the region, PTC Members are requested to again search for the knowledge and research papers on the impact of climate change on tropical cyclone activities available in their respective countries and updated feedback and research papers/reports on the issue may again be sent to the PTC secretariat during 2012 so that a comprehensive assessment on the impact of climate change on tropical cyclone activities in the PTC region may be carried out. Keeping in view of the importance of the Second International Conference on Indian Ocean Tropical Cyclones and Climate Change (New Delhi, India, 14-17 February 2012) in this regards, he especially requested RSMC, New Delhi for sending the outcomes of the Conference to the PTC Secretariat.

5.6.4 He further suggested that on the basis of the collected material Panel may like to explore the possibility of making a detailed research report on the issue by a Team of experts or Group to be appointed by the Panel and based on this detailed report a quality research paper on the issue can also be submitted for publication in some international journal. Endorsing Dr Chaudhry's proposal, the Panel urged the Members to participate in this activity affectively and send their feedback on the issue to PTC Secretariat at the earliest possible but not later than 30th September 2012.

6. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN

6.1 Mr. B. K. Bandayopadhyay, rapporteur of Tropical Cyclone Operational Plan (TCOP), presented a comprehensive review made to produce the 2011 version of the Operational Plan. He suggested that along with the naming of cyclones, its meaning should also be given by the respective countries. Further, he made a few comments to make the Plan more effective. The Panel appreciated Mr. Bandayopadhyay for his devotion to the Operational Plan during last year, noting in particular the heavy workload of the update process. It requested Mr. Bandayopadhyay to continue to serve as the rapporteur for 2012. The 2011 Edition of TCOP is available on the WMO TCP website. For the early issuance of the 2012 Edition of TCOP as well as alleviation of the workload, the Panel urged the

Members to communicate their amendments, if any, to Mr. Bandayopadhyay as early as possible and not later than 31 March 2012.

6.2 To secure the close communication between operational forecasters of the RSMC New Delhi and the Member countries, the Panel requested the rapporteur to pay special attention to reestablishment of the list of focal points of the forecast centers (ANNEX V-A-1) with the support of the PTC Secretariat.

7. PTC Secretariat

7.1 The Panel expressed its gratitude to the Government of Pakistan for hosting the PTC Secretariat and appreciated the services being rendered by Dr Qamar uz Zaman Chaudhry, Permanent Representative of Pakistan with WMO in his capacity as Secretary of PTC and Mr. Ata Hussain, Deputy Director (Coordination and International Cooperation) PMD as the Meteorologist of PTC Secretariat.

7.2 Secretary of PTC offered his thanks to the Panel on the confidence that Panel imposed on him and Pakistan with regards to the hosting of the PTC Secretariat.

7.3 The Panel was briefed by Mr. Hussain on the activities of PTC Secretariat during the intersessional period. The Panel expressed its satisfaction with the work of the PTC Secretariat. The summary of the activities of PTC Secretariat is given in **Appendix XII**.

7.4 The Panel was informed that the new website of PTC (www.ptc.wmoescap.org) was launched in 2011. For making the website more informative and useful, the Panel urged the Members for send their views and comments to PTC Secretariat.

7.5 The PTC Secretariat provided the Panel with a detailed breakdown of its expenses incurred during the Intersessional period (see **Appendix XIII**). Keeping in view some savings, PTC Secretariat requested the Panel for provision of US\$ 4,000 for its expenses during the year 2012-2013.

8. SUPPORT FOR THE PANEL'S PROGRAMME

8.1 The Panel was informed that the WMO Technical Cooperation Programme (TCO) activities are being implemented with funding from the WMO Voluntary Cooperation Programme (VCP), Trust Fund (TF) arrangements and a modest Regular Budget contribution, mainly for fellowship and training purposes to ensure successful implementation of WMO programmes, as well as the WMO Programme for the Least Developed Countries (LDCs). Technical cooperation activities are also being implemented through bilateral and multilateral arrangements and through funding provided by financial institutions such as the World Bank and regional development banks and other partners.

8.2 The Panel noted that in 2011, Maldives made a cash contribution to the Voluntary Cooperation Fund (VCP(F)). A new VCP project request was submitted by Sri Lanka for the provision of upper-air consumables (radiosondes and balloons) for the CINDY/DYNAMO field experience and this request was supported by Japan and TOTEX (Japan). A TDCF Migration Expert Mission to Bangladesh was completed in 2011. An expert mission to Myanmar on the satellite data utilization was carried out in December 2011. An expert mission on feasibility investigations for the future projects of BMD took place in January 2012. Two VCP projects are under implementation in Pakistan for the restoration of Automatic Weather Stations (AWSs) and meteorological observation stations damaged by the severe flooding in July-August 2010.

8.3 The Panel was informed that within the Trust Fund project "Installation of a Doppler radar system in Sri Lanka", two factory training courses (September/October 2010), Factory Acceptance Tests (September/October 2010 and January 2011), a Coordination Meeting (October 2010) were conducted at the premises of the supplier of the radar. The installation of the radar and relevant training are scheduled for the first half of 2012.

8.4 It is recalled that the basic objective of the Technical Cooperation among Developing Countries (TCDC) (or South-South Cooperation) was to promote and strengthen collective self-reliance among developing countries through the exchange of expertise, pooling of resources, sharing of technical capabilities and development of complimentary capacities. Expert missions, familiarization visits, study tours and training were also implemented under the TCDC. The Member countries are invited to utilize such a scheme to promote the technical cooperation activities. In this regard, the Panel recognized the usefulness of the training courses organized by PMD for the Panel members and requested WMO to explore the possibility to find financial resources to support to conduct similar training courses in Pakistan.

8.5 The Panel was informed that China organized the 40th China Study Tour and the Regional Training Seminar on WMO Information System (WIS) in April 2011. Maldives, Myanmar, Pakistan, Sri Lanka and Thailand of the Panel participated in the event, which witnessed the donation of communication and information systems (CMACast and MICAPS) to all the participating countries aimed at enhancing the capabilities of NMHSs in the implementation of WIS in Asia.

8.6 The Panel noted that the WMO "Emergency Assistance Fund" (officially entitled "WMO Disaster Assistance Fund for Meteorological and Hydrological Services"), established in 1991, is an existing WMO emergency assistance mechanism to assist Members affected by disasters in the rehabilitation and restoration of observing network, data collection and processing facilities and in international data exchange, in cases where disasters have destroyed or severely disabled the meteorological and/or hydrological infrastructure. In recent years (2005-2011), Bangladesh, Myanmar, Pakistan and Sri Lanka were assisted by this scheme. Affected Members who need emergency assistance are advised to utilize this scheme, and all Members are requested to consider possible support to the affected NMHSs.

