CONSULTANCY MISSION REPORT FOR Myanmar

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As part of the project on Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System, three expert consultants, one on meteorology, one on hydrology, and one on Disaster Risk Reduction, conducted a highly successful two-day mission to Myanmar on 4 –5 August 2014. The purpose of the mission was to collection and compile data, information, examples, and diagrams on standard operating procedures (SOPs) best practices, gaps and needs, and recommendations for inclusion in the Manual on Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazard Early Warning System which will meet the needs of the 13 beneficiary countries involved in the Project.

Top: Consultants with DG, DOM&H Bottom: with participants

Acknowledgments

These workshops were conducted as Activity 1.3 of Project Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System. The lead organizations for the project are the ESCAP/WMO Typhoon Committee and the WMO/ESCAP Panel on Tropical Cyclones in association with a wide cross section of partner agencies. Very kind appreciation is expressed to ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness in Indian Ocean and Southeast Asian Countries who have funded this project; to the (Different organizations involved in the two day meetings) for their vital assistance, support, and active participation in these successfully workshop; and Typhoon Committee Secretariat who provided excellent and very time consuming support, coordination, detailed arrangements, and insights for the missions.

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1. Introduction

The Economic and Social Commission of Asia and Pacific (ESCAP) approved a submitted project *Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System*(EWS) and funded it through the ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness in Indian Ocean and South East Asia. ESCAP/World Meteorological Organization (WMO) Typhoon Committee (TC) and the WMO/ESCAP Panel on Tropical Cyclones (PTC) in cooperation with other agencies had recognized a strong need to create synergies in early warning systems among different types of coastal hazards by reviewing existing Standard Operating Procedures (SOPs).

2. Project Overview

The goal of the project is to promote community resilience to coastal multi-hazards through effective SOPs for multi-hazards EWSs. The project is a collaboration with multiple agencies and organizations. It involves thirteen beneficiary countries in TC and PTC regions. The designated target groups include National Meteorological and Hydrological Services, National Tsunami Warning Centres, and National Disaster Management Offices in TC and PTC Members' countries.

Activity 1 is to collect, review, analyze, and synergize existing SOPs in TC and PTC Members' countries and develop a Manual/Handbook of SSOP Procedures. The third item in Activity 1 is to synergize existing SOPs and develop additional SOPs as needed to meet identified gaps and needs and compile a Manual of Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System (EWS), mainly focusing on the hydro-meteorological aspect, to meet the needs of diverse users, like decision makers, early warning issuers, media, researchers, operational, public, including fishermen at community level.

To complete Activity 1.3 and to meet the success indicator, in addition to the three in-country pilot workshops already carried out, consultants visited targeted countries in the Panel of Tropical Cyclone region, Myanmar, Sri Lanka and Maldives and 3 targeted countries in the Typhoon Committee region, Cambodia, Malaysia and Viet Nam. The missions to the PTC region countries were conducted during 4 – 11 Aug 2014 and to the TC region countries during 28 Aug – 5 Sep 2014.

3. Purposes of the Mission Visits

a. To review existing coastal multi-hazards EWS SOPs of hydro-meteorological services, disaster management, media, roles of elected official, and others from national to district to local levels,
b. To identify best practices, gaps and needs, and recommendations for internal and cross-cutting SOPs, and
c. To compile data, information, examples, and diagrams collected on SOPs best practices, gaps and needs, and recommendations for inclusion in the Manual on Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazard Early Warning System which will meet the needs of the 13 beneficiary countries involved in the Project.

4. Missions Dates and Team Members

Dates:

a. *PTC Countries*

Myanmar	4 - 5 August 2014
Sri Lanka	7 - 8 August 2014
Maldives	10 -11 August 2014

b. *TC Countries*

Malaysia	28-29 August 2014
Cambodia	1-2 September 2014
Viet Nam	4- 5 September 2014

Team members:

a. *For the PTC countries' missions:*

- Dr. Y.E.A. Raj (Dr. Yesudhas Eben Aruma Raj), Former Deputy Director General, Regional Meteorological Centre, Chennai, India Meteorological Department
- Mr. Abdul Majid, Former Director of National Flood Forecasting Bureau, Pakistan
- Mr. Ahmed Kamal, Member (Disaster Risk Reduction - DRR), National Disaster Management Authority, Prime Minister's Office, Pakistan

b. *For TC countries' missions:*

- Dr. Tokiyoshi Toya, Former Regional Director for Asia and the South-West Pacific, WMO;
- Mr. Abdul Majid, Former Director of National Flood Forecasting Bureau, Pakistan;
- Mr. Amir Ali Khan, Assistant Professor, National Institute for Disaster Management, New Delhi, India.

5. Workshop Programme Overview

The programme for the two-day workshops for Myanmar jointly developed by members from the concerned countries, the Project Manager, and the TCS is presented in Appendix 1. The actual program as it took place is given below.

Day 1 : 4 Aug 2014, Venue: Conference Hall, Department of Meteorology and Hydrology (DoM&H), Myanmar, Naypyidaw.

Session 1:	0915-0930	-	Meeting of consultants with DG, DoM&H and other senior officials
Session 2:	0930-1015	-	Introduction to SSOP – Consultants and all participants from DoM&H
Session 3:	1030-1230	-	Group 1. Meteorology and Hydrology
&	1330-1500	-	Group 2. DRR
Session 4:	1515-1600	-	Group 1. DRR and Hydrology

Group 2. Meteorology and Media

Day 2 5 Aug 2014

0915-0945 - Consultant's Interaction with DG and other officials of DoM&H, briefing DG on the proceedings of day 1 and discussions

0945-1045 - Meeting with participants from DoM & H, and districts and local representatives, DG chairing the meeting. Presentation by all the 3 consultants

1100-1230 & 1330-1530 - Discussion with district and local representative continued. Receiving feedback from the participants, consolidation of the outcome of the discussions and formulation of the summary

1530-1600 - Closing session .
Appendix 2 presents the list of participants

Brief description of the proceedings during 4-5 August 2014 at DoM&H, Naypyidaw, Myanmar

On 4 Aug 2014 the consultants had a brief and cordial meeting with Dr. (Mrs). Hrin Nei Thiam DG, DoM&H and other senior officers of DoM during 0900-0930 hours. At about 0930 hours the consultants and participants who are from the warning services i.e., DoM&H held a joint meeting. At 1030hours Met and Hydro consultants (Dr. Raj and Mr. Majid) had a meeting with the Met & Hydro participants. Dr. Kamal, DRR consultant held a parallel meet with DRR participants. These meets were all well attended with more than 25 participants. In the afternoon at 1500 hours Met consultant held a meet with the media participants. There were 4 participants hailing from radio station and TV channels but none from the print media. It was difficult to engage them for 2 hours, but the media personnel were appreciative of DoM&H coordination with media in disseminating weather bulletins and warning messages. As the media personnel were all very young they had not covered the 2004 Tsunami or the 2008 Nargis cyclonic storm, which were two major disastrous events which affected the coastal regions of Myanmar in recent years.

On 5 Aug 2014 the consultants again had a meeting with DG between 0915-0945hours and briefed DG about the previous day's proceedings. Thereafter a plenary session was held in the conference hall in which DG also briefly participated. This meeting was attended by District, local representatives and a few media personnel and also personnel from DoM&H. After brief presentation by all the three consultants there was lively interaction amongst the participants. Representatives from Red Cross briefed about their experience in reaching out to the community during severe weather events, which includes dissemination of severe weather warning messages. Personnel from Department of Health and a few NGO representatives also spoke. The capability of a simple device such as radio in disseminating warning messages and in ensuring last mile connectivity was noted and acknowledged. Transmission of warning messages through mobile phones was being planned by DoM&H. The users wanted quick dissemination of messages,

DoM&H replied that the warning messages were uploaded in the website within one hour of generation.

Representatives from Town administration pointed out some deficiencies of the warning proceedings followed by DoM&H during the 2004 Tsunami and the 2008 Nargis VSCS.

In the afternoon session the previous proceedings were summarised. The consensus by and large was that DoM&H should have robust SOPs for various weather warnings than what are available now. The proceedings were closed at about 1600hours.

6. Mission Summary / Early warning system

6.1 Meteorology

The country of Myanmar which is a littoral country of Bay of Bengal (BoB) is spread over an area of 676,578 sq.km and has a coast line of 2,228 km length (Appendix 3 depicts the geographical location of Myanmar). Weather services to Myanmar are delivered by DoM&H which functions under the Ministry of Transport, Government of Myanmar. Nearly 700 personal work in DoM&H. The major weather hazards which affect the coastal region of Myanmar could be listed as under:

a. Cyclonic Storms (CS) which form and move over BoB. Heavy rainfall, Strong winds and storm surge are the disastrous features associated with a CS land fall
b. Strong winds along the coast – both on shore and off shore
c. Rough seas, high waves, swells closer to the coast.
d. Heavy rainfall over the coast associated with other weather features such as monsoon.
e. Tsunami (not strictly a weather event, but ocean generated).

During the 50 year period (1964-2013) Myanmar has been crossed by 13 CS and 9 Severe CS (SCS) (maximum wind speed 34 knots and above for CS, 48 knots for SCS, over the sea). In the year 2008, during 27 April - 3 May the SCS 'Nargis' which carried winds of intensity of more than 200 km per hour crossed Myanmar coast on 2 May 2008 near Labatla and caused substantial damage which included loss of nearly 1,30,000 human lives. SCS Giri, 165 km/hr winds, (20-24 Oct 2010) made landfall near Kyaukpyu. The coastal region of Myanmar receives annual normal rainfall of more than 200 cms and so is likely to be prone to heavy rainfall occurrences.

The EWS for coastal multi-hazards existing in Myanmar, maintained by the DoM&H of Myanmar is given below. Appendix 4 presents the flow chart.

No. of Surface Meteorological Observatories	-	120	
No. of Coastal observatories	-	11	
Pilot balloon Observatories	-	1	
Upper air (RS/RW) Observatories	-	1	(Yangon)
No. of Automatic weather station/Raingauages	-	14	
No. of Raingauges	-	120	
No. of Cyclone tracking / Doppler weather radars	-	Nil	

International Meteorological data is received through the Global Telecommunication network which was established in Myanmar in the year of 2007 with WMO help. Satellite images are received from MTSAT and FY satellites. Back up facilities for receiving messages

from International sources are also available and these function all the 24hours of the day. A few National organisations such as National Disaster Administrative Committee play an important role in the dissemination of warning messages. For cyclone warning, Myanmar substantially depends upon the input provided by several international meteorological websites besides the advisories issued by the Regional Specialised Meteorological Centre (RSMC) functioning from India Meteorological Department (IMD), New Delhi.

The DoM is able to obtain Numerical weather prediction outputs from the websites of Met Departments of several counties or organisations such as IMA, KMA, ADPC, RIMES etc. NWP WRF models are run by DoM in PCs or workstations for Myanmar Region and the products are made available through the website. Archival of past data is also being done in a systematic way.

DoM&H depends mainly upon International collaboration for receiving Tsunami warning messages. Infrastructural short comings both in equipment and technique exist for Tsunami EWS. Warning for Heavy rainfall, fisheries warning and rough seas are also issued.

At present Myanmar does not have a fully equipped sensor based system for real time continuous monitoring of coastal weather hazards. Recently automatic water level monitoring system and AWS have been installed. Warnings are issued in Myanmar and English languages. Dissemination is through media, newspapers and through DoM&H (Multi Hazard Early Warning Centre). The official website maintained by DoM&H, Myanmar is found to be basic but adequate. Colour-codings are used while issuing warnings. The Government is the most important organisation for the implementation of early warning system with the DoM playing an active role. Dissemination of warning messages through mobile phone using SMS is being planned. Visual and print media and Radio stations are also used in the dissemination of warnings. Radio, TV, loud speaker, siren, hand-held speaker and similar equipment are used to achieve last mile connectivity while disseminating warning messages. The services of NGOs such as Red Cross Society are utilised to disseminate the warnings to the last destination. Obviously Internet connection is a backup though download speeds are lower than what is obtained in other counties.

The warnings originate from the Multi Hazard Early Warning Centre, DoM&H, Naypyidaw which is the capital of Myanmar since 2005 and operates round the clock. However up to mid-2000's the Central forecasting office at Yangon was delivering cyclone warning services.

Best practices

- Good surface observatory network especially over coastal regions.
- Despite that localised warning systems are not fully developed, making full utilisation of weather warning bulletins and advisories issued by neighbouring countries.
- Making use of products from RSMC, New Delhi and other International Centres to issue cyclone warning bulletins.
- Round the clock operation of warning centre
- Continuous improvement of the EWS by interaction with other agencies, and by conducting public awareness programs
- Issuing of coastal bulletins and fisheries warning as per International practices.
- Efficient dissemination through all the available sources of communication.
- Good rapport with the media and NGOs.

Gaps, needs and Recommendations

- No. of stations from which rainfall data is received could be larger.
- A still widespread AWS/ARG network with provision to receive rainfall on real-time basis. This data should be available to users through web on real-time basis.
- Lack of a fully developed in house early warning systems capabilities as of now, this could get developed in due course.
- No cyclone tracking radar or Doppler weather radar installed on the coast. Despite the fact that procurement and maintenance of such radar will be very expensive, this could be planned over a period of time as it can significantly enhance EWS capability of coastal weather hazards.
- The cyclone tracks and several other data on CS frequencies, movement, speed etc. for more than 125 years for North Indian Ocean are freely available in Chennai centre website (www.rmcchennaieatlas.tn.nic.in) of India Meteorological Department. This could be made use of as Myanmar does not have any cyclone atlas or detailed statistics of movement of CS over BoB.
- Similarly the products available in the website of INCOIS (www.incois.gov.in), Hyderabad, India can be made full use of in forecasting several ocean parameters such as wind/wave/swell height along the Myanmar coast which could facilitate issuing of accurate fisherman warnings.

6.2 HYDROLOGY

6.2.1 Flood Forecasting System

a. Floods are one of the major natural hazards in Myanmar. There are around 18 streams and rivers in the country. 8 are the major rivers out of which three flows down to the coast and cause damage to the coastal belt. These three rivers are Aye Yar Wady, Sitaung and Thamlwin rivers, which have 15, 2 and 1 water level monitoring stations established upon them respectively. Flood damage becomes much more severe when the drainage into the sea is reduced on account of the back water effect under the high tide condition. Flowing along a general North to South direction the three rivers drain into the sea along the South East Coast. Even though no river wise flood frequency analysis has been done yet the general experience indicates that some rivers like Jhanlwin River are flooded once or twice every year. Ayey Wady is the longest and the biggest river, having 15 recording stations upon it and when flooded causes severe damage to the coastal region. The river has gone through four severe floods over the period of 48 years.

b. Flood Forecasting Authority & Flood Forecast Methodology

A hydrology division headed by the Director hydrology exists within the Department of Meteorology & Hydrology (DMH). The Hydrological division is responsible for the issuance of flood forecasts for the country including those for the coastal belt. Real time flood forecasting methodology is mainly based upon the use of empirical relationships worked out on the basis of single & multiple regression analysis using upstream & downstream river gauge data and the basin rainfall etc. As a normal practice the river gauge and rainfall data from all the reporting stations is received at the flood forecasting centre of the hydrological division in Nay-Pyi-Taw. Weather situation in relation to the rainfall potential is studied using all the available meteorological forecasting means. Water level data of all the 30 rain stations (over 8 major rivers) is taken into account in issuing the flood forecast /warning. The Hydrological forecast stations along with the river data is shown in Appendix 16. Flood warning is then issued on the

basis of the data of the observed flood levels in relation to a danger level fixed for each flood level observation station.

c. Types of flood Forecasts issued by DMH

The types of forecasts and the flood forecasting methods are as given in Appendixes 17 & 18 respectively. Daily forecasts are issued once in a day and indicate the current water levels of thirty (30) stations over 8 major rivers. Similarly 10 daily forecasts are issued on 8th, 18thand 28th of every month mostly on the basis of prevailing river flow situations with some element of projected flow estimation based upon the projected weather forecast.

Real time flood forecasts during the flood season are issued in the form of flood warnings and flood bulletins. Flood warnings are issued when at any one of observing stations the flood level rises to danger level which is one meter below the risk level. Such warnings are issued in respect of 30 stations over 8 major rivers. Flood bulletins are issued when the water lever reaches the risk level or exceeds it.

Specimens of flood warning and flood bulletins are given as Appendixes 19 and 20 respectively.

d. Dissemination of flood forecast/ warning

Dissemination of flood forecast and warning is carried out as shown in the Appendix 21. The communication scheme is as given in Appendix 22

6.2.2 Best Practices

a. Myanmar's early warning system adequately provides for all the basic needs of an early warning system for the country, even though there is still room for improvement. Amongst the activities which can be termed as the best practices is the effort of the Myanmar's. DHM to undertake the creation of flood risk maps on the basis of 100 year return period computed by using log Pearson scheme III distribution. Use of the HEC RAS model along with GIS provided the necessary tools for delineating the inundation areas for 100 year flood level. Flood hazard maps for HPA- a city and Homalin city have been completed and are given as Appendixes 23& 24 respectively.
b. Another good practice is the flood monitoring system for the Thanlwin River, which is the most flood prone river in the country and is generally flooded a number of times every year. At the moment there is only one water level observing station located within the Kayin state where three water level observations are taken at 0630; 1230 and 18:30 hours every day. Under the flood situation the observations are increased to hourly observations which practice ensures the continuous monitoring of the flood of this important river.

