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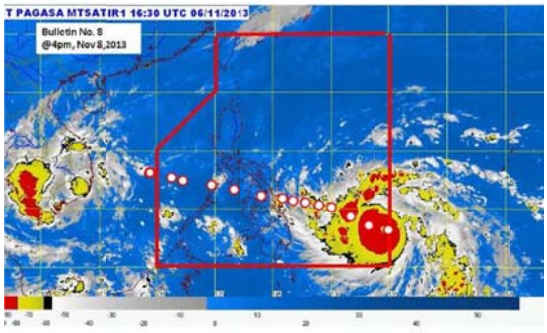
ESCAP/WMO Typhoon Committee

WORLD METEOROLOGICAL ORGANIZATION
UNITED NATIONS ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
ESCAP/WMO TYPHOON COMMITTEE

POST-TYPHOON HAIYAN (YOLANDA) EXPERT MISSION TO THE PHILIPPINES

MANILA AND TACLOBAN, 7-12 APRIL 2014

MISSION REPORT



COVER PAGE PHOTOS

Left: Satellite image of Typhoon Haiyan and the predicted track of Haiyan by PAGASA on 6 November 2013

Right: Ships dragged to land Tacloban after Haiyan (photo taken in April 2014)

CONTENTS

Report of the WMO/UN-ESCAP/Typhoon Committee Expert Mission to the Philippines 7-12 April 2014

1. Introduction

1.1 Typhoon Haiyan (also called "Yolanda" in the Philippines), one of the strongest typhoons ever recorded, crossed the Philippines on 8 November 2013, caused significant casualties and disruption to socio-economic activities in the Philippines although the accurate and timely forecasts and warnings on its movement and intensity had been provided days in advance. After Typhoon Haiyan hit the Philippines and brought catastrophic disasters to the central Philippines, the ESCAP/WMO Typhoon Committee Integrated Workshop (Macao, China, 2-6 December 2013) suggested that a post-Typhoon Haiyan expert mission to the Philippines be jointly organized by the World Meteorological Organization (WMO), the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) and the ESCAP/WMO Typhoon Committee. Following the Workshop, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) requested that an expert mission be organized to consolidate the lessons from Haiyan, from hazard monitoring and early warning perspectives and make recommendations on the way forward. The Typhoon Committee, at its forty-sixth session (Bangkok, Thailand, 10-13 February 2014), endorsed the organization of the mission.

Organization of the mission

1.2 In consultation with Dr Vicente Malano, Permanent Representative of the Philippines with WMO and Acting Administrator of PAGASA, a Post-Haiyan (Yolanda) Expert Mission was carried out from 7 to 12 April 2014. The mission team was composed of seventeen (17) experts from the Asia-Pacific Broadcasting Union (ABU), the Regional Specialized Meteorological Center (RSMC) Tokyo – Typhoon Center/the Japan Meteorological Agency (JMA), the National Disaster Management Institute (NDMI) and the National Emergency Management Agency (NEMA) of Republic of Korea, the Typhoon Committee (TC), the United Kingdom Met. Office (UKMO), UN-ESCAP and WMO. The list of the members of the mission team and Terms of Reference of the mission are given in **Appendix I** and **Appendix II**, respectively.

1.3 The mission was organized to obtain valuable insights from hazards monitoring and early warning systems (policies, institutional coordination and operational aspects before, during and after the event) processes and products in the context of Typhoon Haiyan (Yolanda) in the Philippines. Since the typhoon was well forecasted several days in advance, in addition to the monitoring of the hazard, the mission looked very closely at gaps in understanding the impacts of the hazard, its communication to all hazard partners and to the public in order to prepare the adequate and proper response. It sought to provide recommendations to PAGASA and the relevant Philippine authorities as well as their partners on how to further improve hazard monitoring, early warning, and understanding the impact of such a typhoon on the population in order to reduce death, injury, damage and losses from future natural disasters. The information collected is also expected to help consolidate the lessons that can be learnt at the regional level by members of the Typhoon Committee and the WMO/ESCAP Panel on Tropical Cyclones (PTC).

1.4 The mission utilized the concept of end-to-end hazard monitoring, early warning and identifying the impact of the detected hazard and make reference to the provisions of the Hyogo Framework for Action 2005-2015, particularly Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.