8.7 The Panel also noted in Bangladesh, some meteorological equipment was damaged by floods during the severe Cyclone Sidr in November 2007. Three SSB transceivers and two sets of Automatic Weather Stations (AWSs) were provided with the support of France, UK, VCP(F) and the WMO Emergency Assistance Fund.

8.8 The Panel was informed that following Cyclone Nargis in May 2008, a WMO emergency appeal was made for assistance to re-establish essential meteorological infrastructure and services in Myanmar. China and Japan offered to provide in-kind and cash contributions to the WMO Emergency Assistance Fund. Hydrometeorological instruments including an AWS, an electric generator, PCs for storm surge modeling as well as short-term training and a long-term fellowship, were provided in 2008-2010. More reliable Internet connectivity is to be provided to the Department of Meteorology and Hydrology (DMH), Myanmar, with the Emergency Assistance Fund and the VCP(F). India offered to provide an INSAT Digital MDD system to DMH in 2010.

8.9 The Panel was informed that following the exceptional severe floods in Pakistan in July-August 2010, a WMO fact-finding and needs-assessment mission was carried out from 4 to 8 November 2010 in collaboration with ESCAP and in coordination with UNESCO. The mission assessed the current capability of the Pakistan Meteorological Department (PMD), specifically, with regard to technical details of Pakistan floods in July-August 2010; damage to the hydrometeorological infrastructure; capability of PMD flood monitoring and warning services; responses by stakeholders; and community-level dissemination and public awareness. The mission assisted PMD in the development of a proposal for the

enhancement of its meteorological and hydrological services to implement effective flood early warning systems. Based on the findings and recommendations of the mission, a WMO appeal has been made for assistance to restore essential hydrometeorological infrastructure (AWSs, conventional synoptic meteorological stations, etc.) in Pakistan. Potential donor Members are invited to consider possible in-kind and/or cash contributions to the WMO Emergency Assistance Fund to meet the immediate and medium-term requirements of PMD.

8.10 The Panel was pleased to note that a WMOR/IMES joint regional project for “Reducing risks of tsunami, storm surges, large waves and other natural hazards in low elevation coastal zones” was submitted in August 2010 to the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Tsunami Regional Trust Fund for its sixth round of funding. This project was approved for funding by UN ESCAP in January 2011 and a Letter of Agreement was concluded between UNESCAP and RIMES in May 2011 for the implementation of the project. WMO and RIMES concluded necessary arrangements. This project is to be implemented in six (6) Panel member countries, i.e., Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand for the two year period from May 2011 to April 2013 aiming at reducing tsunami, storm surges, large waves and other natural hazard risks in low elevation coastal zones by strengthening institutional systems for end-to-end warning, and building institutional capacities for the application of warning information products in decision-making.

8.11 The Panel noted that a project meeting was held at the AIT Conference Center from 28 to 30 September 2011 with the participation of the representatives of six (6) participating countries, ESCAP, WMO and RIMES to discuss and finalize country work plans. In addition, six (6) other countries, i.e., Cambodia, China, Lao PDR, Pakistan, Philippines and Viet Nam were also invited to identify approaches for replicating the project.

8.12 The Panel was informed that WMO will mainly implement the component on “Capacity building for the generation of location-specific warning information products” as well as other component related to Public Weather Services, with the close collaboration with the National Meteorological and Hydrological Services of the participating countries and RIMES. In this regard, the Panel noted that the Technical-Planning Workshop on Severe Weather Forecasting Demonstration Project (SWFDP) for the Bay of Bengal (South Asia) was held in New Delhi, India, from 23 to 27 January 2012. Participants included representatives (forecasters) of Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand, representatives from global products centres (JMA, NOAA/NCEP and IMD/NCMRWF), and the WMO Secretariat within this project.

Panel on Tropical Cyclones Trust Fund (PTCTF)

8.13 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 Trust Fund is being used not only for the provision of institutional support but also as funding support to the representatives of Panel Members attending training events and conferences.

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

8.15 A detailed financial report on the Trust Fund as of 31 December 2011 was submitted by WMO to the Panel (see **Appendix XIV**).

8.16 The Panel endorsed the use of the Trust Fund for 2012 for the following specific purpose:

- 1 Support for the attachment training at RSMC New Delhi for per diem of the participants (US\$ 6,000)

- 2 Support to PTC Secretariat for its operating expenses including those for printing Panel News and running PTC-website. (US\$ 4,000)
- 3 Support for participation of PTC in the 10th Session of ICG/IOTWS (US\$3,000)
- 4 Support for participation of PTC in the ESCAP Commission (US\$3,000)
- 5 Support for organizing a PTC Workshop in Oman (US\$15,000)

Any other emergency expenditure that can be justified for the use of the PTCTF requires the concurrence of both the Secretary of PTC and the Chairman of the Panel on Tropical Cyclones.

9. SCIENTIFIC LECTURES

9.1 The Panel devoted a session for presentation of scientific lectures. Some of the lectures were presented in the Technical Conference which was held prior to the opening ceremony. The list of all the presentations inclusive of those in the Technical Conference is as follows:

- Global Framework for Climate Services
- Dr Geoff Love (WMO)
- Storm Surge Inundation in Rekhine and Deltaic coast of Myanmar under climate change scenarios
- Prof. S. K. Dube (IIT)
- Air Traffic Management applications of Tropical Cyclone Information
- Mr. Peter Dunda (ICAO)
- Forecast Demonstration Project (FDP) on Landfalling Cyclones over the Bay of Bengal :An Overview'
- Mr. B. K. Bandyopadhyay (IMD)
- Tropical Cyclone Forecasting Experience after NARGIS in Myanmar
- Mr. Chit Kyaw (Myanmar)
- Bitter experience to Better resilience: Lessons learnt from Cyclone Nargis for disaster risk reduction intervention in Myanmar
- Ms. Lat Lat Aye (UNDP)
- Response to 2011 Disasters
- Mr. Chum Hre (Myanmar)
- WMO's Support activities for Forecasting and Warning Services in Myanmar
- Mr Kuniyuki Shida (WMO)
- Challenging to Innovative Water-related Disaster Risk Management'
- Dr Badri Shrestha (ICHARM)
- Improvement of cyclone and storm-surge forecasting and warning in the Department of Meteorology and Hydrology, Myanmar
- Mr. Kunio Akatsu (JICA)
- Lessons learned from Great East Japan Earthquake, Tsunami
- Mr. Hideomi Oi (JICA)
- Disaster Impacts and Early Warning
- Ms Edle Tenden & Ms Mari Sawai

(ESCAP)

- Update on the status of the IOTWS and the Regional Tsunami Service Providers
 - Mr Tony Elliott (UNESCO/IOC)
- Sensitivity of Physical Parameterization schemes in Simulating the Cyclone Nargis and other major Cyclones over the Bay of Bengal.
 - Dr Potty Jayaraman (RIMES)
- Introduction of Typhoon Nowcasting System in CMA
 - Mr Xu Yinglong (China)
- Coupling atmospheric, crop and econometric models for climate risk reduction in PTC member Countries
 - Mr Sanjay Srivastava (ESCAP)

9.2 The Panel expressed its deep appreciation to the above lecturers for their informative and excellent presentations. PPT files of the presentations will be available on the PTC Website.