6.2.3 Gaps and needs

a. Presently the flood early warning system is essentially based upon the observed water level data only and no element of flood forecast is included in the flood warning. On one hand this is good practice in the sense that it is based upon the observed flood and is thus more reliable but on the other hand however this limits the forecast lead-time, which could be increased if the river level rise can be forecast in advance of its occurrence on the basis of the basin rainfall using some rainfall/ runoff transformation model. This shall provide an advance flood alert which shall be of great advantage to Myanmar disaster preparedness agency. This shall be over above and the present practice of issuing flood warnings on basis of the

observed water level data. Enhanced flood early warning is very useful in gearing up the flood mitigation agencies for timely action. Thus there is a need to utilize the potential of enhancement of the early warning time on the basis of actual & forecast rainfall of the upper basin

b. No pre-flood season or post flood season inspection of the river dikes and bunds of at least the flood prone rivers has been provided for under the existing SOP. During the discussion it was however indicated that the flood protection works on the rivers is carried out as and when required by the water resources and integrated river system authority. There is thus need to include in the SOP the laid down schedule for carrying out the pre flood season and post flood season inspection of the flood protection works.
c. Flood bulletins are issued when at any one of the gauge station the water level rises up to the danger level or above. The bulletins and flood warnings do not provide the information regarding the magnitude of the floods in terms of discharge values. There is need to quantify the floods in terms of the discharge so as to provide more detailed information to the users. Pending the installation of an advance flood forecasting system based upon the rainfall-runoff and flood routing models, the relatively simple approach of categorizing the floods into such qualitative categories as the low, medium, high and very high floods by assigning the range of flood (discharge) magnitude to each category could be adopted. This calls for creating the rating tables for all the observational stations on the rivers. Rating tables for most of the stations are said to be already available. This is an important need since flood damage potential is strongly related to the height of the flood peak above the danger level.

6.3 DRR (Disaster Risk deduction)

The Union of Myanmar has drafted the Action Plan on Disaster Risk Reduction, Preparedness, Relief and Rehabilitation. This is for the entire country comprising 74 districts, 15 states and over 300 townships. The objectives of the Action Plan are:

a. To formulate a programs/action plan for Disaster Risk Reduction in consolidated manner;
b. To carry out search and rescue activities in a speedy manner in the aftermath of disasters and organize mock drills for improved disaster response;
c. To undertake reconstruction and rehabilitation activities systematically; and
d. To protect the resources of the nation effectively from disaster

The strategies to achieve the objective include: a) Formation of the National Disaster Preparedness Central Committee; b) Formation of the Management Working Committee and Sub-Committees based on activities; c) Formation of the National Disaster Preparedness Management Working Committees at different levels (State/Division, District, Township and Ward/ Village Tracts), d) To obtain input for the preparation of the Action Plan by Sub-committees, by Ministries, by States/Divisions, Districts/Townships); e) To establish systems and organizations for systematic receiving and distribution of local and foreign aid including food, drugs, etc.; f) To stock materials including vehicles, machineries, food, etc. which will be required during emergency periods; g) To conduct mock drills and make revisions in the action plan based on the findings of the mock drill; h) To study the past disasters of Myanmar and other countries to draw lessons; and i) To collect information on disaster management and establish a database which may be used at various levels.

6.3.1 National Disaster Preparedness Central Committee (NDPCC):

The National Disaster Preparedness Central Committee, constituted in 2005, is a thirty-seven member committee chaired by the Prime Minister. Composition is shown in Appendix 26. The roles and responsibilities include: a) To constitute committees at various levels for the implementation of Disaster Management, lay down Disaster Management Policy, Guidelines and Review progress; b) To formulate Policy and Guidelines for the utilization of national resources for emergency relief measures; c) To provide basic principles for receiving foreign aid; d) To provide relief assistance where it is necessary by managing State budgets and resources; f) To enact/issue Laws, Acts, Decrees, Rules &Regulations for effective disaster management activities.

6.3.2 National Disaster Preparedness Management Working Committee:

The 36-member National Disaster Preparedness Management Working Committee is chaired by the Secretary (I) and composition is shown in Appendix 26. It has been constituted to supervise the implementation of disaster management activities in accordance with NDPCC and also to coordinate the activities of NDPCC. The roles and responsibilities of the National Disaster Preparedness Management Working Committees include : a) Formulate plans for four identified phases namely mitigation and prevention phase, Receiving early warning period, Disaster period and Reconstruction and rehabilitation phase; Implement Guidelines laid down by higher authorities; b) Management of foreign and local aid for Relief, Resettlement and Rehabilitation; c) Educate people on disaster preparedness & organize and implement programs for improvement to motivate people; d) Prepare and submit quarterly report to NDPCC; e) Setup Early Warning System and ensure dissemination of early warning to the grassroots level; f) Assign tasks to Ministries and Organizations depending on the intensity of the disaster; g) Identify Departments, Organizations, Persons for reporting and reporting system; h) Supervise functioning of Sub-committees and facilitate coordination among the Sub- committees; and i) Directly supervise management of Relief and Resettlement during disasters.

Organization structure for disaster management in Myanmar is given in Appendix 27.

6.3.3 Sub-Committees

Ten Sub-committees have been constituted for effective implementation of activities laid down by the National Disaster Preparedness Management Working Committee. The composition and roles & responsibilities of these Sub Committees are given in Appendix 28. The Ten Sub Committees are:

a. Sub Committee on Information & Education (11 members);
b. Sub Committee on Emergency Communication (7 members);
c. Sub Committee on Search & Rescue (12 members);
d. Sub Committee on Information on Losses & Emergency Assistance (17 members);
e. Sub Committee on Assessment of Losses (8 members);
f. Sub Committee on Route Clearance & Transportation (10 members);
g. Sub Committee on Mitigation & Establishment of Emergency Shelters (8 members);
h. Sub Committee on Health (7 members);
i. Sub Committee on Rehabilitation & Reconstruction (13 members); &
j. Sub Committee on Security (8 members).

Under each Ministry, the Management Committee of the Ministry is created for disaster preparedness as per the Action Plan on Disaster Risk Reduction, Preparedness, Relief and

Rehabilitation of NDPCC. The roles and responsibilities of the Disaster Preparedness Management Committee of Ministry are determined by the concerned Ministry. The objective of this committee is to undertake effective risk reduction and preparedness activities and to perform necessary activities during an emergency period continuously.

Best Practices:

- Based on 7 priorities, 65 projects on DRR being implemented under the national government in line with the Action Points of Hyogo Framework of Action (HFA)
- Government has shown its priority to DRR sector by allocating money from the Government budget besides financing by UNDP and UN related NGOs
- 30 ware houses across upper Myanmar to ensure good response in time of disaster
- Drills/Simulation exercises for storm surge, Tsunami, floods
- Comprehensive Health Contingency Plan
- 12 NGOs working on DRR related projects under various MOUs (ADPC, UNOCHA, UNHABITAT, Solidarity International, PACT Myanmar, Oxfam, UNHCR, Action Aid, World Vision, Plan International, Care Myanmar, IRC).

Gaps and Recommendations:

Key gaps found included:

- Too much focus on emergency planning and response and not enough on prevention and risk reduction
- Lack of understanding of the complex vulnerabilities of the population and in sufficient attention to reducing their vulnerabilities
- No specific mention of addressing the needs of women, children, aged persons or persons with disabilities
- Gaps in knowledge and capacity between central and local level disaster management councils
- Unclear communication channels between central and local levels
- Omission of references to the private sector, an important act or able to exacerbate or mitigate disaster
- Disaster risk insurance having no priority
- Risk assessment of entire country is not there. Only macro level assessments made. Record not available
- Contingency planning only at township and village level
- Data collection and sharing not strong, problems in obtaining damage & loss data
- Media interaction/engagement found weak
- Communities' source of information is Radio and TV. So they miss the warning and forecasts as they receive only through these two mediums.

Key recommendations for the government and other relevant stakeholders are:

- The government should be explicit in its aim to reduce risk rather than simply respond to disasters
- The government should engage CSOs in consultation meetings and be clear on their role in the disaster management cycle

- Efforts should be made to build capacity at all levels to undertake participatory vulnerability and capacity analysis in order to inform planning
- Where possible, Rules and Regulations should aim to ensure horizontal co-ordination between disaster management and other sector laws
- The Rules and Regulations should overtly mention how the needs of women, children, persons with disabilities and aged persons are to be met at each stage of the disaster management cycle
- The government should demonstrate strong and responsible governance over the private sector
- DRRWG should lead by example and mainstream inclusive practices.
- Micro level hazard and risk assessment needs to be made especially in the context of cyclones, earthquake, tsunami, floods

7. Mission summary / Standard Operating Procedures

7.1 Meteorology /SOP

The DoM&H, Myanmar is the mandated agency to issue warnings for weather hazards to the general public and various Government agencies. The status of presently available SOPs for the various hazards is now presented.

7.1.1 The Government of Myanmar has issued a very detailed *'Standing Orders'* running into 161 pages (restricted circulation) a copy of which in soft from has been made available to the consultants. This document provides a detailed SOP for the disaster warning and management part to be followed by the various arms of Government. It contains instructions to be followed in the event of several non-weather hazards as well and is very generic. A flow chart depicting SOP for different agencies during severe weather used by DoM&H is presented in Appendix 5. Well drafted and comprehensive SOPs are generally not available. The forecasters obviously learnt the various steps involved in severe weather warning from circulars, standing instructions, portion of manuals etc., and also from work experience.

7.1.2 SOP for cyclone warning and dissemination

Cyclone warning bulletins are issued whenever a CS forms and moves over BoB and the bulletins are disseminated through the various agencies promptly. However there is neither a comprehensive cyclone manual nor is there any detailed SOP for CS tracking, warning and dissemination of warning messages.

The consultants were supplied with the following SOP documents by the DoM&H, Myanmar.

a. A two and half page document entitled SOP of DoM&H, Myanmar. Cyclone warning procedures are covered in one page (Appendix 6)
b. Cyclone forecasting check lists for decision making (Appendix 7 presents the sub titles only and not the full contents). This SOP is technical in nature and focuses on how to forecast the various features of a CS.
c. Besides the above, the standing order published by Government of Myanmar provides SOP for cyclone warning in a somewhat restricted way. Appendix H of the above report defines the various categories of cyclonic storms, lists the storm related details a storm warning bulletin must contain such as current location, forecasted track, forecast on landfall, rainfall,

winds and storm surge. Six stages of storm warning are defined viz. Yellow, Green, Red, Brown and Green. Yellow stage indicates formation of a CS in BOB, orange when the CS moves towards Myanmar coasts, red when the CS is expected to reach landfall within 12 hours, brown when CS makes land fall on the coast and green stage when the storm hazard has passed. Port warning signals have also been defined and these are consistent with the regional practice. It also contains a section on Cyclone shelters.

For various definitions of the different stages of a CS evaluation, DoM follows WMO/TD No.84 TCP-21 which is frequently updated, the latest edition has been published in 2013. Appendix 8 presents the bulletins issued by DoM&H during the occurrence of an impending cyclone and also an alert for Tsunami. Appendix 9 presents the BoB severe weather bulletin flow chart. Appendix 10 presents the various stages of Port warnings when a port is likely to be affected by severe weather in association with cyclone movement. These Port warning procedures are almost a century old and followed by most of the Asian countries including Myanmar. The different colour codings that are used while issuing cyclone warnings are presented in Appendix 11. The list of Very Severe cyclonic Storms (VSCS) that crossed the Myanmar coast is presented in Appendix 12a. The output from IMD's cyclone e-atlas depicting the tracks of 10 SCS that crossed Myanmar coast during the 50 year period 1964-2013 is presented in Appendix 12b. Appendix 13 presents a flow chart on preparation of daily weather bulletins which also by and large covers coastal/sea area bulletins and fisheries warnings. Appendix 14 depicts the various disaster prone areas of Myanmar.

7.1.3. Requirements for a comprehensive cyclone warning SOP

The SOP for cyclone warning as followed by DoM&H Myanmar contains only partial documentation. A robust SOP for cyclone warning must include the following aspects.

a. Stage warning of CSs, Alert, Pre-warning, warning and de-warning. The various categorisation of CS should preferably follow international/ regional practices.
b. The frequency of warning messages should be clearly defined. It could be of 6 hours duration in the alert stage, 3 hours in the later stages and 1 hour when the CS approaches the coast.
c. Each bulletin for a specific CS should be serially numbered. The current bulletin should clearly mention the serial no, date and time of issue, the name of the CS, to whom bulletin is addressed and when the next bulletin would be issued.
d. Technically the bulletin should contain details such as the intensity of the CS, the wind strength, the likely time of land fall, the likely extent of damage that will be caused at the time of land fall to coastal and interior regions and also the extent of storm surge.
e. As coastal observations play a crucial part in tracking a CS when it approaches the coast, the frequency of coastal observations should be increased, normally it could be one observation per hour. This should be included in the SOP.
f. A list of people receiving the warnings with all contact details such as telephone, fax no., mobile no., email addresses should be available.
g. The SOP should also include warnings for fishermen, shipping and also for ports. Detailed Standardised Port Warning procedures which include the type of signals to be hoisted are already available (the Port warning messages using standard terminology are issued by DoM, - as briefed during the various meets, Appendix 10).

h. If the warning messages are to be delivered to a Disaster Management Centre of the Government, which would be responsible for further dissemination to end users same should be clearly stated in the SOP.

i. Once the CS has made land fall, a post landfall survey team of the DoM should immediately proceed to the affected coastal region. The team should take photographs of the damage and also collect data of several features which can provide crucial data on the exact location of land fall and damages caused. The height of storm surge also can be estimated by such a survey. A detailed SOP for the procedures to be followed during post land fall survey should also be included in the cyclone SOP.

j. A detailed report on the CS should be prepared shortly after its landfall and dissipation. Its genesis, track, intensity during its life, place of land fall, lowest pressure of the TC, maximum wind sustained, satellite pictures, actual track, forecast track, forecast error, pictures of damages suffered, storm surge realised are some of the aspects which must be included in the report.

k. The SOP for TC warning should also include warning in respect of specalised areas such as agriculture, horticulture and aviation.

l. In the dissemination of messages Radio, TV and SMS dissemination could play a vital role in ensuring the *'Last Mile Connectivity'*.

m. It is possible that TV, telephone and SMS might fail in the event of failure of land line communication in the affected area. Battery powered radios can easily work if the radio transmitter is located in an interior region not likely to be affected by the TC. The SOP should provide details of standby fail safe communication and dissemination systems.

The above are suggestive but not exhausted aspects which an SOP for cyclone warning must include. The SOP for cyclone warning available with DOM&H and also in the document '*Standing Instructions'* contain a few of the above aspects and misses out a few other procedures.

The World Meteorological Organisation (WMO) s Technical Document, i.e. WMO/TD No.84, Report TCP No.21, 2013, entitled *"Tropical Cyclone Operational Plan for the Bay of Bengal and the Arabian sea"* extensively covers the cyclonic warning procedures, which could be adopted by the panel countries, including Myanmar. The cyclone manual published by IMD and updated in 2003 is also quite detailed. IMD has recently (in 2013) published a very detailed SOP for Cyclone warning which though India specific also includes several procedures which could be followed by any panel country.

7.1.4 SOP for Heavy rainfall

Definition of heavy rainfall is defined by DoM as 3 inches (7.5 cms) realised in one day. For dry areas it is defined as 1.5 inches. Heavy rainfall warning phrased as untimely rainfall warning is issued by DoM. However no authentic documentation on HRF of SOP was furnished.

7.1.5 Coastal bulletins, Fisheries warnings &forecasts for high seas

These bulletins are available in the web site of DoM. DoM, Myanmar also issues forecasts for high seas over BoB for the region east of 92°E and North of 10°N. BoB bulletins are issued for 10°-16°N, E of 92°E and 16-20°N, E of 92°E. Weather, visibility, surface wind and sea conditions are the parameters described (Appendix 15, Bay bulletin dt 21.8.2014). Squally winds warning both for coastal regions and interior, resulting from isolated thunderstorm activity are also issued.

No SOPs are available. No SOP for issuing of specific agro meteorological advisories during severe weather over coastal regions.

7.1.6 SOP for Tsunami warning

Tsunami warning message format is available (Appendix 8). No SOP is available.

7.1.7 Various warning bulletins issued by DoM&H

As per the website of DoM, (www.dmh.gov.mm), DoM issues the following forecasts for severe weather affecting the coastal regions of Myanmar.

a. Sea Forecast
b. Cyclone & storm surge warning
c. Strong wind warning
d. Port warning
e. Untimely (Heavy) rainfall warning
f. Tsunami warning

Thus weather warnings are issued for almost all the events that affect coastal regions. However detailed SOPs are lacking.

7.1.8 Interaction with the Media

The media plays a crucial role in taking the severe weather warning messages to the public, end users and several other stake holders. Though only a small cross section of the media was available for direct interaction during our visit, it was evident that DoM has kept good rapport with the different spectra of media such as visual, print media etc., (though print media was not represented). Aside from the media, the task of dissemination is shared by several other agencies including NGOs such as Red Cross.

7.1.9 Best practices, Gaps & Needs, Recommendations

The SOPs available currently at the disposal of DOM&H for coastal severe weather events are not fully documented. SOPs for cyclone warning though including stage warning procedures and list of contents for the warning messages, are a bit sketchy and not that detailed or systematic. SOPs for other coastal weather hazards such as heavy rainfall, strong winds, high waves also over the sea are either not available or also not systematically documented.

The best practices are that despite the absence of written SOPs which are complete in all respects, the DoM&H has been able to deliver warning services to the users and stake holders well. There have been well prepared flow charts depicting a few procedures to be followed in the event of TC, how forecasts are prepared and so on. However there is a gap between what is needed and what is available at present.

Thus fresh and detailed SOPs need to be prepared for almost all the severe weather events that affect Myanmar coastal belt. Some of the useful material available in the existing SOPs (even if they are not complete or fully documented) could be incorporated in the new SOPs.

The SSOP manual which will be drafted should address all these issues, viz. it should include comprehensive SOPs for cyclone warning and dissemination of warning messages, coastal sea bulletins, Fisheries warnings, Heavy rainfall warnings and Tsunami warnings. It also should be versatile enough to be open to customisation depending upon the practices and

procedures followed by a specific country. For Myanmar the SSOP manual will be very useful as the presently available SOPs are not that detailed or complete.

7.2. SOP/ Hydrology

Gaps and need

a. The existing flood early warning SOP is the one given in the document titled "Standing Operating Procedure (SOP)" of the department of Meteorology and Hydrology Myanmar (Appendix 22). Under para 2 of this document SOP for Hydrology is given.

   The SOP gives set of steps to be followed in carrying out the following functions.

   - Data receiving, checking and correction
   - Issuing of flood warnings and bulletins
   - Dissemination list of the recipients of the flood warnings/ bulletins

Even though the SOP does provide for the basic need for the flood early warning system, yet however it does not give the breakdown of the roles and responsibilities at all levels. There is thus need to elaborate the SOP and to make it more precise and specific.

b. No SOP is provided for the measures to be taken prior to the onset of the flood season. Pre flood preparedness calls for ensuring that the river protection works such as river dikes/ bunds and other hydraulic structures are well maintained to withstand the impact of possible flood. Similarly the SOP needs to lay down the measures to be taken for the river system restoration after the flood.

c. No flood plain-zoning concept is being practiced. There is a need that in order to stop the people from creating settlements within high risk zones along the rivers, a zoning policy be enforced, wherein a number of zones relating to the risk level be delineated by carrying out the detailed river survey. Socio economic activity within the flood risk zone be regulated on the basis of a legal frame work formulated for this purpose. This measure shall go a long way in reducing the damage to life and property in the event of a major flood.

Conclusions & Recommendations (Hydro)

Myanmar has the basic infrastructure tuned for the development of an improved EWS including the development of the required SOPs. However uptill now the system can be said to be in the development stage with large gaps and needs. DMH Myanmar is making effective use of the international products to overcome the technical limitations in the EWS. DMH effectively keeps the users informed of the impending hazards on account of good warning dissemination system in use. Desire of the Myanmar DMH to develop more advanced systems was expressed by the DG and her staff during the discussion. The country is presently faced with funding constraints and is thus unable to modernize the meteorological observational network including the procurement of a weather radar for rainfall monitoring. Presently there is no such part of the EWS in Myanmar which could be synergized.

Myanmar appears to be one of such country which has the potential to benefit from the SSOP project by making use of the synergized SOPs to be provided thru the forthcoming SSOP manual. SOPs for coordinating disaster mitigation activities amongst various disaster relief organizations at national district and local levels are urgently needed.

Despite the lack of modern flood and weather monitoring system, once the SOPs for various EWS components are developed and practiced, improvement in the EWS is expected to take place.

7.3. SOP/ DRR

- The National Committee has the SOPs for handling different coastal hazards to organize local communities. For example-Myanmar Red Cross Society. Although there are SOPs in place for the process of real time sharing and availability of data collected, the same were not produced during the Mission. For example data are downloaded from GTS.
- The term 'vulnerable groups' needs to be comprehensively defined (i.e., each group deemed vulnerable identified and described). This needs to be appropriately included in the SOPs for Meteorology and Hydrology.
- There should be specific mention of how vulnerable groups will have their vulnerabilities and resilience addressed. In addition greater emphasis and detail is needed for risk reduction activities at both central and local level.
- Horizontal co-ordination between DRM systems and other sector laws must be planned for and carried out to ensure a comprehensive disaster risk reduction system that integrates all sectors, particularly development, building (codes), land use planning, private sector investment and infrastructure development.
- Policy makers must embed DM, disaster risk reduction and risk management across all sectors in the legal reform process and make the topic of disaster a central development issue. Identifying key people in each department(both public and private sectors), to be responsible for DM and risk reduction/ management in order to form a cross-sector team is one way to ensure DRR is integrated throughout.
- It would be highly useful to work towards the aim of all DMCs having an inclusive advisor or, even better, being composed of representatives from all groups on each council
- DMCs should equip themselves with the necessary knowledge and tools on inclusivity.
- Conducting local capacity and organizational analysis would enable the government to find out which specialist CSOs and local NGO networks are available to support the delivery of training.
- Contingency planning at the state (15 No.) as well at the national needs to be done on regular basis and also to be updated regularly. It should have well devised SOPs for all relevant stakeholders (Communities, Fishermen, Farmers, various departments etc.). No information on this issue was available during and after the Mission. This needs to be appropriately included in the SOPs for Meteorology and Hydrology.
- Well devised SOPs on working among various national, state and township/village level stakeholders seem mandatory to eliminate gaps in coordination among government offices. This needs to be appropriately included in the SOPs for Meteorology and Hydrology.
- In order to have authentic and reliable data sets, a national working group on hazard and vulnerability data is proposed. The Working Group should have members from all relevant technical offices to have a dedicated repository of DRM/DRR related data for effective use by all concerned while undertaking their respective development planning. In this context SOPs are proposed for better working and regular updating of data
- According to the 2008 Constitution district level and local level General Administration Officials are the decision makers in DRM/DM. They work in line with approved SOPs

(Copies not provided) with Pre/During/Post disaster responsibilities. During the normal days, they prepare plans, projects, undertake drills, evacuation exercise, health and environment pamphlets for public awareness to understand warning

- Well prepared SOPs for engaging Media in disaster risk reduction and management need to place as a priority including all the phases of the disaster.
- Forecasts and disaster information dissemination needs to be expanded by using SMS services, FM Radio Services, Sirens, Loud Speakers etc. Proper Sops in this regards are mandatory to ensure effective preparedness.

8. Conclusions

The purpose of the workshop was to review existing coastal multi-hazards EWS SOPs of hydro-meteorological service, disaster management, media, elected official, and others from national to district to local levels; identified best practices, gaps and needs, and recommendations for internal and cross-cutting SOPs; and then to compile data, information, examples, and diagrams collected on SOPs best practices, gaps and needs, and recommendations for inclusion in the Manual on Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazard Early Warning System which will meet the needs of the 13 beneficiary countries involved in the Project. These purposes have been met and were described above.

Now the challenge is to take the information from these six missions and develop a Manual/Handbook of Synergized Standard Operating Procedures for Coastal Multi-hazards Early Warning Systems focusing on the hydro-meteorological aspects to meet the needs of diverse users and to create a Manual that can and will be used. This development will be done in collaboration and coordination with the five consultants, the beneficiary countries, the Task Force, the TC Advisory Working Group, and 7 partner organizations. This Manual/Handbook will then form the foundation for the training and working meeting scheduled under Activity 2 of the project.

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Common

1. Originally planned schedule of meets for Days 1 & 2
2. List of participants - Days 1 & 2

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3. Geographical location of Myanmar
4. EWS flow chart
5. SOP Flow chart
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7. Cyclone forecasting check lists for decision making
8. Storm warning bulletin date 20.11.2013 & Tsunami warning bulletin
9. Bay of Bengal severe weather bulletin (Flow chart)
10. Port warning signals
11. Colour coding for the storm

12a. List of VSCS that Crossed Myanmar coast.

12b. Tracks of cyclonic storms that crossed Myanmar coast during the 50 years period 1964- 2013 (source: Cyclone eAtlas, IMD)

13 Daily weather forecast, Issuing steps and Dissemination – (Flow chart)

14 Natural disaster prone areas of Myanmar (Map)

15 Bay bulletin issued by DoM, Myanmar.

Hydro

16. Hydrological forecasting station and the river data.
17. Types of forecast and warnings
18. Flood forecasting methods
19. Flood warning
20. Flood bulletin
21. Hydrological warning system
22. Warning Communication system
23. 100 year flood inundation map for HPA an city
24. 100 year flood inundation map for Homalin city
25. SOP for Hydrology

DRR

26. Composition of NDPCC
27. Organizational Structures for Disaster Management, Myanmar SOP for Hydrology
28. List of sub committees

References & Bibliography (Met)

WMO, TD No.84, TCP 21, Tropical cyclone operational plan for the Bay of Bengal and the Arabian Sea, 2013 edition, 106p.

India Met. Dep., 2003, cyclone manual, 469p

India Met. Dep., 2013, Cyclone warning in India, Standarad Operation procedure, 204p

Govt. of Myanmar, Standing orders on Natural Disaster Management in Myanmar, 161p

List of Appendixes (General)

Appendix IA	Guide to Writing Effective SOPs
Appendix II	Checklist for Effective SOPs for EWS
Appendix III	Information on Early Warning System Overview
Appendix IV	Early Warning System Checklist Items
Appendix V	General Basic Information on EWS for NHMS, Warnings, Communications, and Relationships

Appendix 1 (p 23-26)

Consultants Visits for the Synergized Standard Operating Procedures (SSOPs)
Myanmar – 4-5 August 2014

SSOPs Schedule			
Time	**Activity**	**Participants**	**Venue**
Day 1			
08:30 – 09:00	***Registration***		
09:00 – 09:40	Introduction to the SSOP Project	Consultants and All Participants	DMH
09:40 – 09:50	Questions/Discussion of Overall Project	Consultants and All Participants	DMH
09:50 – 10:00	***Coffee Break***		
10:00 – 12:00	**Parallel Meetings I (2 Groups)**		
	Group -1 These discussions should focus on developing a useful, comprehensive Manual of Synergized Standard Operating Procedures for Coastal Multi-hazard Early Warning System (SSOP Manual) which will meet the needs of the countries. 1. Identify specific existing coastal related MOUs/SOPs which could be synergized. 2. Identify existing coastal MOUs/SOPs which need improvement. 3. Identify specific areas both technical and non-technical where additional coastal related SOPs are needed 4. Collect recommendations for SSOP Manual.	Meteorological and Hydrological Consultants and Warning Services Participants (Met/Hydro/Seismo)	DMH
	Group-2 These discussions should focus on developing a useful, comprehensive Manual of Synergized Standard Operating Procedures for Coastal Multi-hazard Early Warning System (SSOP Manual) which will meet the needs of the countries. 1. Identify specific existing coastal related MOUs/SOPs which could be synergized. 2. Identify existing coastal MOUs/SOPs which need improvement.	DRR Consultant and DRR Participants	DMH

	3. Identify specific areas both technical and non-technical where additional coastal related SOPs are needed 4. Collect recommendations for the SSOP Manual.		
12:00 – 13:00	***Lunch Break***		
13:00 – 14:40	**Continue Parallel Meeting I**		
14:40 – 15:00	***Coffee Break***		
15:00 – 17:00	**Parallel Meetings II (2 Groups)**		
	Group -1 These discussions should focus on developing a useful, comprehensive Manual of Synergized Standard Operating Procedures for Coastal Multi-hazard Early Warning System (SSOP Manual) which will meet the needs of the countries. 1. Identify what the district and local different agencies need and when, for both short notice events like tsunami or longer notice events like a tropical cyclone. 2. A focused discussions and identifying especially what is needed to get information/warnings to the "last kilometer" and how to receive information back from this level. 3. Identify any specific coastal related MOUs/SOPs which exist and which could be synergized. 4. Identify existing coastal MOUs/SOPs which need improvement. 5. Identify specific areas both technical and non-technical where additional coastal related SOPs are needed 6. Collect recommendations for the SSOP Manual.	Hydrological and DRR Consultants and Decision Makers participants. (Warning services representatives are encourage to attend but only as observers)	DMH
	Group-2 These discussions should focus on developing a useful, comprehensive Manual of Synergized Standard Operating Procedures for Coastal Multi-hazard Early Warning System (SSOP Manual) which will meet the needs of the countries. 1. Identify what the media needs and	Meteorological Consultant and Media participants. (Warning services representatives are encourage to attend but only as observers)	DMH

	when, for both short notice events like tsunami or longer notice events like a tropical cyclone. 2. Identify any specific coastal related MOUs/SOPs which exist and which could be synergized. 3. Identify existing coastal MOUs/SOPs which need improvement. 4. Identify specific areas both technical and non-technical where additional coastal related SOPs are needed 5. Collect recommendations for the SSOP Manual.		
Day 2			
09:00 – 10:20	**Discussion with District and Local Representatives**		
	These discussions should focus on developing a useful, comprehensive Manual of Synergized Standard Operating Procedures for Coastal Multi-hazard Early Warning System (SSOP Manual) which will meet the needs of the countries. 1. Identify what the district and local different agencies need and when, for both short notice events like tsunami or longer notice events like a tropical cyclone. 2. A focused discussions and identifying especially what is needed to get information/warnings to the "last kilometer" and how to receive information back from this level. 3. Identify any specific coastal related MOUs/SOPs which exist and which could be synergized. 4. Identify existing coastal MOUs/SOPs which need improvement. 5. Identify specific areas both technical and non-technical where additional coastal related SOPs are needed 6. Collect recommendations for the SSOP Manual.	Meteorological, Hydrological and DRR Consultants and District and Local Representatives. (Warning services representatives are encourage to attend but only as observers)	DMH
10:20 – 10:40	***Coffee Break***		
10:40 – 12:00	**Continued Discussion**		
12:00 – 13:00	***Lunch Break***		

Combined Meeting Present Results and to Seek Solutions Needed for SSOP Manual			
13:00 – 13:15	Summary of Parallel National Meteorological / Hydrological/ Tsunami Warning Services	Meteorological and Hydrological Consultants lead and all participants	DMH
13:15 – 13:30	Summary of Parallel Disaster Risk Reduction Management Offices	DRR Consultant lead and all participants	DMH
13:30 – 13:45	Summary of Parallel Decision Makers – Government Officials and Others	Hydrological and DRR Consultants lead and all participants	DMH
13:45 – 14:00	Summary of Parallel Media	Meteorological Consultant lead and all participants	DMH
14:00 – 14:15	Summary of District and Local Representatives	Meteorological, Hydrological, and DRR Consultants lead and all participants	DMH
14:15 – 14:35	***Coffee Break***		
14:35 – 16:30	Discussion of the integration, collaboration, and coordination needed by the five areas discussed. 1. Focus discussion on what is needed and how the SSOP Manual can help fulfill the needs. 2. What does the SSOP need to contain. 3. Recommendations for SSOP Manual	Meteorological, Hydrological, and DRR Consultants lead and moderate and all participants	DMH
16:30 – 17:00	1. Summary of the meeting and results 2. Final comments by participants	Meteorological, Hydrological, and DRR Consultants and all participants	DMH

Appendix 2 (p27-29)