10. DATE AND PLACE OF THE FOURTIETH SESSION

10.1 The representative of Sri Lanka proposed to host the next session of PTC in Sri Lanka subject to approval by the government of Sri Lanka. The dates of the 40th session in 2013 would be determined based on the consultation between Sri Lanka, WMO, ESCAP, Chairman of the Panel and Secretary of PTC.

11. ADOPTION OF THE REPORT

11.1 The report of the thirty-ninth session was adopted at 1145 hours on Friday, 9th March 2012.

12. CLOSURE OF THE SESSION

12.1 The Panel expressed its sincere appreciation to the Government of Myanmar, the host country, for providing the excellent facilities, the venue, other arrangements and its warm hospitality. The Panel also expressed its deep appreciation to Dr Hrin Nei Thiam, Chairperson of the Panel, Mr Sunil H Kariyawasam, Vice-chairperson of the Panel as well as Mr Ali Shareef, Chairperson of the Drafting Committee, for their successful conduct of the session. The Panel also wished to express its gratitude to the Local Organizing Committee led by Dr Hrin Nei Thiam for their hard work in organizing the session, assistance provided to the participants and producing a session report.

12.2 The thirty-ninth session of the Panel was concluded at 1250 hours on Friday, 9th March 2012.

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APPENDIX I

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AGENDA

1. ORGANIZATION OF THE SESSION
 - 1.1 Opening of the session
 - 1.2 Election of the Chairman and Vice-chairman
 - 1.3 Adoption of the agenda
 - 1.4 Working arrangements
2. FOLLOW-UP ACTION ON PTC-38
3. REVIEW OF THE 2011 CYCLONE SEASON
 - 3.1 Report of RSMC New Delhi
 - 3.2 Reports of Members on the impact of tropical cyclones
4. COORDINATION WITH OTHER ACTIVITIES OF THE WMO TROPICAL CYCLONE PROGRAMME
5. REVIEW OF THE COORDINATED TECHNICAL PLAN AND CONSIDERATION OF THE WORK PROGRAMME FOR THE NEXT FIVE YEARS
 - 5.1 Meteorological Component
 - 5.2 Hydrological Component
 - 5.3 Disaster Prevention and Preparedness Component
 - 5.4 Training Component
 - 5.5 Research Component
 - 5.6 Publications
 - (a) *Panel News*
 - (b) *Annual Review*
6. REVIEW OF THE TROPICAL CYCLONE OPERATIONAL PLAN
7. PTC SECRETARIAT
8. SUPPORT FOR THE PANEL'S PROGRAMME
9. SCIENTIFIC LECTURES
10. DATE AND PLACE OF THE FORTIETH SESSION
11. ADOPTION OF THE REPORT
12. CLOSURE OF THE SESSION

Action Sheet on the 38th session of the Panel

Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
4.1	Establishment of Storm Surge Watch Scheme (SSWS)	Development of SSWS in the Panel region	WMO(TCP), RSMC New Delhi		Operational. IIT training continues
4.4	Update of the Global Guide to Tropical Cyclone Forecasting	The updated version of the Global Guide to be published, and linked to the Tropical Cyclone Forecaster website.	WMO (TCP)	ASAP	On-going
4.4	Development of the Tropical Cyclone Forecaster Website	The Tropical Cyclone Forecaster Website to be developed in the WMO Website.	WMO (TCP)	ASAP	To be hosted by Hong Kong, China
4.6	JCOMM/CHy Coastal Inundation Forecast Demonstration Project	WMO obtains agreement from the responsible national agencies in Bangladesh.	WMO (JCOMM)		
4.10	Tropical Cyclones Ensemble Forecast Project	To examine the feasibility of conducting the project in the Panel region.	WMO (TCP, WWRP)		On-going
5.0.3	Assessment of the impact of climate change on tropical cyclone activities in the Panel region	To organize an Ad-hoc Group and collect available knowledge and research papers on this issue from the Members.	PTC Secretariat		On-going
5.0.4	Finalization of the 2011 AOP for each of the components	To propose and send workable activities to the PTC Secretariat.	PTC Secretariat	End of March 2011	Not done
5.0.7	AOP for DPP activities	Report to WG-DPP on activities on a national level, and conduct WG-DPP activities on a regional level	WG-DPP		

APPENDIX III

Para. No.	Subject	Action Required	Responsible	Deadline	Remarks
5.0.8	WG-DPP focal points	To establish a complete list of the WG-DPP focal points.	PTC Secretariat	During 2011	Completed
5.0.9	Support to WG-DPP	To explore potential sources of funding to support the WG-DPP activities	ESCAP		
5.0.10	Support to WG-DPP	To develop the work space for the WG-DPP in the Panel website	PTC Secretariat		Completed
5.0.11	Capacity building in hydrology	To explore opportunities for PTC Member countries to benefit from ICHARM's regular capacity building programmes including application of IFAS in Member countries	ICHARM		Continued
5.1.11	Availability of TEMP data	Due registration for reporting of TEMP data	WMO		On going
5.1.13	Availability of AMDAR data	To collaborate with the airlines for promoting the regional AMDAR programmes	Members		
5.4.10	Training of meteorologists	To continue and strengthen that Members' endeavors to offer their national training facilities to other Members	PTC Secretariat, WMO, Members		
7.4	New website of PTC	To launch new website of PTC. Members to send views and comments to PTC Secretariat on the website.	PTC Secretariat, Members		Completed
8.8	ESCAP Tsunami Regional Trust Fund	Utilize the resource mechanisms to support the Panel's Programme.	ESCAP, Members		
8.9	Cooperation with WMO RA II WGs	WG-DPP to link with RA II WG on DRR and Service Delivery.	WG-DPP, WMO, PTC-Secretariat		

CYCLONIC ACTIVITIES OVER NORTH INDIAN OCEAN DURING 2011

The north Indian and adjoining land surface Ocean witnessed the formation of ten cyclonic disturbances during the year 2011. Out of ten disturbances five cyclonic disturbances formed over the Bay of Bengal, four over the Arabian Sea and one over land. Out of the five cyclonic disturbances over the Bay of Bengal, one intensified upto the stage of very severe cyclonic storm, THANE, two upto the stage of deep depression and rest two upto the stage of depression. Out of four cyclonic disturbances formed over the Arabian Sea, one intensified upto the stage of cyclonic storm, KEILA, two upto the stage of deep depression and one upto the stage of depression. Tracks of the cyclonic disturbances formed over the north Indian Ocean during the period are shown in Fig 2.1.