SSOP meet 4-5 August 2014, DoM&H, Naypyidaw, List of participants

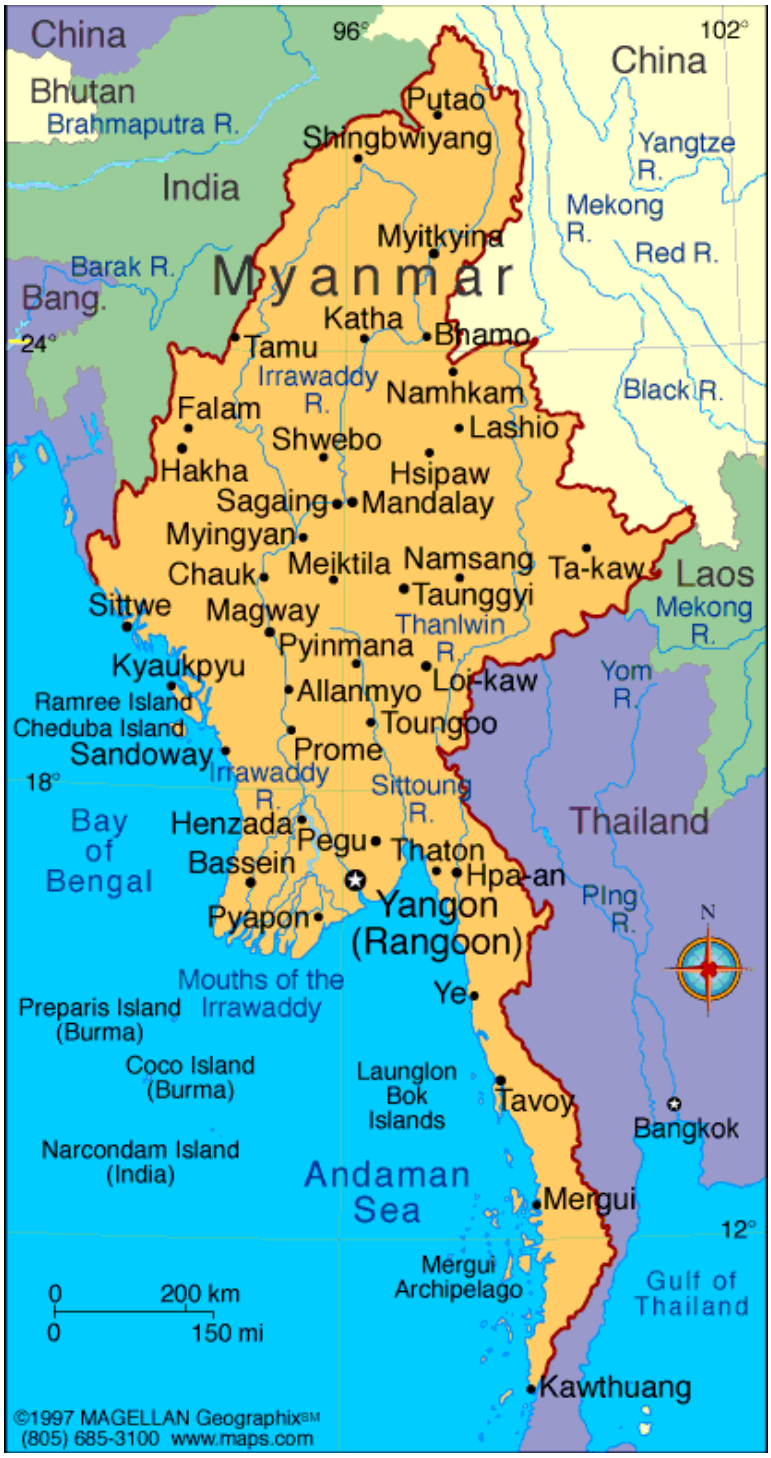
Days – 1&2 Nay PYI Taw - 4&5 Aug, 2014

S.No..	Name	Designation	Organisation
1	U Kyaw Lwin Oo	Deputy Director	DMH
2	U Tin Hut	Deputy Director	DMH
3	U Hla Tun	Deputy Director	DMH
4	Daw Htwe Win	Assistant Director	DMH
5	U Kyaw Kyaw Lin	Assistant Director	DMH
6	Dr. Yin Myno Min Htwe	Assistant Director	DMH
7	U Win Maw	Staff Officer	DMH
8	Daw Han Swe	Staff Officer	DMH
9	Dr. Tin Mar Htay	Staff Officer	DMH
10	U Jhun Ha Ye (Lhum Hre)	Director	Relief and Resettlement Department (RRD)
11	Daw Win Chnmar	Assistant Director	RRD
12	Daw Su Su Tun	Assistant Director	RRD
13	Daw Aye Nandar Win	Assistant Director	RRD
14	Daw Ay Aye Soe	Deputy Superintendent	RRD
15	Daw Nyo Nyo Aye	Upper Division Clerk	RRD
16	U Soe Myint	Assistant Director	MRTV
17	Daw Tin Tin Win	Technician	MRTV
18	U Ye Naing ( ) U Than Htun Aye	Staff Officer	General Admin Dept.
19	Daw Ohn Khin	Deputy Director	General Admin Dept.
20	U Kyaw Swar Nyunt	Staff Officer	General Admin Dept.
21	U Sein Thaung	Deputy Township Officer	General Admin Dept.
22	Daw Tin Yi	Director	DMH
23	Daw Kyu Kyu Sein	Staff Officer	MRTV
24	Daw Su Su Sat	MRTV	MRTV
25	Daw Swe Swe Than	MRTV	MRTV

S.No	Region	Name	Designation	Organisation
1	NPT	U Kyaw Lwin Oo	Deputy Director	DMH
2	NPT	U Tin Hut	Deputy Director	DMH
3	NPT	U Hla Tun	Deputy Director	DMH
4	NPT	Daw Htwe Win	Assistant Director	DMH
5	NPT	U Kyaw Kyaw Lin	Assistant Director	DMH
6	NPT	Dr. Yin Myno Min Htwe	Assistant Director	DMH
7	NPT	U Win Maw	Staff Officer	DMH
8	NPT	Daw Han Swe	Staff Officer	DMH
9	NPT	Dr. Tin Mar Htay	Staff Officer	DMH
10	Aye Yar Wody, Lidputtar	U Pud Zan Co	Staff Officer	DMH
11	NPT	Sa Myint	MRTV	MRTV
12	NPT	Daw Tin Tin Win		MRTV
13	OYE Yar Wody, (Lakputta)	U Win Taw Way	Relief and Resettlement	
14	Aye Yar Wady (Lakputta)	U Win Aing Kyaw	Assistant Director	RRD
15	NPT	Daw Win Ohn Mar	Assistant Director	RRD
16	NPT	Daw Aye Nandar Win	Assistant Director	RRD
17	NPT	Daw Cha Khin		General Admin. Dept.
18	NPT	Than Htun Aye		General Admin. Dept.
19	Aye Yar Wady (Pathein)	U Sein Thaung		General Admin Dept.
20	Aye Yar Wady (Lakputta)	U That Zin		General Admin Dept.
21	Aye Yar Wady (Thar Pone)	Myo Min Soe		General Admin Dept.

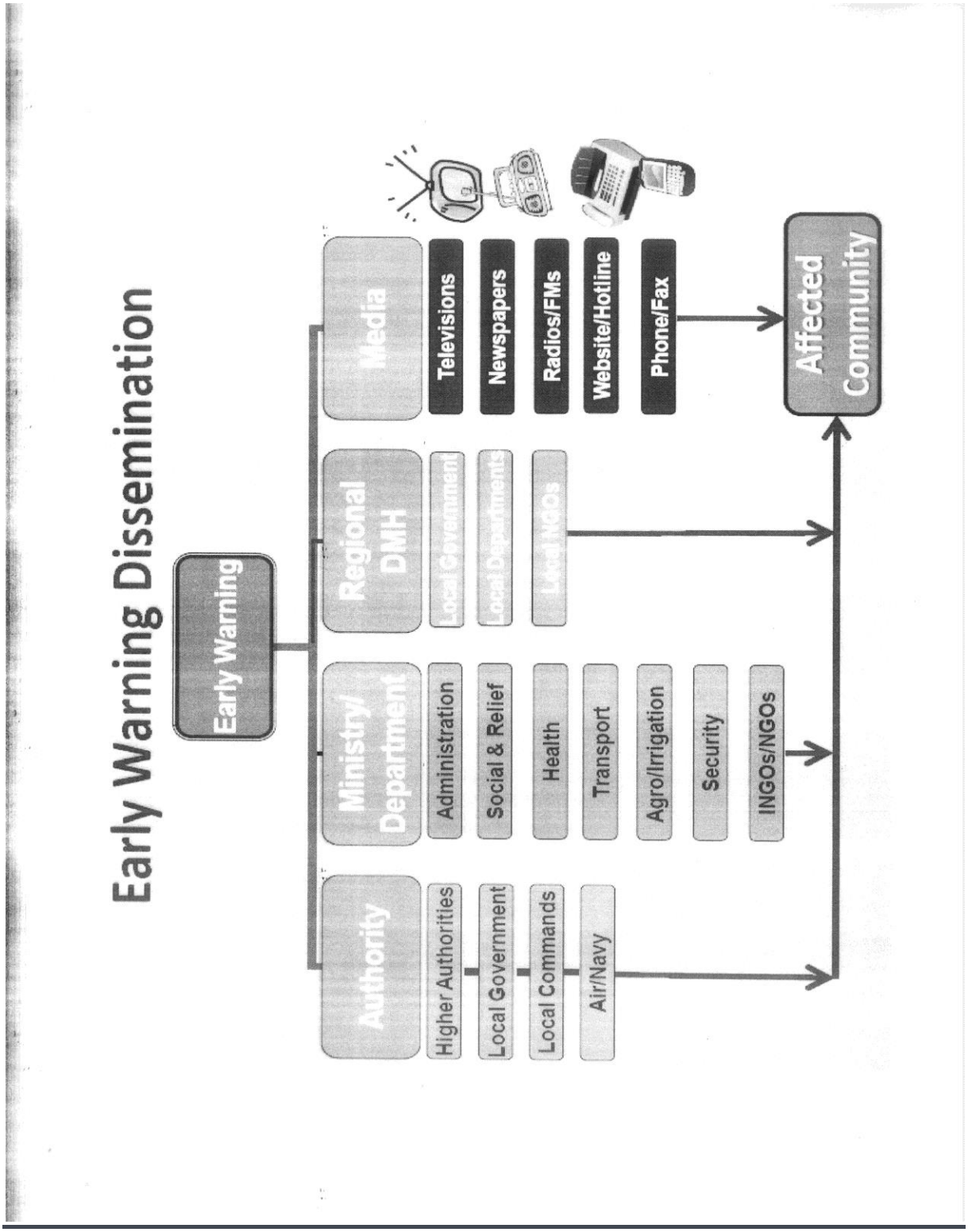
22	Aye Yar Wady (Pyinsalu)	U Myat Kyan Kyan		General Admin Dept.
23	NPT	Maung Maung Khin	Director	Myanmar Red Cross Society
24	NPT	U Kyaw San Wan	Program Officer	MRCS
25	NPT	Dr Nu Nu Kyi		Dept. of Health
26	NPT	Daw Tin Lin Than		Dept. of Health
27	NPT	Daw Swe Swe Than	Television	MRTC
28	NPT	U Win NHNG		General Admin Dept.

Appendix 3



Geographical Map of Myanmar

Appendix 4

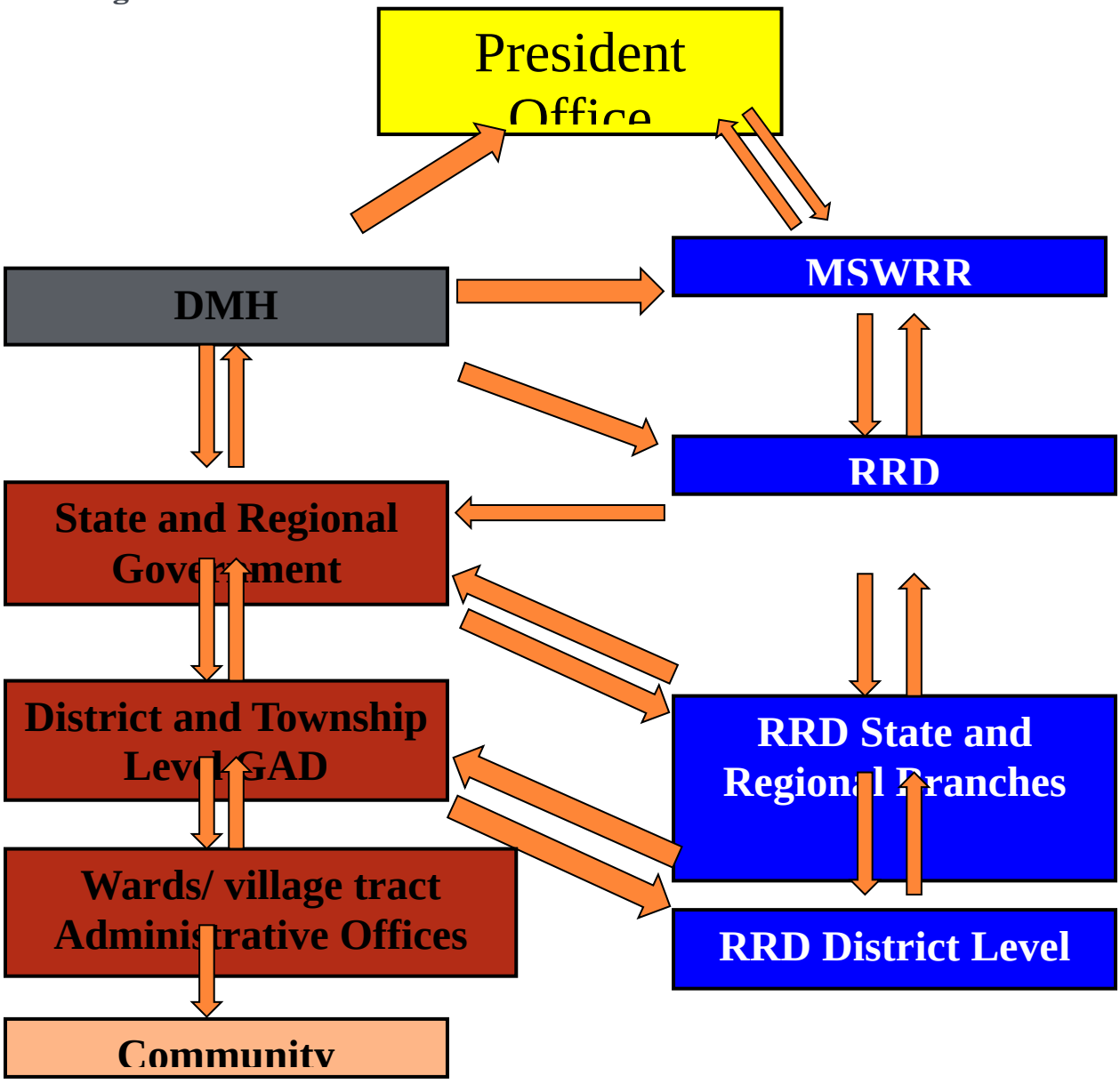

Early Warning Dissemination
Early Warning
Authority
Higher Authorities
Local Government
Local Commands
Air/Navy
Ministry/ Department
Administration
Social & Relief
Health
Transport
Agro/Irrigation
Security
INGOs/NGOs
Regional DMH
Local Government
Local Departments
Local NGOs
Media
Televisions
Newspapers
Radios/FMs
Website/Hotline
Phone/Fax
Affected Community

Appendix 5

SOPs from Different agencies

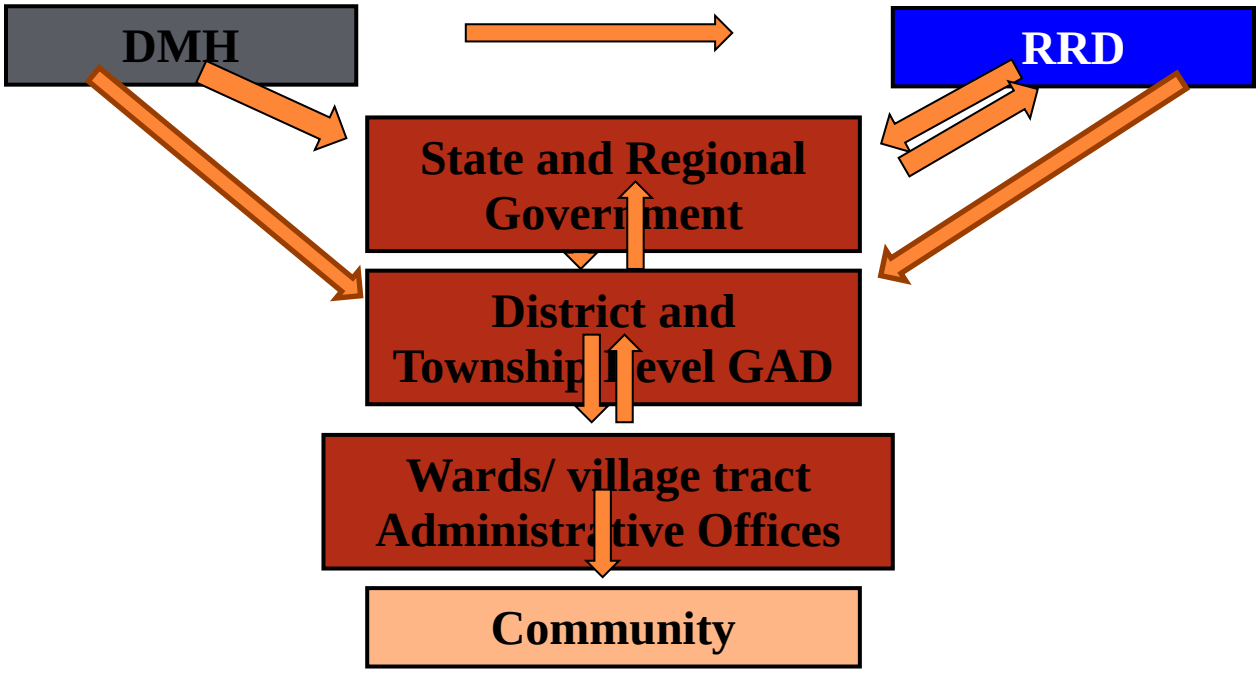
(1) Relief and Resettlement Department

Warning Dissemination Mechanism



(2) General Administration Department

Warning Dissemination Mechanism



Appendix 6 (p34-36)

Standard Operating Procedure (SOP) of the Department of Meteorology and Hydrology, Myanmar

(1) SOP for METEOROLOGY

- *Step (1)* Local data receive from the reporting stations through telephone and Single Side Band (SSB), and international data received from New Delhi and Bangkok via GTS link and than analysis the data at the National Meteorological Center in Nay Pyi Taw.
- *Step (2)* Issuing the Weather Forecast after analyzing synoptic chart International forecasts, Satellite Images (MTSAT & FY satellite), NWP product of international web site and regional climate model output and WRF products (Rainfall, upper air. Temperature forecast for 24, 48, 72, 96, 120, 144, 168 hours) from our department, upper level stream line pattern.

Issuing of Storm Warning

- *Step(1)* Analyze the Wind Pattern, Pressure Gradient, Composition of Cloud and Sea Surface Temperature(SST)
- *Step(2)* Analyze the Convergence Wind, Pressure fall and Density of cloud
- *Step(3)* Issuing Low Pressure Area(LPA)
- *Step(4)* Issuing Strong convergence, pressure fall and cloud structure are well organized
- *Step(5)* Issuing Depression, Storm,
- *Step(6)After we issue Strom warning give the following colour code*
    - *(a)* ***Yellow Stage****-Depression/Storm formed Andaman Sea and in the Bay of Bengal, but its not direct hit to Myanmar coast.*
    - *(b)* ***Orange Stage****- Depression/Storm formed Andaman Sea and in the Bay of Bengal, its direction may come to Myanmar coast.*
    - *(c)* ***Red Stage****- Depression/Storm must be pass during the next (12) hours to Myanmar coast. DMH issue emergency condition.*
    - *(d)* ***Brown Stage-*** *Depression/Storm during the crossing Myanmar coast DMH also issue emergency condition.*
    - *(e)* ***Green Stage-*** *Depression/Storm weaken or dissipated, its not significant for Myanmar.*

After we issued Storm Warning, Bulletin, News sent to the following Dissemination.

- President Office
- Union Government Office
- Myanmar Disaster Preparedness Agency(MDPA)
- Ministry of Defense (Army and Navy)
- Ministry of Information, Transport, Health, Home Affairs, Social Welfare, Relief and Resettlements
- Chief Ministers of States and Regions
- Township General Administrators
- Media(Television, Radio, 7 FM channels, Newspapers, Journals), DMH web site, , INGOs, NGOs(by Fax), Telephone and Single Site Band (SSB)

(2) SOP for HYDROLOGY

Data Receiving, Checking and Correction

- Hydrological data are observed three times daily at 06:30, 12:30 and 18:30 MST (we observed hourly water level by starting from 1.0 m below danger level).
- Data are received from the reporting stations through telephone and single side band (SSB).
- Water level hydrographs are plotted every day for all forecasting stations for checking upstream and downstream stations.
- The observed data are checked by statistical test as well as comparing upstream and downstream stations.
- The observed data are corrected whenever unreliable data are found.

Issuing of Flood Warnings and Bulletins

- Flood warning is issued when the water level rises up 1 meter below danger level, its water level can reached or exceed danger level. (30 stations for 8 major rivers in Myanmar)
- Flood Bulletin is issued when the water level reached or exceeded the danger level and till reached below the danger level. (30 stations for 8 major rivers in Myanmar)
- Significant Water Level Bulletin is issued when suddenly water level rise at least t feet during the pre monsoon period.
- Minimum Water Level Bulletin is issued during low flow season in Myanmar, issued seven stations located in Central Myanmar areas for two major rivers.

After we issued Flood Warning or Bulletin sent to the following Dissemination.

- President Office
- Union Government Office
- Myanmar Disaster Preparedness Agency(MDPA)
- Ministry of Defense (Army and Navy)
- Ministry of Information, Transport, Health, Home Affairs, Social Welfare, Relief and Resettlements
- Respective Chief Ministers of States and Regions.
- Respective States and Regions of DMH office.
- Respective Hydrological station.
- Media(Television, Radio, 7 FM channels, Newspapers,), DMH web site, NGOs(by Fax), Telephone and Single Site Band (SSB)

(3) SOP for TSUNAMI

- (1) **Local Tsunami** (near offshore Myanmar as well as Andaman sea and Bay of Bengal)
  Tsunami Alert together with earthquake news
  ($M \geq 6.5$, Depth < 50 km, Expected Run up >2 meter)
  (Related local departments/ officers have to prepare for public evacuation)
  Tsunami Warning
  ($M \geq 6.5$, Depth < 50 km, Expected Run up >2 meter)
  (Less than 60 minutes travel times to coast from the source)
  (Public evacuation as to move higher grounds)
  Tsunami Cancellation
  (Tsunami warning may be cancelled when non- destructive tsunami)
- (2) **Distant Tsunami** (Indian Ocean)
  Tsunami Alert together with Earthquake News
  ($M \geq 7.5$, Depth < 50 km, Expected Run up 0.5 to 2 meter)
  (Greater than 3 hours travel times to coast from the source)
  (Related local departments/ officers have to prepare for public evacuation)

Tsunami Warning

($M \geq 7.5$, Depth < 50 km, Expected Run up > 2 meters)

(Public evacuation as to move higher grounds)

Tsunami Cancellation

(Tsunami warning may be cancelled when non-destructive tsunami)

After we issued Warning or Bulletin sent to the following Dissemination.

- President Office
- Union Government Office
- Myanmar Disaster Preparedness Agency(MDPA)
- Ministry of Defense (Army and Navy)
- Ministry of Information, Transport, Health, Home Affairs, Social Welfare, Relief and Resettlements
- Chief Ministers of States and Regions
- Township General Administrators
- Respective States and Regions of DMH office.
- Respective Hydrological station.
- Media(Television, Radio, 7 FM channels, Newspapers, Journals), DMH web site, , INGOs, NGOs(by Fax), Telephone and Single Site Band (SSB)

Appendix 7

Cyclone forecasting Check lists for decision making

(Only major headings are given, sub heading & text are not included)

The process of the detection and forecasting of the cyclonic storm should be made logical, all technical features should be identified and given due place in reaching conclusions so that no snap decisions based on preconceived notions are taken. The conclusions should be arrived at step by step: It is essential therefore that a check list for decision making should be devised and the forecaster meticulously fills in all the technical details available and skillfully draws conclusions.

A. Synoptic Features

1. Mean sea level Pressure
2. Number of days the Low pressure area is persisting
3. Region of occurrence of LPA
4. (24)hr Pressure change
5. Pressure departure from Normal
6. Circulation
7. Upper Tropospheric Ridge (200hPa level) Position
8. Location of Upper Tropospheric anti cyclonic circulation
9. Location of upper Tropospheric westerly Trough (Lat/Lon)
10. SST (based on buoy and ship observations)
11. Rainfall
12. Cloud
13. Significant Weather (Thunderstorm/Squall Report?)
14. Any other Low pressure system in neighborhood within 29 deg LAT/Lon?
15. Any other features
16. Conclusion

B. Satellite Features

1. Convection
2. Circulation
3. Upper Tropospheric Ridge
4. Upper Tropospheric anti cyclonic circulation
5. Location of Upper Tropospheric westerly Trough (Lat/Lon)
6. Lower level convergence
7. Upper level divergence
8. Lower level vorticity
9. Vertical wind shear
10. Wind shear tendency

11. QPE
12. OLR
13. SST
14. Location and intensity from other sources
15. Any other features
16. Conclusion

C. NWP Model Features

1. Circulation
2. Upper Tropospheric Ridge
3. Upper tToposphеric anti cyclonic circulation
4. Location of Upper Tropospheric westerly Trough (Lat/Lon)
5. Lower level convergence
6. Upper level divergence
7. Lower level vorticity
8. Vertical wind shear
9. Wind shear tendency
10. Relative humidity at 500 hPa
11. Upper air temperature at 300 hPa
12. Any other features
13. NWP and statistical Model guidance maximum intensity and location (06/12/18/36/48/60/72)
14. NWP and statistical Model guidance maximum intensity and location (06/12/18/36/48/60/72) at different quadrant
15. Conclusion for maximum intensity and location
16. Conclusion for maximum intensity and location in different quadrant

Appendix 8

Storm News

(Issued at 13:00 hours MST on 20 - 11 - 2013)

According to the observations at (12:30)hours MST today, the depression over West Central Bay of Bengal intensified into a tropical storm "Helen" and centered at about(250)miles Northeast of Chennai, about (100)miles South - Southeast of Visakhapatnam, India and about (580)miles West-Northwest of Coco Island, Myanmar. It is forecast to move West-Northwest wards and cross South Andhra Pradesh coast, India within next (36) hours. Under the influenced of the tropical storm "Helen", occasional squalls with rough seas will be experienced off and along Myanmar Coasts. Surface wind speed in squalls may reach (40) m.p.h.

The present stage of the depression is coded yellow stage and it is not moving towards Myanmar coasts.

Trawlers, vessels and ships are advised to advert possible danger by cyclone.

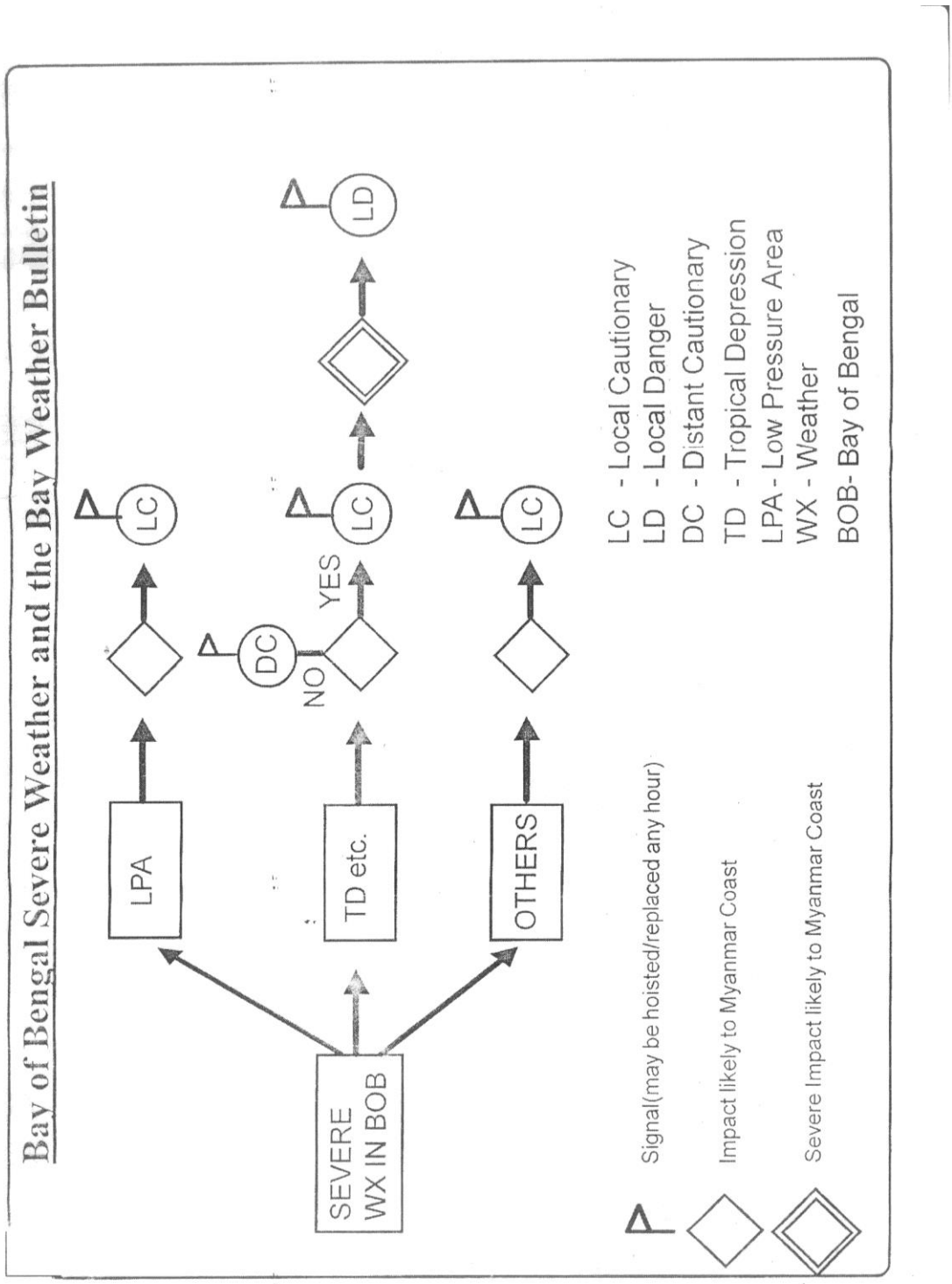
Tsunami Warning

(Issued at 08:30 hrs M.S.T on Today)

A very strong earthquake of magnitude (9.2)Richter Scale with its epicenter outside Myanmar (Indonesia) about (950)miles southeast of Kaba-Aye seismological observatory was registered at (07)hrs (30)min (30)sec M.S.T, on 12th October, 2012.

Run to the higher ground far away atleast one mile from the water edge because the tsunami waves with the height of about (5 - 10) feet will raise to the Myanmar coast at (09:00 – 10:00) hours M.S.T today, due to this very strong earthquake.

Appendix 9


Bay of Bengal Severe Weather and the Bay Weather Bulletin
SEVERE WX IN BOB
LPA
TD etc.
OTHERS
DC
NO
YES
LC
LC
LC
LD
Signal(may be hoisted/replaced any hour)
Impact likely to Myanmar Coast
Severe Impact likely to Myanmar Coast
LC - Local Cautionary
LD - Local Danger
DC - Distant Cautionary
TD - Tropical Depression
LPA - Low Pressure Area
WX - Weather
BOB- Bay of Bengal

Appendix 10

Table 6.4. Port Warning Signals (General System) used in India

Signal/ Flag No.		NAME	Symbols		Description
			Day	Night	
1	DISTANT BAD WEATHER	DC1			Depression far at sea. Port NOT affected.
2		DW2			Cyclone far at sea. Warning for vessels leaving port.
3	LOCAL BAD WEATHER	LC3			Port Threatened by local bad weather like squally winds.
4		LW4			Cyclone at sea. Likely to affect the port later.
5	DANGER	D5			Cyclone likely to cross coast keeping port to its left.
6.		D6			Cyclone likely to cross coast keeping port to its right.
7.		D7			Cyclone likely to cross coast over/ near to the port.
8.	GREAT DANGER	GD8			Severe cyclone to cross coast keeping port to its left.
9.		GD9			Severe cyclone to cross coast keeping port to its right.
10.		GD10			Severe cyclone to cross coast over or very near to the port.
11.		XI			Communication failed with cyclone warning office.

COLOUR CODING FOR THE STORM

Doesn't depend on storm 's intensity

(ie, whatever it is TD, TC or CS), it means only for RISK of the storm.