The salient features of the cyclonic disturbances during 2011 were as follows:

- The number of total cyclonic disturbances (depression and above) during the year was below normal, as only 10 cyclonic disturbances formed during 2011 against the normal of 13. Similarly only two cyclones formed during the year against the normal of about 5.
 - Both the cyclones made landfall .While cyclone 'Keila' made landfall over Oman, the very severe cyclonic storm, 'Thane' made landfall over Tamilnadu and Puducherry coast.
 - The track of the cyclone "KEILA" was rare in nature as it made a loop after the landfall over Oman near Salalah.
 - There were four cyclonic disturbances formed over the north Indian Ocean and adjoining land surface during monsoon season (June-Sep.) against the normal of 7 cyclonic disturbances. There were no cyclonic disturbances over the north Indian ocean during the main monsoon month of July and August 2011. However, one land depression formed during July.
- (a) Cyclonic Storm, "KEILA" over the Arabian Sea (29 October-04 November, 2011.)**

A cyclonic storm 'Keila' developed over the southeast Arabian Sea with genesis of depression on 29th October, 2011. It moved initially west-northwestwards and then northwestwards and crossed Oman coast close to north of Salalah. It then emerged into Arabian Sea and dissipated gradually. It caused death of 14 people in Oman. The system was mainly monitored by the satellite. However, crucial ship and buoy observations also helped in estimation of location and intensity.

The special features of the storm are as follows:

- It was one of the rarest track in recent years, as the cyclone made a loop after its landfall over Oman and emerged into the Arabian Sea.
- The track of the system could not be predicted accurately by most of the NWP models
- The cyclone slowed down during landfall period and gradually dissipated after emerging into Arabian Sea.

(b) Very Severe Cyclonic Storm, 'THANE' over the Bay of Bengal (25-31 December 2012)

A very severe cyclonic storm, 'THANE' developed from a low pressure area which lay over the southeast Bay of Bengal on 25th December, 2011. The low pressure area concentrated into a depression over the same region on 25th December, 2011. It moved initially in a north-northwesterly direction, and then west-northwestwards. Later it moved west-southwestwards and crossed Tamil Nadu and Puducherry coast close to Cuddalore between 0100 and 0200 UTC of 30th December, 2011 with a wind speed of 12-140 kmph.

The system was initially monitored by satellite. As the system came closer to coast it was monitored by DWR and coastal observations in addition to satellite observation. The crucial observations from ship and buoys also helped in estimation of location and intensity. The salient features of cyclone THANE are given below:

- The system intensified despite the relatively colder sea (SST 26-27⁰C, low ocean thermal energy (<50 KJ/cm²) over southwest Bay of Bengal near north Tamil Nadu coast.
- The continuous intensification could not be picked up by most of the NWP models which suggested slight weakening before landfall.
- The track was also rare, as there is no analogue in the month of December based on the recorded historical data of IMD during 1891-2010.

The statistics of the cyconic disturbances formed during 2011 are given in Table 2.1. The characteristic features of these disturbances are given in Table 2.2. The intraseasonal variation in frequency of genesis, intensification and life period of the disturbances is shown in Table 2.3.

Table 2.1: Cyclonic disturbances formed over north Indian Ocean and adjoining land areas during 2011

1.	Depression over the Bay of Bengal 02-03 February 2011
2.	Depression over the Arabian Sea (11-12 June 2011)
3.	Deep depression over the Bay of Bengal (16-23 June, 2011)
4.	Land depression over Jharkhand (22-23 July 2011)
5.	Depression over Bay of Bengal (22-23 Sept 2011)
6.	Deep depression over the Bay of Bengal (19-20 October, 2011)
7.	Cyclonic storm 'KEILA' over the Arabian Sea (29 October- 04 November, 2011)
8.	Deep Depression over the Arabian sea (06- 10 November 2011)
9.	Deep depression over the Arabian Sea (26 November to 1 st December, 2011)
10	Very Severe Cyclonic Storm Over the Bay of Bengal 25-31 December 2012

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Table 2.2: Some Characteristic features of cyclonic disturbances formed over north Indian Ocean and adjoining region during 2011

Cyclonic Storm / Depression	Date, Time & Place of genesis (Lat. ^o N/ Long. ^o E)	Date, Time (UTC) place (Lat./Long.) of landfall	Estimated lowest central pressure, Time & Date (UTC) & lat ^o N / long ^o E	Estimated Maximum wind speed (kt), Date & Time	Max. T.No. Attained
Depression over the Bay of Bengal (02-03 February 2011)	02 Feb. 0900 UTC near 6.5/82.5	Weakened into a well marked low pressure area over southwest Bay of Bengal at 0000 UTC of 03 Feb. 2011.	1002 hPa at 0900 UTC of 02 Feb. near 6.5/82.5	25 kt at 0900 UTC of 02 Feb. near 6.5/82.5	T-1.5
Depression over the Arabian Sea (11-12 June 2011)	11 June, 1200 UTC near 20.0/71.5	Crossed Saurashtra (Gujarat) coast near 20.8/71.2 around 2200 UTC of 11 June, 2011.	996hPa at 1200 UTC of 11 June near 20.0/71.5	25 kt at 1200 UTC of 11 June near 20.0/71.5	T- 1.5
Deep depression over the Bay of Bengal (16-23 June, 2011)	16 June, 0300 UTC near 21.5/89.0	Crossed West Bengal- Bangladesh coast near lat. 21.8^oN/89.0^oE between 1100 & 1200 UTC of 16 June, 2011	978 hPa at 0600 UTC of 17 June near 22.8/88.5	35 kt at 0600 UTC of 17 June near 22.8/88.5	T- 2.0
Land depression over Jharkhand (22-23 July 2011)	22 July 0300 UTC near 23.5/84.5	Weakened into a well marked low pressure area over north Madhya Pradesh and neighbourhood.	990 hPa at 0300 UTC of 22 July, near 23.5/84.5	20 kt at 0300 UTC of 22 July, near 23.5/84.5	T- 1.5