- **YELLOW COLOR STAGE: Whatever the storm is TC or CS , which is not expected to move towards Myanmar coast by the present.**

- **ORANGE COLOR STAGE: Whatever the storm is TC or CS, which is leading to Myanmar coast by the present.**

- **RED COLOR STAGE: Whatever the storm is TS or CS, which may cross to Myanmar coast within next (12)hrs.**

- **BROWN COLOR STAGE: Whatever the storm is TS or CS, which is crossing to Myanmar coast by the present.**

- **GREEN COLOR STAGE: Whatever the storm is TS or CS, which has**

Appendix 12 a

Very Severe Cyclonic Storm crossed Myanmar Coasts

No	Name	Time Duration	Landfall point
1.	Sittwe Cyclone	6-5-1968 to 10-5-1968	Near Sittwe
2.	Pathein Cyclone	4-5-1975 to 8-5-1975	Near Pathein
3.	Gwa Cyclone	30-4-1982 to 5-5-1982	Near Gwa
4.	Maungdaw Cyclone	26-4-1994 to 3-5-1994	Near Maungdaw
5.	"Mala" Cyclone	25-4-2006 to 29-4-2006	Near Gwa
6.	"Akash" Cyclone	13-5-2007 to 15-5-2007	Maungdaw & Bangladesh
7.	"Nargis" (SCS)	25-4-2008 to 5-5-2008	Ayeyarwady, Mon & Kayin
8.	"Giri"(SCS)	20-10-2010 to 24-10-2010	Near Kyaukpyu

Appendix 12 b

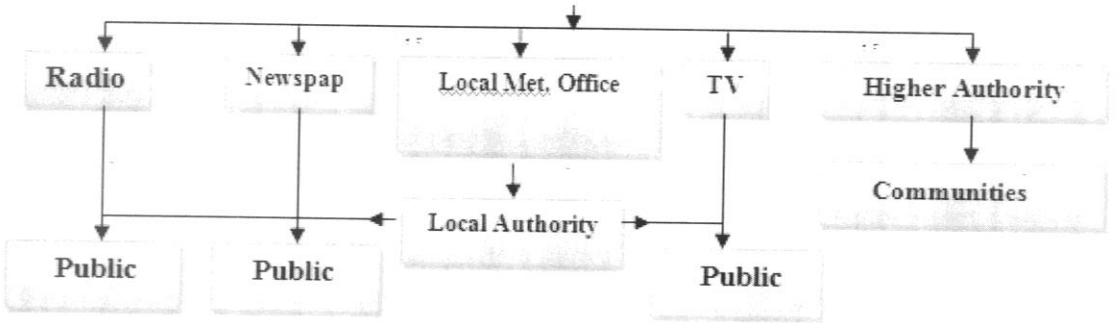
Tracks of cyclonic storms that crossed Myanmar coast during the 50 years period 1964-2013 (source: Cyclone eAtlas, IMD)

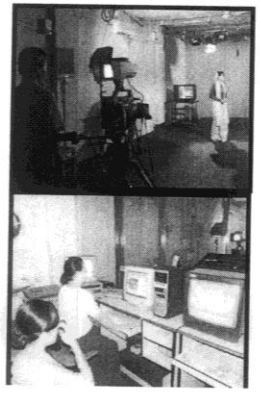
Appendix 13

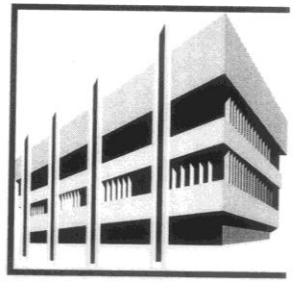
Daily Weather Forecast
Issuing Step
Synoptic Data
(Myanmar Other Country)
Upper Air Data
(Myanmar Other
Satellite Data
(Grid point Data and
Satellite Picture)
Rader Data
Result from
JMA Model
Synoptic Chart
Upper Air Chart
Satellite Picture
(Past 24 hours & Present)
Compare with Present
chart and Monthly Mean
Chart
Result from
PC Version Model
RIME WRF Model output
Various Satellite
Picture and
Chart from
other
international
Met. Dep
Other NWP Model
Output
Compare and Analysis
by using this Chart
Draft Forecast
Discuss with DG and
Other Meteorologist
Final Forecast
SAMPLE

Daily Weather Forecast

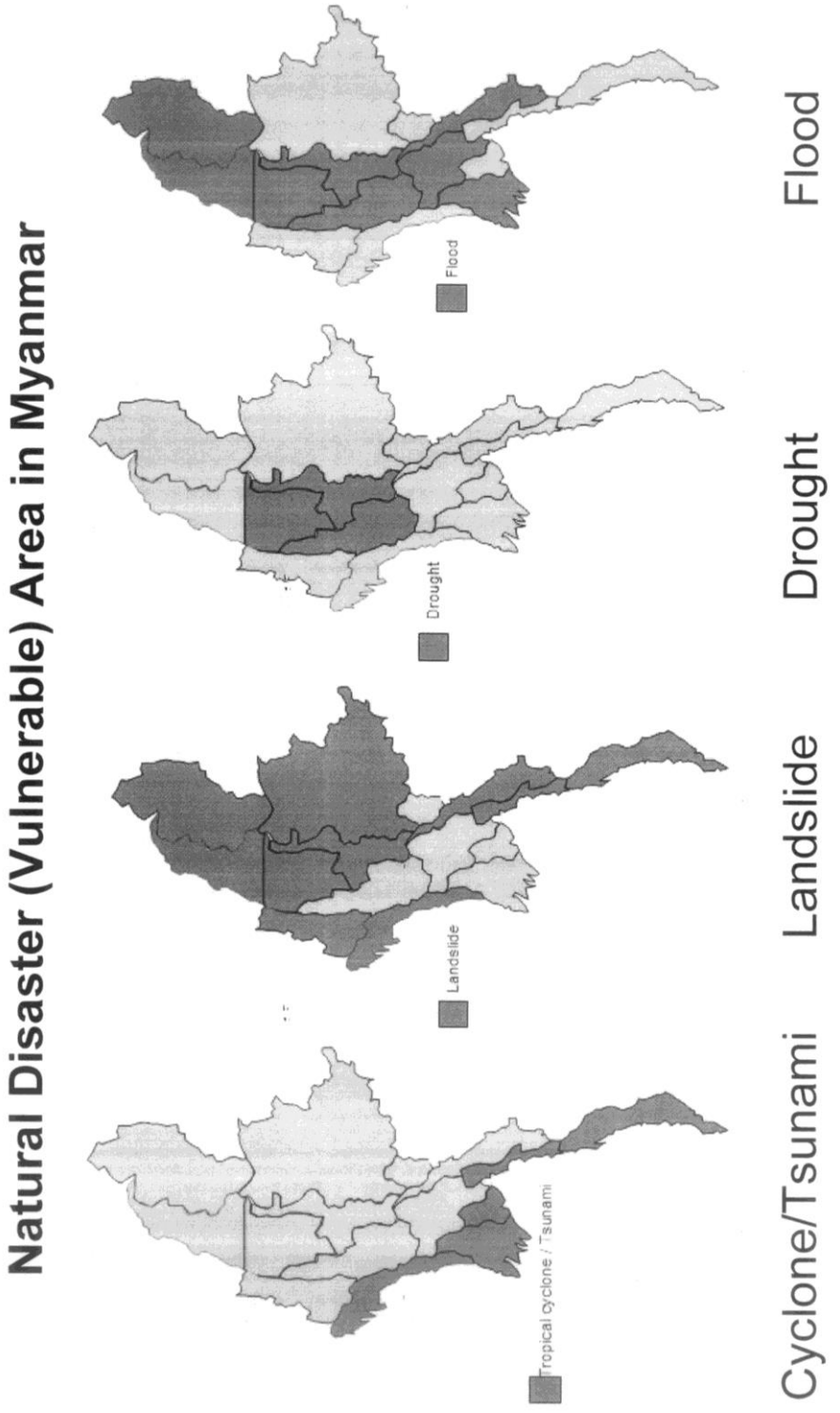
Dissemination System



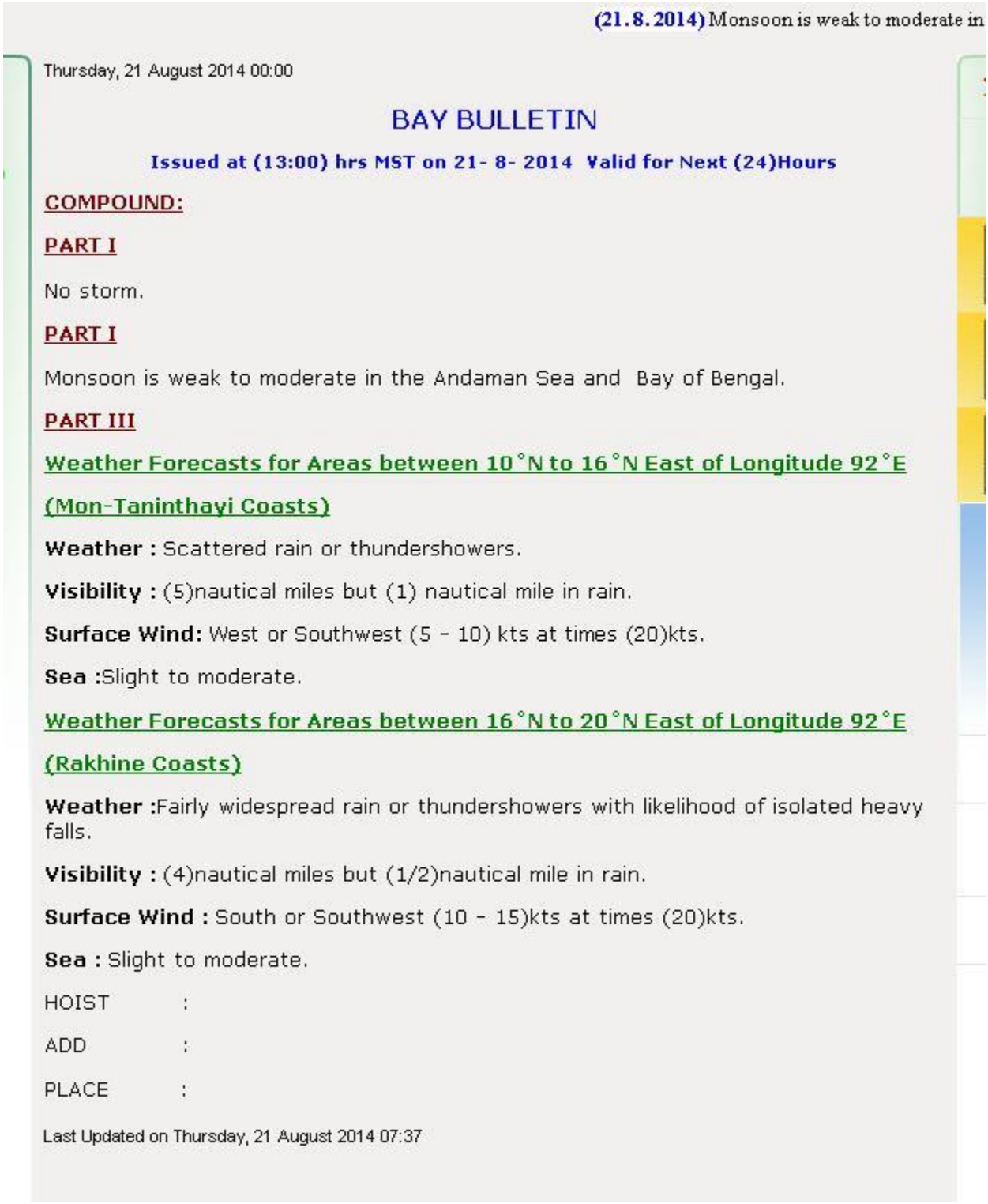




Appendix 14


Natural Disaster (Vulnerable) Area in Myanmar
Tropical cyclone / Tsunami
Landslide
Drought
Flood
Cyclone/Tsunami
Landslide
Drought
Flood

Appendix 15



(21.8.2014) Monsoon is weak to moderate in

Thursday, 21 August 2014 00:00

BAY BULLETIN

Issued at (13:00) hrs MST on 21- 8- 2014 Valid for Next (24)Hours

COMPOUND:

PART I

No storm.

PART I

Monsoon is weak to moderate in the Andaman Sea and Bay of Bengal.

PART III

Weather Forecasts for Areas between 10°N to 16°N East of Longitude 92°E (Mon-Taninthayi Coasts)

Weather : Scattered rain or thundershowers.

Visibility : (5)nautical miles but (1) nautical mile in rain.

Surface Wind: West or Southwest (5 - 10) kts at times (20)kts.

Sea : Slight to moderate.

Weather Forecasts for Areas between 16°N to 20°N East of Longitude 92°E (Rakhine Coasts)

Weather : Fairly widespread rain or thundershowers with likelihood of isolated heavy falls.

Visibility : (4)nautical miles but (1/2)nautical mile in rain.

Surface Wind : South or Southwest (10 - 15)kts at times (20)kts.

Sea : Slight to moderate.

HOIST :

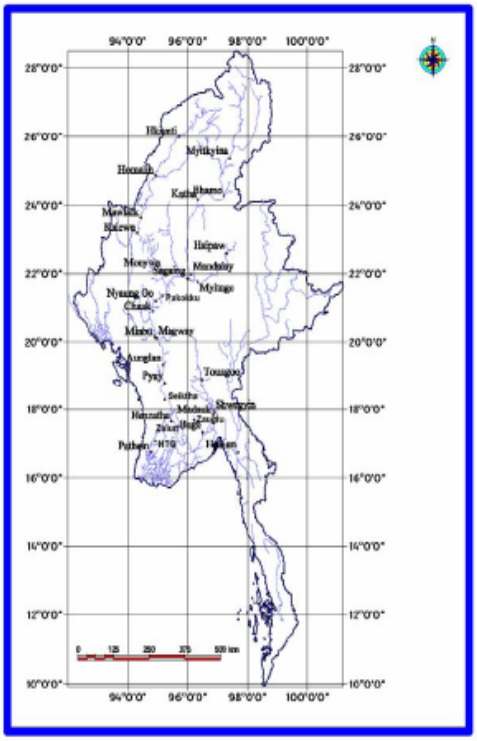
ADD :

PLACE :

Last Updated on Thursday, 21 August 2014 07:37

Appendix 16

Hydrological Forecasting Stations



River system

Myanmar has eight major rivers which generally flow from North to South.

Ayeyarwady	- 1789 km
Chindwin	- 901 km
Thanlwin	- 1223 km
Sittoung	- 407 km
Bago River	- 331 km

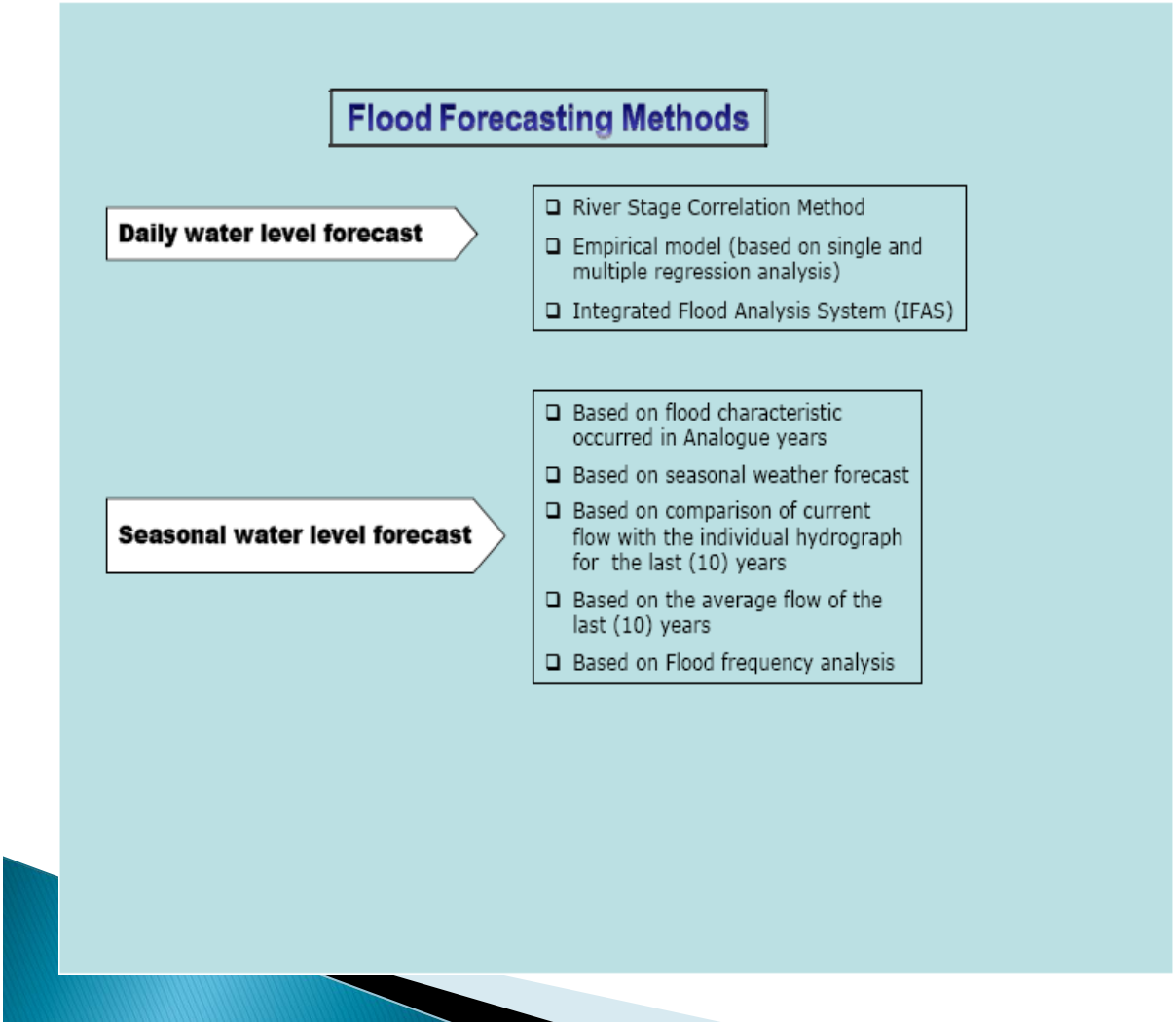
Ayeyarwady	- 15 Stations
Chindwin	- 5 Stations
Sittaung	- 2 Stations
Thanlwin	- 1 Station
Dokehtawady	- 2 Stations
Bago	- 2 Stations
Shwegyin	- 1 Station
Ngawun	- 2 Stations

Appendix 17

Types of forecast and warning (Hydrological Division)