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Depression over Bay of Bengal (22-23 Sept 2011)	22 September at 0300UTC near 21.5/87.5	Crossed north Orissa coast close to Balasore between 1700 & 1800 UTC of 22 September.	995 hPa at 1200 UTC of 22 September near 21.7/87.2	25 kt at 1200 UTC of 22 September near 21.7/87.2	T- 1.5
Deep depression over the Bay of Bengal (19-20 October, 2011)	19 October, 0000 UTC near 20.0/90.5	Crossed Bangladesh coast near lat 21.2°N /92.1°E around 1300 UTC of 19 October.	1000 hPa at 0300 UTC of 19 October near 20.2/91.0	30 kt at 0600 UTC of 19 October near 20.5/91.5.	T- 2.0
Cyclonic storm 'KEILA' over the Arabian Sea (29 October- 04 November, 2011)	29 October, 0600 UTC near 13.0/62.0	Crossed Oman coast close to north of Salalah near 17.1/54.3 between 1600-1700 UTC of 02 November.	996 hPa at 0600 UTC of 02 November near 16.0/54.5	35 kt at 0300 UTC of 02 November near 16.0/55.0 .	T-2.5
Deep Depression over the Arabian Sea (06- 10 November, 2011)	06 November 0600 UTC near 10.5/65.5	Weakened into a well marked low pressure area over westcentral Arabian Sea off Oman coast at 1200 UTC of 10 November, 2011	1000 hPa at 0300 UTC 08 November near 13.5/60.0	30 kt at 0300 UTC 08 November near 13.5/60.0	T-2.0
Deep depression over the Arabian Sea (26 November to 1 st December, 2011)	26 November at 0300 UTC near 7.5/76.5	Weakened into a well marked low pressure area over westcentral Arabian Sea near 19.5/62.5	998 hPa at 0000 UTC of 28 November near 13.5/70.0	30 kt at 0000 UTC 28 November near 13.5/70.0	T-2.0
Very Severe Cyclonic Storm over the Bay of Bengal (25-31 December, 2011)	25 December at 1200 UTC near 8.5/88.5	Crossed north Tamil Nadu & Puducherry coast between Cuddalore and Puducherry within 0100 and 0200 UTC of 30 December, 2011 near	969 hPa at 2100 UTC of 29 December near 11.8/80.3	75 kts at 0600 UTC of 29 December near 12.0/82.0	T-4.5

Table 2.3: Statistical data relating to cyclonic disturbances over the north Indian Ocean during 2011

A) Monthly frequencies of cyclonic disturbances ($CI \geq 1.5$)

S.N	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.	D		↔				↔			↔			
2.	DD						↔				↔	↔	
3.	CS										↔		
4.	SCS												
5.	VSCS												↔
6.	SuCS												
7	Land Depression							↔					

↔ Peak intensity of the system

B) Life time of cyclonic disturbances during 2011 at different stages of intensity

APPENDIX IV

S. No.	Type	Life Time in (Days)
1.	D	17.50
2.	DD	9.25
3.	CS	1.37
4.	SCS	0.25
5.	VSCS	1.25
6.	SuCS	00
Total Life Time in (Days)		29.62

C) Frequency distribution of cyclonic disturbances with different intensities based on satellite assessment

CI No.	≥1.5	≥2.0	≥2.5	≥3.0	≥3.5	≥4.0	≥4.5	≥5.0
No. of disturbances	10	5	2	1	1	1	1	0

D) Basin-wise distribution of cyclonic disturbances

Basin	Number of cyclonic disturbances
Bay of Bengal	5
Arabian Sea	4
Land depression	1

Table 2.4. Cyclonic disturbances formed over the north Indian Ocean and land areas of India during 1997-2010

Year	Basin	D	DD	CS	SCS	VSCS	SuCS	Total
1997	BOB	1	4	1	1	1	0	8
	ARB	1	0	0	0	0	0	1
	Land	0	0	0	0	0	0	0
	Total							9
1998	BOB	0	3	0	1	2	0	6
	ARB	0	1	1	1	1	0	4
	Land	1	0	0	0	0	0	1
	Total							11
1999	BOB	2	2	1	0	1	1	7
	ARB	0	0	0	0	1	0	1
	Land	1	0	0	0	0	0	1
	Total							9
2000	BOB	1	1	2	--	2	0	6
	ARB	0	0	0	0	0	0	0
	Land	1	0	0	0	0	0	1
	Total							7
2001	BOB	2	0	1	0	0	0	3
	ARB	0	0	2	0	1	0	3
	Land	0	0	0	0	0	0	0
	Total							6
2002	BOB	1	1	2	1	0	0	5
	ARB	0	0	0	0	0	0	1
	Land	0	0	0	0	0	0	0
	Total							6
2003	BOB	2	2	0	1	1	0	6
	ARB	0	0	0	1	0	0	1

APPENDIX IV

	Land	0	0	0	0	0	0	0
	Total							7
2004	BOB	2	0	0	0	1	0	3
	ARB	0	2	0	3	0	0	5
	LAND	2	0	0	0	0	0	2
	Total							10
2005	BOB	2	3	4	0	0	0	9
	ARB	2	0	0	0	0	0	2
	LAND	1	0	0	0	0	0	1
	Total							12
2006	BOB	5	2	1	0	1	0	9
	ARB	0	1	0	1	0	0	2
	LAND	1	0	0	0	0	0	1
	Total							12
2007	BOB	3	4	1	0	1	0	9
	ARB	0	1	1	0	0	1	3
	Land	0	0	0	0	0	0	0
	Total							12
2008	BOB	1	2	3	0	1	0	7
	ARB	1	1	0	0	0	0	2
	LAND	1	0	0	0	0	0	1
	Total							10
2009	BOB	0	2	2	1	0	0	5
	ARB	2	0	1	0	0	0	3
	LAND	0	0	0	0	0	0	0
	Total							8
2010	BOB	2	1	0	2	1	0	6
	ARB	0	0-	1	0	1	0	2
	LAND	0	0	0	0	0	0	0
	Total							8
2011	BOB	2	2	0	0	1	0	5
	ARB	1	2	1		0	0	4
	LAND	1	0	0	0	0	0	1
	Total							10

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

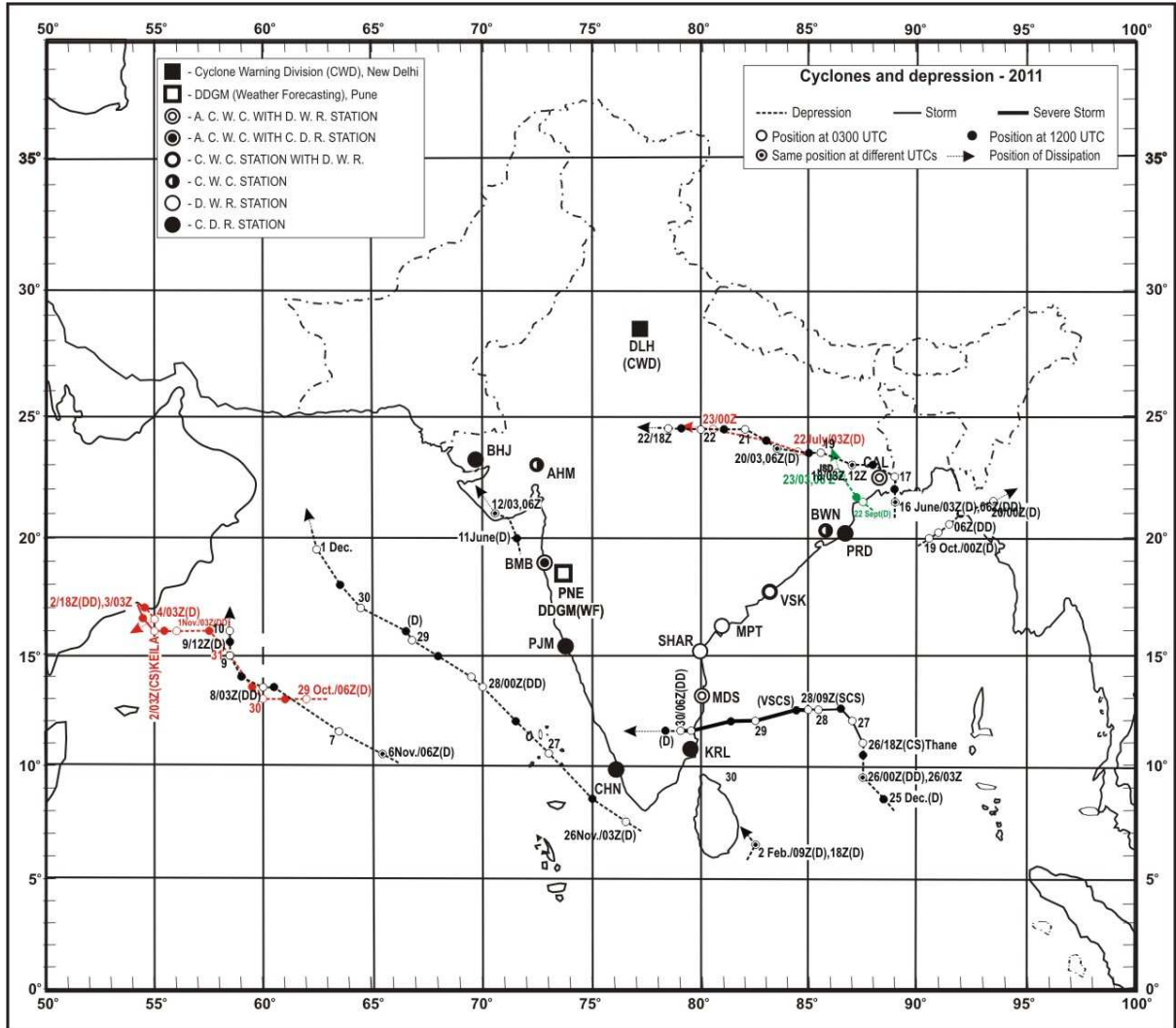


Fig. 2.1 Tracks of the cyclonic disturbances formed over the north Indian Ocean during the year, 2011

COUNTRY REPORT OF THE MEMBERS

(Submitted by Members of the Panel on Tropical Cyclones)

Reports are posted on the WMO/TCP Website along with the main report.

Annual Operating Plan for 2012 - WGM

Meteorology	1	To strengthen the cooperative relationship with the Airlines for development of the regional AMDAR programme (Members, WMO).
	2	Members to implement plans to deploy WIS functionality.
	3	To conduct case studies on the events where gaps were found in TC intensity analysis between RSMC and the Members (Oman, RSMC).
	4	To establish and enhance the communication between the operational forecasters in RSMC and the Members (RSMC, PTC-S).
	5	To develop a close link with the Severe Weather Forecasting Demonstration Project (Members, PTC-S, WMO)
	6	To develop a close link with the Coastal Inundation Forecasting Demonstration Project (Members, Bangladesh, PTC-S, WMO)
	7	To promote the use of Cummon Alerting Protocol (CAP) in partnership with WGDPP (WMO, Members).
	8	To implement TC Landfall FDP (RSMC, Members)
	9	To establish the Tropical Cyclone Ensemble Forecast Website at RSMC New Delhi and to improve the website through feedback from the Members (RSMC).
	10	To upgrade the computing facility of RSMC New Delhi (tentative)
	11	To provide the graphical storm-surge forecast charts from RSMC New Delhi through collaboration between RSMC and IIT (led by B.K. and Prof Dube).

Annual Operating Plan for 2012 - WGH

Hydrology	1	Make a close link with the Working Group of Hydrology of the RAI. It was recommended that the Chair of the PTC WG on Hydrology report its activities to them.
	2	Conduct an ICHARM/ESCAP Workshop on Space Application to Reduce Flood Hazard Risks and Hands-on training on IFAS and Flood Inundation Model and organize a meeting of the Working Group on Hydrology.
	3	Review the progress on the annual operational plan and draft the next year's plan at the occasion of the meeting of the Working Group on Hydrology. Share information on how to maintain critical communication between the remote hydrological observation and the Headquarter during the disasters when communication and transportation system is being disturbed.
	4	Request the PTC Secretariat to seek information of the Typhoon Committee Working Group on Hydrology, including the outcomes of the Urban Flood Risk Management project and lessons learnt from the Tropical Storm Washi in Mindanao, Philippines. The PTC Secretariat is asked to develop the web space for the WGH and upload the above information accordingly.
	5	Actively participate in the multi-hazard early warning system SOP activities in case the Typhoon Committee/PTC joint project proposal is funded by ESCAP.