Type of Forecast	Date of Issue	Forecast Validity	Forecast Area
Daily water level forecast	Daily	1 day	30 Stations(8 Major Rivers)
Dekad Forecast	8th , 18th , 28th of Every Month	10 days	20 Stations (Ayeyarwady and Chindwin River)
Monthly Forecast	28th of Every Month	1 Month	20 Stations (Ayeyarwady and Chindwin River-Low Flow Period)
			30 Stations(8 Major Rivers-Monsoon Season)
Significant Water Level Bulletin	Pre Monsoon Period	Depend on WL rising	20 Stations (Ayeyarwady and Chindwin Rivers)
Flood Warning and Bulletin	Monsoon Season	Depend on WL rising/falling	30 Stations(8 Major Rivers)
Minimum Alert Water Level and Bulletin (for low flow)	Low Flow Season	Depend on WL falling	7 Stations (Ayeyarwady and Chindwin Rivers)
Seasonal water level forecast			
- General Long Range Flood Forecast	28th April	The whole monsoon season	30 Stations(8 Major Rivers)
- Flood Forecast for Early monsoon period	28th April	2 Month	
- Flood Forecast for Mid-monsoon period	28th June	2 Month	
- Flood Forecast for Late-monsoon period	28th Aug	2 Month	

Appendix 18


Flood Forecasting Methods
Daily water level forecast
River Stage Correlation Method
Empirical model (based on single and multiple regression analysis)
Integrated Flood Analysis System (IFAS)
Seasonal water level forecast
Based on flood characteristic occurred in Analogue years
Based on seasonal weather forecast
Based on comparison of current flow with the individual hydrograph for the last (10) years
Based on the average flow of the last (10) years
Based on Flood frequency analysis

Appendix 19 & 20

Early Warning Products from Department of Meteorology and Hydrology-DMH(Myanmar)

Flood Warning

(Issued at 13:00 hr M.S.T on 13-9-2013)

According to the (12:30) hr M.S.T observation today, the water level of Ayeyarwady River at Hinthada is observed as (56) cm (about 1.8-ft) below its danger level. It may reach its danger level during the next (48) hours commencing noon today

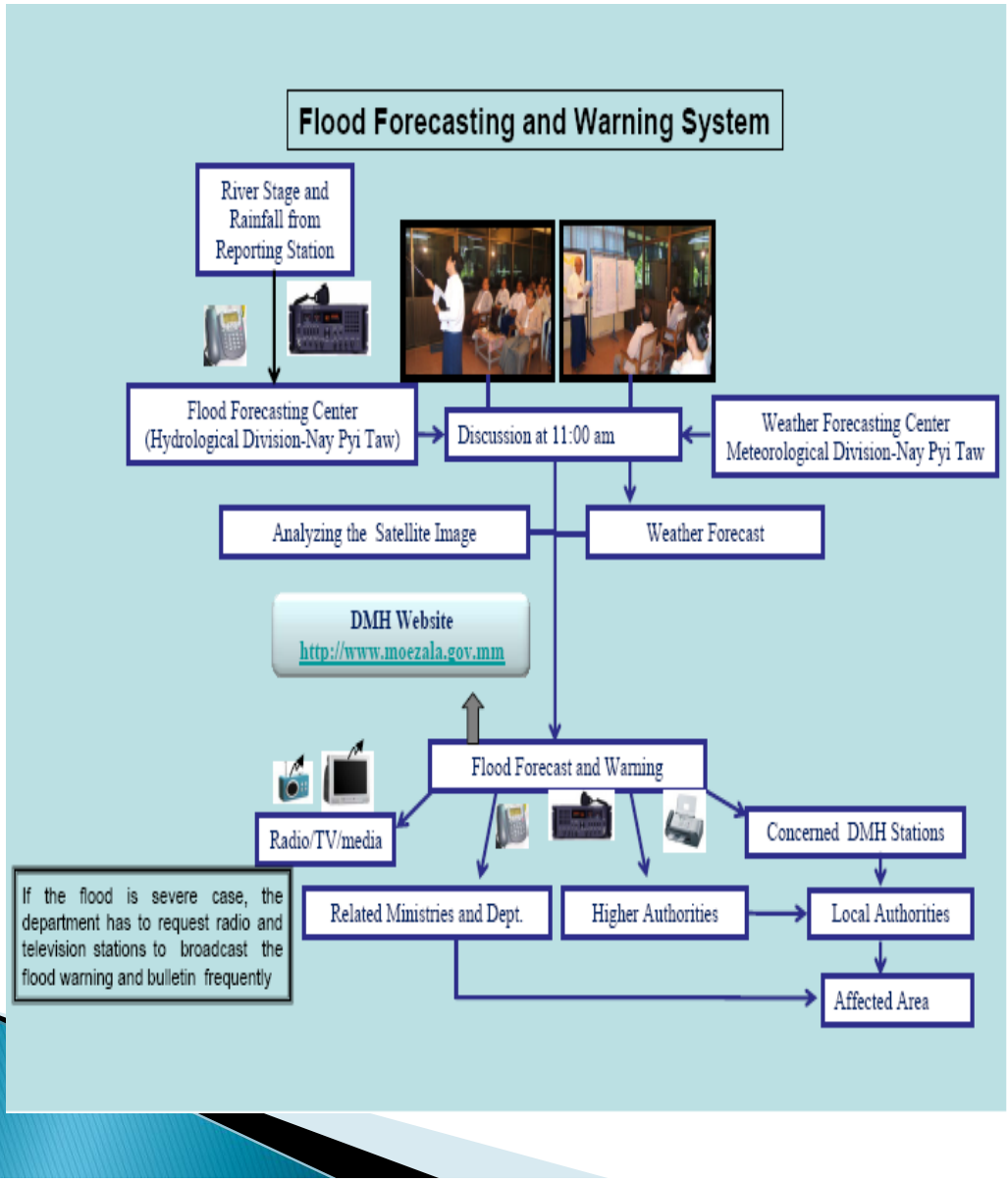
Flood Bulletin

(Issued at 13:00 hr M.S.T on 16-9-2013)

The water level of Ayeyarwady River at Hinthada has exceeded its danger level starting from 15-9-2013, (18:30) am. According to the (12:30) hr M.S.T observation today, the water level has exceeded by (15) cm (about 0.5 -ft) above its danger level. It may continue to rise (60) cm (about 2-ft) and remain above its danger level during the next (3)days

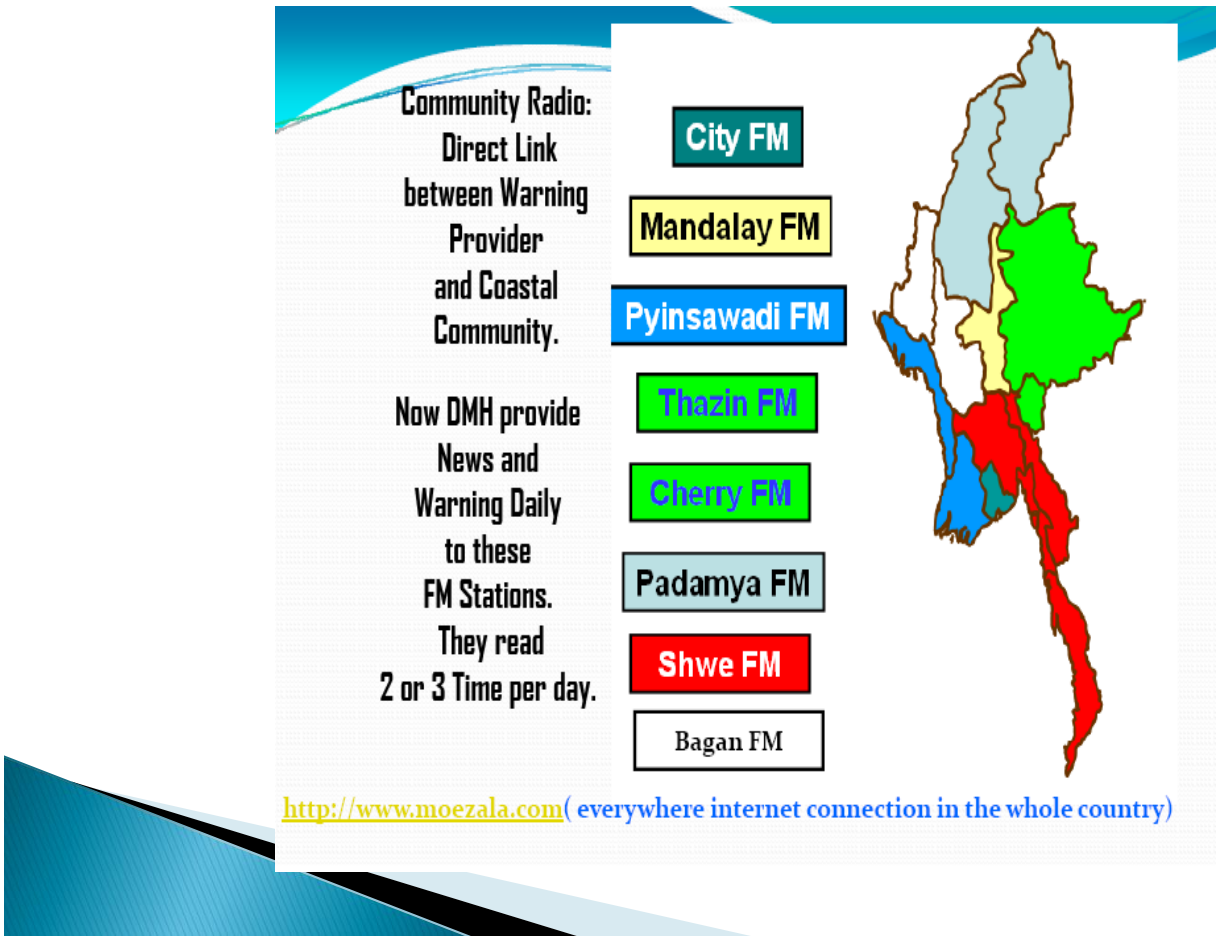
Appendix 21

Hydrological Warning System

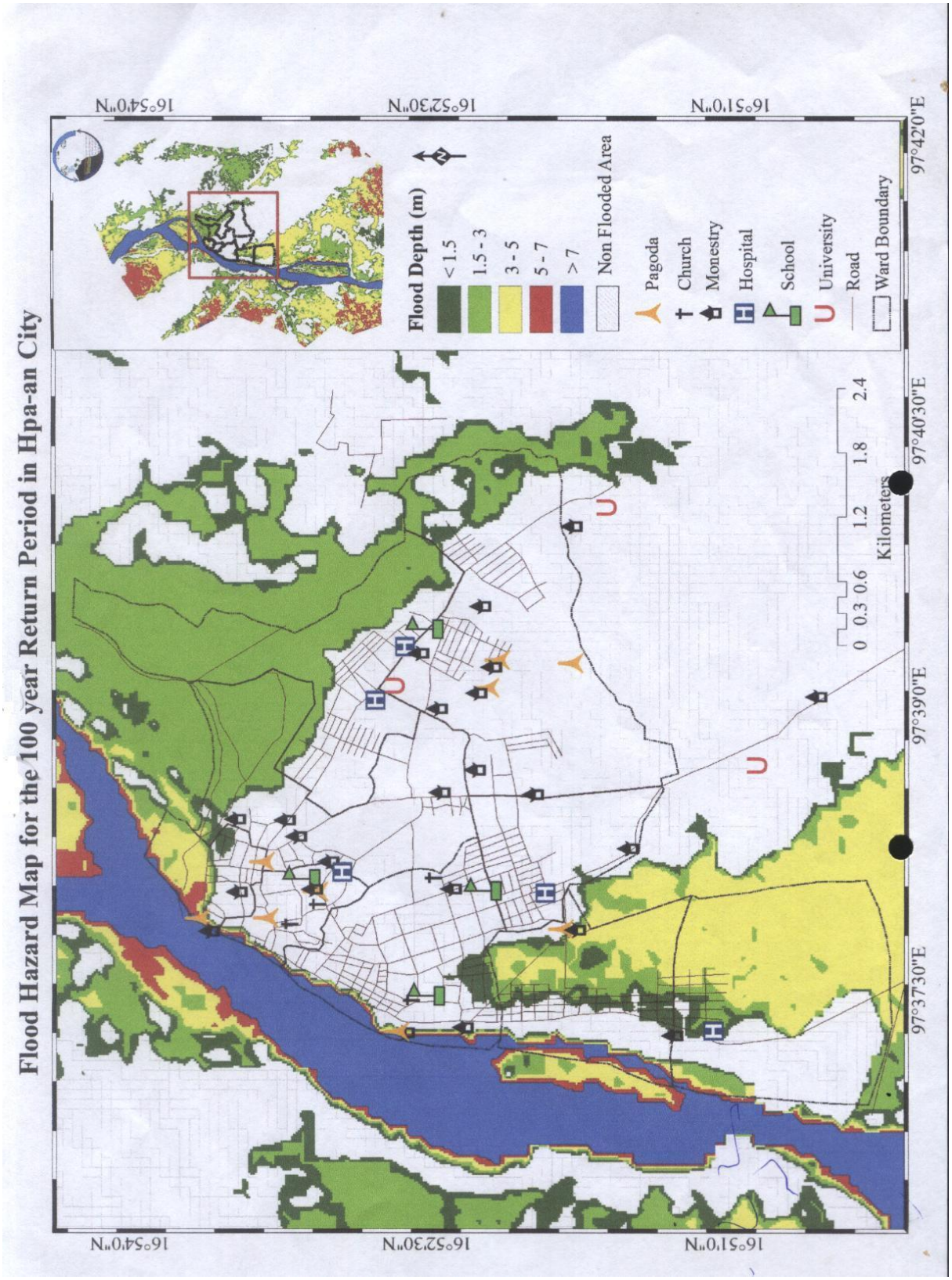


Appendix 22

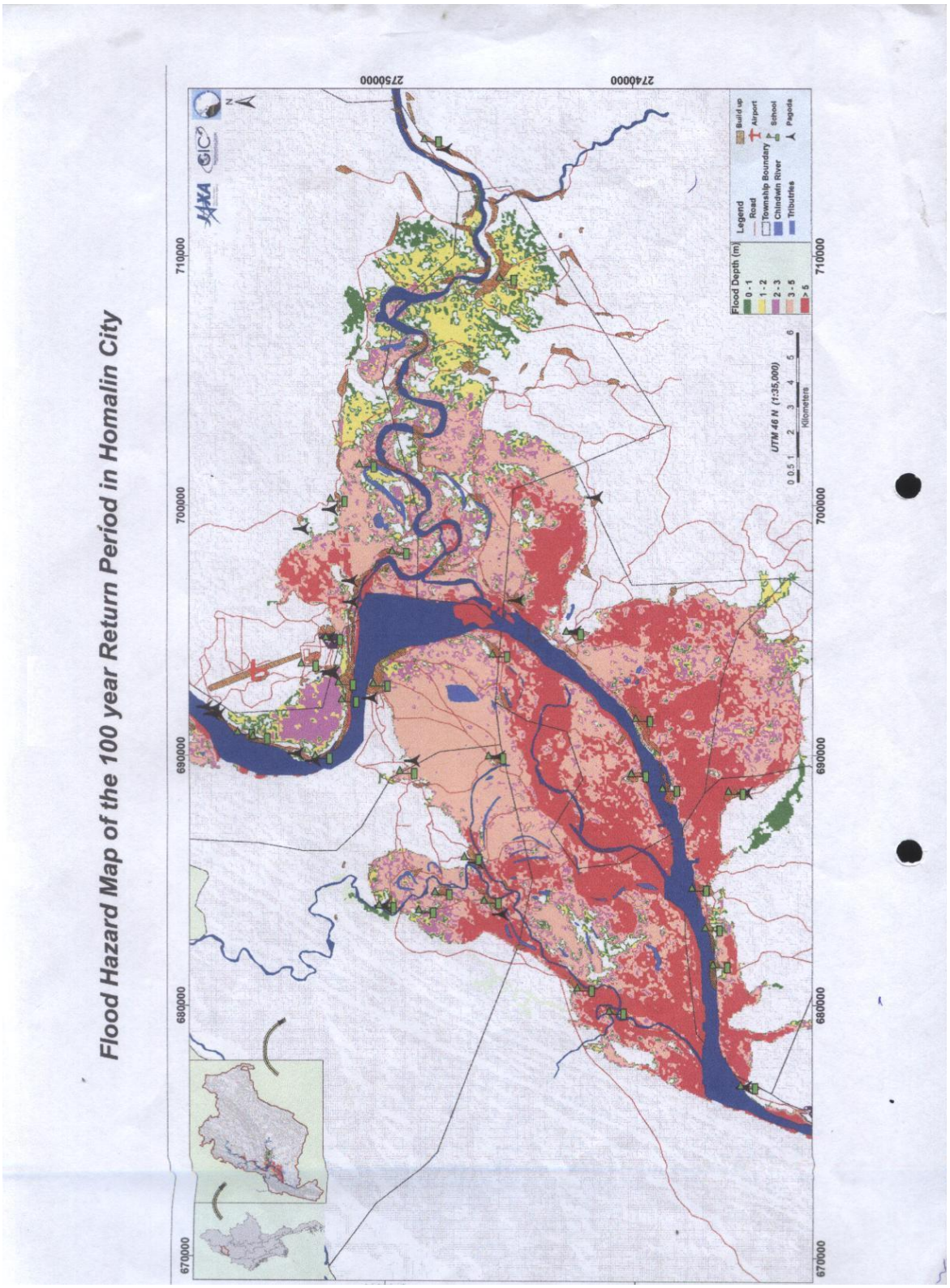
Warning Information and Communication Technologies for National/Regional/Local Levels



Appendix 23


Flood Hazard Map for the 100 year Return Period in Hpa-an City
16°54'0"N
16°52'30"N
16°51'0"N
97°37'30"E
97°39'0"E
97°40'30"E
97°42'0"E
Flood Depth (m)
< 1.5
1.5 - 3
3 - 5
5 - 7
> 7
Non Flooded Area
Pagoda
Church
Monestry
Hospital
School
University
Road
Ward Boundary
0 0.3 0.6 1.2 1.8 2.4
Kilometers

Appendix 24


Flood Hazard Map of the 100 year Return Period in Homalin City
Flood Depth (m)
0 - 1
1 - 2
2 - 3
3 - 5
> 5
Legend
Road
Township Boundary
Chindwin River
Tributries
Build up
Airport
School
Pagoda
UTM 46 N (1:135,000)
Kilometers
670000
680000
690000
700000
710000
2740000
2750000
N

Appendix 25

(2) SOP for HYDROLOGY

Data Receiving, Checking and Correction

- Hydrological data are observed three times daily at 06:30, 12:30 and 18:30 MST (we observed hourly water level by starting from 1.0 m below danger level).
- Data are received from the reporting stations through telephone and single side band (SSB).
- Water level hydrographs are plotted every day for all forecasting stations for checking upstream and downstream stations.
- The observed data are checked by statistical test as well as comparing upstream and downstream stations.
- The observed data are corrected whenever unreliable data are found.