Annual Operating Plan for 2012 - WGDPP

DPP	1	Conduct an ICHARM/ESCAP Workshop on Space Application to Reduce Flood Hazard Risks and Hands-on training on IFAS and Flood Inundation Model and organize a meeting of the Working Group on Disaster Prevention and Preparedness jointly with the Working Group on Hydrology.
	2	Conduct mock drills for evacuation of the affected people. Publication and distribution of brochures, leaflets and other educational materials.
	3	To share information related to early warning dissemination and mechanism, as well as response to early warning during past disasters. This will be reported in August in Bangkok during workshop combined with mock drills
	4	Sharing of lessons learnt during Thai floods 2011, Cyclone Nargis from Myanmar and Tropical Cyclone Washi 2011 among Members
	5	To promote regional information system to support development of policies and strategies on DPP at the regional level as well as at the national level By establishing a national disaster-specific mortality data and economic losses by Members
	6	Review the progress on the annual operational plan and set priorities for the coming year at the workshop of the WGDPP. Establish effective communication channels and network between DPP focal points of PTC

List of participants in the training workshops in Oman

(to be inserted later)

Annual Cyclone Forecasters Training

Conducted by RSMC, New Delhi during 20 February to 02 March 2012

RSMC, New Delhi is conducting two weeks training for cyclone forecasters from WMO/ESCAP panel countries since 2005. Every year 2 to 3 cyclone forecasters from WMO/ESCAP panel countries participate in this programme. This year RSMC, New Delhi conducted annual cyclone forecasters training during 20th February to 2nd March 2012 for the cyclone forecasters, one each from Maldives, Sri Lanka and Thailand. The training is also attended by the forecasters from Area Cyclone Warning Centres (ACWCs) and Cyclone Warning Centres (CWCs) and National Weather Forecasting Centre (NWFC) of IMD. This training consists of both theoretical and practical aspects of cyclone monitoring, prediction and warning/advisory services over the North Indian Ocean. The important components of the trainings are mentioned below.

- (i) Observational aspects (including surface, upper air, satellite and radar)
- (ii) Monitoring aspects (Determination of location, intensity and structure)
- (iii) NWP modeling aspects
- (iv) Forecasting aspects (forecast of track, intensity and quadrant wind upto 72 hrs)
- (v) Warning aspects (prediction of heavy rainfall, gale wind and storm surge)
- (vi) Warning products and bulletins (text and graphics) generation, presentation and dissemination
- (vii) Check lists and road maps for monitoring and prediction and warning services
- (viii) Forecast verification, documentation
- (ix) Organisational aspects
- (x) Feedback from the participants
- (xi) Visit to different centres of IMD, NCMRWF and National Institute of Disaster Management (NIDM).

All the above aspects are taught with theoretical lectures and hands-on exercises. Out of about 70 hours of total training classes excluding lunch and tea break, 36 hours were dedicated to theoretical classes, 24 hours to practical/hands on exercises and 10 hours towards visit to different centres. The feedback was also collected from the participants for improving the training programme in future. The certificates were distributed to the participants on successful completion of the training. The brief inaugural and valedictory functions were also conducted in the beginning and end of the training respectively.

Brief report on the attachment of storm surge experts from DMH Myanmar and TMD Thailand to IIT Delhi during December 2011 within the framework and overall guidance and supervision of the Tropical Cyclone Programme (TCP) of the World Meteorological Organization (WMO)

The National Meteorological and National Hydrological Services of many countries have achieved some success in provision of storm surge warnings and for implementing improved models through co-operative and co-ordinated sharing of responsibilities within the framework and overall guidance and supervision of the Tropical Cyclone Programme (TCP) of the World Meteorological Organization (WMO). The TCP of WMO supports technology transfer from the Indian Institute of Technology-Delhi to run and make operational storm surge models for Bangladesh, Myanmar, Pakistan, Sri Lanka, and Oman. Every year since 2001, WMO has been sending two persons from North Indian Ocean countries to IIT Delhi for two weeks training and transfer of technology.

The TCP of WMO supported storm surge training and technology transfer to NMHS of Myanmar and Thailand from the Indian Institute of Technology-Delhi during **12-23 December 2011**.

Ms. Thet Htar Su Hlaing from DMH, Myanmar and Mr. Sorot Sawatdiraksa of TMD were attached to IIT Delhi for two weeks period in **December 2011** who were provided extensive hands on training in use location specific improved very high resolution storm surge model together with latest visualization softwares. During the period of their training Ms. Hlaing and Mr. Sawatdiraksa performed more than 30 numerical experiments using IIT model to understand the basic features of the storm surge phenomena through numerical simulations and to test the feasibility and sensitivity of IIT storm surge model in operational use. In particular numerical experiments were performed to test the effect of bathymetry (especially over continental shelf), the relationships between angle of cyclone landfall and the location (distance from landfall) and amplitude of surges, sensitivity of model to input parameters required for computing wind stress and impact of duration of cyclone. In order to validate the models, several simulation experiments were performed by using the data of severe cyclonic storms hitting the coasts of Myanmar/Thailand.

At the end of the training the latest version of the storm surge prediction model together with visualization software were transferred to the trainees for implementation in their respective weather services.

**Activities of PTC Secretariat
during the Intersessional Period 2011-2012**

- Summary of the PTC activities was submitted to the 67th Session of UNESCAP (19-25 May 2011, Bangkok, Thailand). The summary report was based on the draft report of 38th Session of PTC (New Delhi, 21-25 February, 2011)
- PTC Secretariat launched website of PTC (www.ptc-wmoescap.org). The PTC Members were encouraged to send their comments and suggestions for further improving the website.
- As decided by the PTC during its 38th Session (New Delhi, 21-25 February, 2011), the PTC Secretariat requested the Panel Member countries (through their respective PRs with WMO) for nomination of DDP experts/Focal Points for WG-DPP after coordinating with their respective National Disaster Management Offices responsible for disaster management / risk reduction / prevention / preparedness / mitigation in their countries. On receipt of the nominations from Members, PTC Secretariat prepared the list of DDP experts/ Focal Points for WG-DPP and also sent the same to NMHSs of all Member countries, the Chair and Vice Chair of WG-DPP, Focal Points for WG-DPP, UNESCAP and WMO. It was also uploaded on the PTC website at the following web link dedicated for the WG-DPP: www.ptc-wmoescap.org/working_group
- PTC Secretariat collected the contributions from Member countries for PTC Newsletters and published two issues of PTC Newsletter “**Panel News**” (Issue No.31 and 32) and distributed these issues among the PTC Member countries, UNESCAP, WMO and the other concerned international organizations. The electronic versions of the PTC Newsletters were also uploaded on the PTC website at the following web link: www.ptc-wmoescap.org/newsletters
- Additionally, the PTC Newsletters have also been sent to P Rs of Saudi Arabia and Iran. PTC Secretariat in its formal letter has also renewed its earlier request to Saudi Arabia and Iran to consider joining PTC as members because both countries have shown their willingness to join PTC earlier and their representatives also attended the 36th Session of PTC (Muscat, Oman, 2-6 March 2009) as observers.
- About the intension of Bhutan to become a Member of PTC (as informed by the WMO), the PTC Secretariat extended the invitation to Bhutan (through PR of Bhutan with WMO) to join PTC and it was requested to complete formal procedure in this regard as soon as possible. Copies of the Coordinated Technical Plan 2009-2011 and PTC Flyer were also sent to P R of Bhutan with WMO.
- As decided by PTC at its 38th Session (New Delhi, India from 21 - 25 February, 2011), WMO made arrangements with the Indian Institute of Technology (IIT), New Delhi for the attachment of two storm surge experts - one each from Myanmar and Thailand. PTC Secretariat extended invitation for this training to both countries