Issuing of Flood Warnings and Bulletins

- Flood warning is issued when the water level rises up 1 meter below danger level, its water level can reached or exceed danger level. (30 stations for 8 major rivers in Myanmar)
- Flood Bulletin is issued when the water level reached or exceeded the danger level and till reached below the danger level. (30 stations for 8 major rivers in Myanmar)
- Significant Water Level Bulletin is issued when suddenly water level rise at least t feet during the pre monsoon period.
- Minimum Water Level Bulletin is issued during low flow season in Myanmar, issued seven stations located in Central Myanmar areas for two major rivers.

After we issued Flood Warning or Bulletin sent to the following Dissemination.

- President Office
- Union Government Office
- Myanmar Disaster Preparedness Agency(MDPA)
- Ministry of Defense (Army and Navy)
- Ministry of Information, Transport, Health, Home Affairs, Social Welfare, Relief and Resettlements
- Respective Chief Ministers of States and Regions.
- Respective States and Regions of DMH office.
- Respective Hydrological station.
- Media(Television, Radio, 7 FM channels, Newspapers,), DMH web site, NGOs(by Fax), Telephone and Single Site Band (SSB)

(3) SOP for TSUNAMI

- (1) **Local Tsunami** (near offshore Myanmar as well as Andaman sea and Bay of Bengal)

  Tsunami Alert together with earthquake news

  ($M \geq 6.5$, Depth < 50 km, Expected Run up >2 meter)

  (Related local departments/ officers have to prepare for public evacuation)

  Tsunami Warning

  ($M \geq 6.5$, Depth < 50 km, Expected Run up >2 meter)

  (Less than 60 minutes travel times to coast from the source)

  (Public evacuation as to move higher grounds)

  Tsunami Cancellation

  (Tsunami warning may be cancelled when non- destructive tsunami)

  (2) **Distant Tsunami** (Indian Ocean)

  Tsunami Alert together with Earthquake News

  ($M \geq 7.5$, Depth < 50 km, Expected Run up 0.5 to 2 meter)

  (Greater than 3 hours travel times to coast from the source)

  (Related local departments/ officers have to prepare for public evacuation)

Appendix 26 (page 58-59)

Composition of NDPCC

Sr. No.	Members	Designation
1	Prime Minister	Chairman
2	Secretary (1), State Peace and Development Council	Co-Chairman
3	Chairman, Kachin State Peace and Development Council	Member
4	Chairman, Kayah State Peace and Development Council	Member
5	Chairman, Kayin State Peace and Development Council	Member
6	Chairman, Mon State Peace and Development Council	Member
7	Chairman, Chin State Peace and Development Council	Member
8	Chairman, Shan State (North) Peace and Development Council	Member
9	Chairman, Shan State (East) Peace and Development Council	Member
10	Chairman, Shan State (South) Peace and Development Council	Member
11	Chairman, Tanintharyi Division Peace and Development	Member
12	Chairman, Rakhine State Peace and Development Council	Member
13	Chairman, Sagaing Division Peace and Development Council	Member
14	Chairman, Mandalay Division Peace and Development Council	Member
15	Chairman, Bago Division Peace and Development Council	Member
16	Chairman, Ayeyarwady Division Peace and Development	Member
17	Chairman of Yangon Division Peace and Development Council	Member
18	Chairman of Magway Division Peace and Development	Member
19	Minister for Rail Transportation	Member
20	Minister for Energy	Member
21	Minister for Home Affairs	Member
22	Minister for Health	Member
23	Minister for Foreign Affairs	Member
24	Minister for Information	Member
25	Minister for National Planning and Economic Development	Member
26	Minister for Construction	Member
27	Minister for Education	Member

28	Minister for Communications, Posts and Telegraphs	Member
29	Minister for Transport	Member
30	Minister for Commerce	Member
31	Minister for Progress of Border Areas & National	Member
32	Minister for Finance and Revenue	Member
33	Minister for Agriculture and Irrigation	Member
34	Chairman, Yangon City Development Council	Member
35	Chairman, Mandalay City Development Council	Member
36	Minister for Social Welfare, Relief and Resettlement	Secretary
37	Deputy Minister for Home Affairs	Joint-Secretary

National Disaster Preparedness Management Working Committee

Sr. No.	Members	Designation
1	Secretary (I), State Peace and Development Council	Chairman
2	Minister, Ministry of Social Welfare, Relief and Resettlement	Co-Chairman
3	Minister, Ministry of Home Affairs	Co-Chairman
4	Minister, Education	Member
5	Minister, Information	Member
6	Chairman, Sub-Committees (10)	Member
7	Representative of State/Division Peace and Development Councils	Member
8	Representative of Defense Ministry	Member
9	Chairman, Yangon City Development Council	Member
10	Chairman, Mandalay City Development Council	Member
11	Deputy Minister, Ministry of Home Affairs	Secretary
12	Deputy Minister, Ministry of Social Welfare, Relief and Resettlement	Joint-Secretary

Appendix 27

Organizational Structures for Disaster Management, Myanmar

	National Disaster Preparedness Central Committee Chairman: Prime Minister	
	National Disaster Preparedness Management Working Committee Chairman: Secretary (I)	
	Ten Sub-Committees	
News and Information	: *Chairman : Minister, Information Department*	
Emergency Communication	: *Chairman: Minister, Communication, Posts & Telegraphs*	
Search and Rescue	: *Chairman: Minister of Transportation*	
Assessment and Emergency Relief of Damage and Loss	: *Chairman: Minister, Commerce* Confirmation : *Chairman: Minister, National Planning & Economic Development*	
Transportation and Route Clearance: *Chairman: Minister, Rail Transport*		
National Disaster Reduction Emergency Shelter Provision	: *Chairman: Minister, Cooperative*	
Health Care Sub-Committee	: *Chairman: Minister, Health*	
Rehabilitation and Reconstruction	: *Chairman: Minister, Social Welfare, Relief and Resettlement*	
Security	: *Chairman: Minister, Home Affairs*	

Appendix 28 (page 61-67)

(i) Sub Committee on Information and Education

Sr. No.	Members	Designation
1	Minister, Information	Chairman
2	Deputy Minister, Foreign Affairs	Member
3	Deputy Minister, Education	Member
4	Deputy Minister, Construction	Member
5	Deputy Minister, Health	Member
6	Director General, News and Periodical	Member
7	Director General, Department of	Member
8	Director General , Fire Services	Member
9	Director General, Myanmar Radio and	Member
10	Deputy Minister, Information	Secretary
11	To be assigned by chairman of sub-	Joint-Secretary

The roles and responsibilities are:

- To educate people on disaster preparedness by various means such as curriculum, newspaper, journal, magazine, television broadcasting and radio transmission
- To disseminate the information during different phases namely before-disaster, during-disaster and after-disaster to the concerned masses; Release news after verification
- To disseminate information on hazard prone areas and forecast on likely situation to the concerned masses
- To review the awareness activities on disaster preparedness and make it more effective
- To oversee and manage the information and educating activities organized at various levels
- To make arrangements for the timely communication of necessary disaster news and information to people in disaster prone regions through printed materials, airplanes & helicopters, and through radio broadcasts.

(ii) Sub Committee on Emergency Communication

Sr. No.	Members	Designation
1	Minister, Communications, Posts and Telegraphs	Chairman
2	Deputy Minister, Home Affairs	Member
3	Deputy Minister, Transportation	Member
4	Representative from Ministry of Defense	Member
5	Director General, Department of Meteorology and Hydrology	Member
6	Director General, Posts and Telecommunications Department	Secretary
7	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by the Minister, Communication, Pots and Telegraphs. The roles and responsibilities are:

- To set up an emergency communication system and occasionally conduct mock drills
- To impart training on communication for the concerned organizations
- To maintain records of mobile phone numbers, fax numbers and technical terms and frequencies of communication facilities and provide it to the responsible persons
- To make arrangements for immediate communication as soon as early warning is received
- Besides the existing communication system, if it is necessary, an auxiliary communication system should be set up to get continuous weather forecast from neighboring countries and international Meteorology and Hydrology departments during the emergency period
- To set up a communication system which will be used by the supervisory organizations of the central committee to contact vertically and horizontally during their field trip to the disaster affected areas

(iii) Sub Committee on Search and Rescue

Sr. No.	Members	Designation
1	Minister, Transportation	Chairman
2	Deputy Minister, Home Affairs	Member
3	Deputy Minister, Foreign Affairs	Member
4	Deputy Minister, Rail Transportation	Member
5	Deputy Minister, Social Welfare, Relief & Resettlement	Member
6	Deputy Minister, Construction	Member
7	Representative from Ministry of Defense	Member
8	Director General, Department of Transport Planning	Member
9	Director General, General Administration Department	Member
10	Representative from Social Organizations	Member
11	Deputy Minister, Transportation	Secretary
12	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by the Minister, Transportation. The roles and responsibilities are:

- To prepare for search and rescue activities in the disaster prone regions, based on population and types of disasters (flood, storm, tsunami, fire, earthquake), and offshore islands, flooded plains, low plains, the shelter for victims, immediate relief materials, food and materials for live-saving.

- To constitute and train Regional Search and Rescue Teams
- To constitute Regional Teams of boats and assign duties to each member; Assign and dispatch Teams to the flood-prone regions
- To prepare and train Team members on rescue during fires and earthquakes
- To organize and train special teams on rescue from the collapsed buildings during earthquakes; To keep machines, tools and emergency life-saving tools in a state of readiness.

(iv) Sub-Committee on Information of Losses and Emergency Assistance

Sr. No.	Members	Designation
1	Minister, Commerce	Chairman
2	Deputy Minister, Social Welfare, Relief and Resettlement	Member
3	Deputy Minister, Agriculture and Irrigation	Member
4	Deputy Minister, Livestock Breeding & Fisheries	Member
5	Deputy Minister, Health	Member
6	Deputy Minister, Industry No.(1)	Member
7	Deputy Minister, Transportation	Member
8	Deputy Minister, Rail Transportation	Member
9	Deputy Minister, Foreign Affairs	Member
10	Deputy Minister, Forestry	Member
11	Director General, Co-operative	Member
12	Director General, General Administration Department	Member
13	Police Major General , Myanmar Police Force	Member
14	Chairman, Union of Myanmar Federation of Chamber of Commerce and Industry	Member
15	Representative from Social Organizations	Member
16	Deputy Minister, Commerce	Secretary
17	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, Commerce. The roles and responsibilities are:

- Assess damage and losses of the affected region through satellite imagery, aerial photographs, and reports from aviation and from the field

- Assess the need for relief materials based on the type of disasters and prepare for emergency period and regional transportation arrangements
- To make arrangements for distribution of relief materials in coordination with Regional authorities, Security forces and Police forces
- To systematically constitute relief materials distribution teams at Township Wards/Village Tracts levels
- To ensure availability of drinking water, water, fuel and emergency medicines
- To get data on human death toll, losses and damages
- To make arrangements for Emergency treatment, cremation, restoration of family units and other social activities

(v) Sub Committee on Assessment of Losses

Sr. No.	Members	Designation
1	Minister, National Planning & Economic Development	Chairman
2	Deputy Minister, Finance & Revenue	Member
3	Deputy Minister, Construction	Member
4	Deputy Minister, Agriculture & Irrigation	Member
5	Deputy Minister, Immigration & Population	Member
6	Director General, General Administration Department	Member
7	Director General, National Archive Department	Secretary
8	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, National Planning & Economic Development. The roles and responsibilities are:

- To collect, analyze and confirm data on death, damage and losses
- To estimate and verify data on requirement of relief and rehabilitation activities
- To keep record of long-term damage such as farms flooded by salt water

Sub Committee on Route Clearance and Transportation

Sr. No.	Members	Designation
1	Minister, Rail Transportation	Chairman
2	Deputy Minister, Transportation	Member
3	Deputy Minister, Energy	Member
4	Deputy Minister, Construction	Member
5	Deputy Minister, Finance and Revenue	Member
6	Deputy Minister, Social Welfare, Relief & Resettlement	Member
7	Director General, General Administration Department	Member
8	Director General, Communication, Posts and Telegraphs	Member
9	Deputy Minister, Rail Transportation	Secretary
10	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, Rail Transportation. The roles and responsibilities are:

- To maintain lists of regional transportation vehicles, boats and equipment and machinery for use in emergencies, to manage transportation facilities assigned by the higher level.
- To maintain lists of approach roads and auxiliary approach roads and monitor their condition and carry out maintenance work as necessary.
- To study main water way and approach water ways.
- To keep lists of airports and heli-pads.
- To make arrangements for fuel at the right place and in the amounts required.
- To identify vehicles stops check-points and communication machine.
- To provide a communication device for each vehicle group.
- To maintain lists of Vehicles, Water tank vehicles, Fuel tank vehicles, Ambulances, etc.

Sub Committee on Mitigation and Establishment of Emergency Shelter

Sr. No.	Members	Designation
1	Minister, Co-operative	Chairman
2	Deputy Minister, Progress of Border Areas & National Races & Development Affairs	Member
3	Deputy Minister, Construction	Member
4	Deputy Minister, Social Welfare, Relief and Resettlement	Member
5	Deputy Minister, Agriculture & Irrigation	Member
6	Deputy Minister, Health	Member
7	Director General, Co-operative	Secretary
8	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, Co-operative. The roles and responsibilities of Sub-committee are:

- To identify activities to be performed for Disaster Risk Reduction
- To select emergency shelter to be used during disaster.

Sub Committee Health

Sr. No.	Members	Designation
1	Minister of Health	Chairman
2	Deputy Minister, Home Affairs	Member
3	Deputy Minister, Social Welfare, Relief & Resettlement	Member
4	Chairman, Myanmar Red Cross Society	Member
5	Representative from Health Organization	Member
6	Deputy Minister, Health	Secretary
7	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, Health. The roles and responsibilities are:

- To formulate and take action for emergency health care
- To prepare emergency hospitals/ clinics/ mobile clinics for affected regions
- To impart necessary trainings on emergency health care
- To stock necessary drugs and to have plan for storage and distribution.
- To prepare for epidemic prevention

Sub Committee Rehabilitation and Re-construction

Sr. No.	Members	Designation
1	Minister, Social Welfare, Relief and Resettlement	Chairman
2	Deputy Minister, Construction	Member
3	Deputy Minister, Finance and Revenue	Member
4	Deputy Minister, Agriculture and Irrigation	Member
5	Deputy Minister, Home Affairs	Member
6	Deputy Minister, Health	Member
7	Deputy Minister, Industry No.(1)	Member
8	Deputy Minister, National Planning and Economic Development	Member
9	Director General, National Archives Department	Member
10	Director General, General Administration Department	Member
11	Representative from Myanmar Engineering Society	Member
12	Deputy Minister, Social Welfare, Relief & Resettlement	Secretary
13	To be assigned by chairman of sub-committee	Joint-Secretary

Chaired by Minister, Social Welfare, Relief and Resettlement. The roles and responsibilities are:

- To collect data on damage and losses
- To clear debris and undertake relief activities
- To coordinate on repair, reconstruction activities of education, health, agriculture and other sectors
- To give technical advice to disaster prone factories, work stations, building, roads, and bridges on having early warning system and emergency plan