through their P Rs with WMO. The training for Storm Surge Experts was hosted by IIT, New Delhi during the period from 12th – 23rd December, 2011. Financial support in lieu of travel and per diem was provided to the participants from the PTC Trust Fund through WMO.

- As requested by PTC at its 38th Session (New Delhi, India from 21 - 25 February, 2011), WMO made arrangements with the RSMC, New Delhi for the attachment of three Tropical Cyclone Forecasters - one each from Sri Lanka, Maldives and Thailand. PTC Secretariat extended invitation for this training to these countries through their P Rs with WMO. The training for the Tropical Cyclone Forecasters has been hosted by RSMC, New Delhi, India during the period from 20 February – 2 March, 2012. Financial support in lieu of travel and per diem was provided to the participants from the PTC Trust Fund through WMO.
- PTC at its 38th Session (New Delhi, 21-25 February, 2011) (as per Para 5.0.3 of the Final Report of PTC-38) urged for the organization of an Ad-hoc Group (under the Chairmanship of Dr. Chaudhy, Secretary of PTC) to collect the available knowledge and research papers on the impact of climate change on tropical cyclone activities in the Panel region from the Members during the next inter-sessional period. Subsequently, PTC Secretariat requested the PTC Members (through their P Rs with WMO) for sending the available information on the issue. Information from four out of eight Members was received to PTC Secretariat and a preliminary report on the issue was prepared for the PTC. However, owing to the importance of the issue, further information and research papers on the impact of climate change on tropical cyclone activities in the PTC region from Members need to be collected for some comprehensive analysis and assessment.
- Referring to WMO circular regarding holding of Second International Conference on Indian Ocean Tropical Cyclones and Climate Change (New Delhi, India from 14 to 17 February 2012), PTC Secretariat urged PTC Members for participation in the conference and invited research papers relevant to the thematic areas of the conference. The conference was organized by India Meteorological Department (IMD) and the WMO/WWRP Expert Team on Climate Change Impacts on Tropical Cyclones in collaboration with WMO's Tropical Cyclone Programme (TCP) and World Climate Research Programme (WCRP). The National Meteorological and Hydrological Services (NMHSs), scientists and representatives from countries located within the Indian Ocean cyclone basins were especially encouraged for participation and for sending their research contributions to the conference.
- Information regarding financial support by WMO from the PTC Trust Fund and detailed breakup of expenses incurred by PTC Secretariat during the intersessional period (2011-2012) is attached as **APPENDIX XIII**.

Statement of PTC Secretariat Accounts
(2011 - 2012)

Sr. No.	Opening Balance and Receipts	Amount in Pak. Rs.
1.	Balance after 38 th Session of PTC	212,670/-
2.	Amount received during the inter-sessional period (US\$ 4000/= equivalent to Pak Rs.354,400/- @US\$ 1= 88.60)	354,400/-
	Total	567,070/=
<i>Expenditures</i>		
1.	Printing of 31 th and 32 th Issues of the Panel News	90,000/-
2.	PTC Website Hosting Fee etc.	12,000/-
3.	Services for PTC website design and construction support.	10,000/-
4.	Services for compilation work of Panel News Issues	20,000/-
5.	Stationery, envelops, postages and other miscellaneous items etc.	9,000/-
6.	Honorarium to Meteorologist-PTC Secretariat @ US\$100/= per month (equivalent to Pak Rupees)	106,320/-
7.	Purchase of Colour Toner for Colour Laser Jet printer	Nil
	Total	247,320/=
	Net Balance in hand	319,750/=



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PANEL ON TROPICAL CYCLONE TRUST FUND

Interim Statement of Income and Expenditure
For the period 1 January to 31 December 2011
Amounts in US dollars

1.	Balance of fund at 1 January 2011		101,263
2.	Income:		
2.1	Contributions		
2.1.1	Bangladesh	1,970	
2.1.2	Maldives	2,000	
2.1.3	Pakistan	2,000	
2.1.4	Thailand	2,000	
2.1.5	Sri Lanka	2,000	
2.1.6	Total contributions		9,970
2.2	Interest		470
2.3	Unrealized gain on differences in exchange	a/	247
2.4	Total revenue		10,687
3.	Total available funds during reporting period		111,950
4.	Expenditure:		
4.1	Direct project costs:		
4.1.1	Travel-Other representatives to attend other mtgs	10,831	
4.1.2	Total direct project costs		10,831
4.2	Indirect project costs		
4.2.1	Support costs (13%)	1,408	
4.2.2	Bank charges	22	
4.2.3	Total indirect project costs		1,430
4.3	Total project expenditure		12,261
5.	Balance of fund at 31 December 2011		99,689

a/ WMO's official currency is the Swiss Franc (CHF). Accordingly, all transactions completed in currencies other than the CHF are converted to Swiss Francs at the United Nations Operational Rate of Exchange (UNORE) in force on the day of the transaction. Project account balances (in CHF) are translated to applicable donor reporting currencies based on UNOREs in force at the end of the month to facilitate reporting to donors. As the Swiss Franc has been appreciating against the US Dollar (the reporting currency for the Panel on Tropical Cyclone Trust Fund), foreign exchange gains resulted from conversion of net asset balances from CHF to USD as of the reporting date. This explains the foreign exchange gain. It should be noted that the gain was not realized as of the reporting date, i.e. they were not actual, as they resulted from (a) revaluing the Fund's assets and liabilities as of that date, and (b) converting the resulting CHF balances to USD.

Certified correct:

Luckson Ngwira
Chief, Finance Division
20 February 2012