1.5 The programme of the mission, given in **Appendix III**, included: (1) meetings with PAGASA; (2) a meeting with PAGASA and stakeholders in Manila; (3) individual meetings with stakeholders including the National Disaster Risk Reduction and Management Council (NDRRMC), the United Nations Development Programme (UNDP) and the Japan International Cooperation Agency (JICA); (4) a meeting with stakeholders in Tacloban. In order to avoid any unexpected

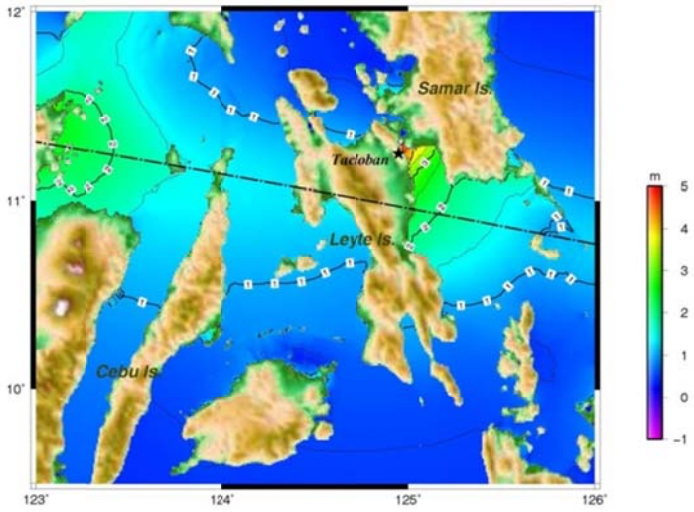
influence on the activities of the mission by a tropical disturbance developing east of the Philippines during the mission, the mission team was divided into two groups, i.e., one to visit Tacloban and the other to stay in Manila, on 9-10 April 2014. The list of persons consulted is given in **Appendix IV**. A report on the field visit to the area around Tacloban City is given in **Appendix V**

Typhoon Haiyan (Yolanda)

1.6 Haiyan (Yolanda) formed as a Tropical Depression (TD) over the sea southwest of Pohnpei Island at 06 UTC on 3 November 2013. Moving westward, it was upgraded to Tropical Storm (TS) intensity south of the Chuuk Islands at 00 UTC on 4 November. Keeping its westward track, Haiyan was upgraded to Typhoon (TY) intensity over the sea southeast of the Yap Islands at 12 UTC on 5 November and it reached its peak intensity with maximum sustained winds of 125 knots (64.3 m/s) and a central pressure of 895 hPa northeast of Mindanao Island at 12 UTC on 7 November. Moving west-northwestward, Haiyan crossed the Philippines with TY intensity and entered the South China Sea late on 8 November. The best track data of Haiyan and storm surge forecast (initial time: 18 UTC, 6 November) are given in **Appendix VI**.

Box 1 Storm Surge

Storm surge is an abnormal rise of sea level caused by meteorological forcing such as pressure depression (inverse barometer effect) and wind (wind setup). 1 hPa decrease corresponds to 1 cm rise by the inverse barometer effect. Surge height by wind setup is proportional to a) square of wind speed, b) wind range (fetch) of shallow zone, and c) reciprocal of water depth. Storm surges become large in large shallow seas.



Typhoon Haiyan generated large storm surges in many islands in the Philippines. Especially, quite high storm surge occurred in Leyte Island around at 00UTC on 08 November 2013, although it was in low tide time. Tacloban City of Leyte Island, located in inner part of Leyte Gulf, had devastating damage: high death toll and many broken buildings.

As storm surge more than 3 meters occurred in wide area of Leyte Gulf, surge height would be 4-5m around Tacloban City; even over 7m trace heights were observed in some points. Many buildings were inundated to the second floor level, which indicates inundation depth would be 2-3 m. Almost whole beach zone and the peninsula, where Tacloban airport is located, were deeply inundated, most houses were destroyed and many remained residents were killed.

People saw that sea water moved to off-shore at first, and then huge water quickly rushed into beaches as if tsunami. Several people testified that water level rise had three phases in the surge event.

Damages caused by Haiyan

1.7 Due to Typhoon Haiyan with wind speed of more than 300 km/h and storm surge of over four (4) meters, over 6,000 people were killed, about 28,000 injured, about 1,000 missing, and 12.2

million affected. The economic loss of the country is estimated USD 2 billion. **Appendix VII** shows the damage caused by Haiyan in Tacloban City.

1.8 A number of stations and facilities of PAGASA were damaged by Haiyan. **Appendix VIII** shows the photos of the Guiuan radar station and synoptic stations in Guiuan and Tacloban after Haiyan. The list of PAGASA stations and facilities damaged by Haiyan is given in **Appendix IX**.

Box 2 PAGASA's Tacloban Station

On 8 November 2013, at the PAGASA Tacloban Station in Tacloban airport, Mr Marion Peñaranda, Chief Meteorological Officer, and three (3) other staff members continued to make meteorological observations and to report to headquarters of PAGASA until 5 a.m. Due to the extremely strong winds and heavy rainfalls, they were unable to continue operations and try to move for safer/higher place. As the station was very close to the sea and affected by storm surge, it was extremely difficult for them to move. Finally they broke the windows and moved to the higher place but one staff was missing. After storm surge receded around 10:30 a.m., they walked through rubbles to their homes, 11km away from the station, for half a day.

Currently, Tacloban station is temporarily located in the building of the Department of Science and Technology in Palo District and meteorological observations are made with instruments/equipment which were not damaged during Haiyan and some other equipment supplied by the PAGASA headquarters.

Chronology of PAGASA's activities

1.9 PAGASA responded to Haiyan as follows:

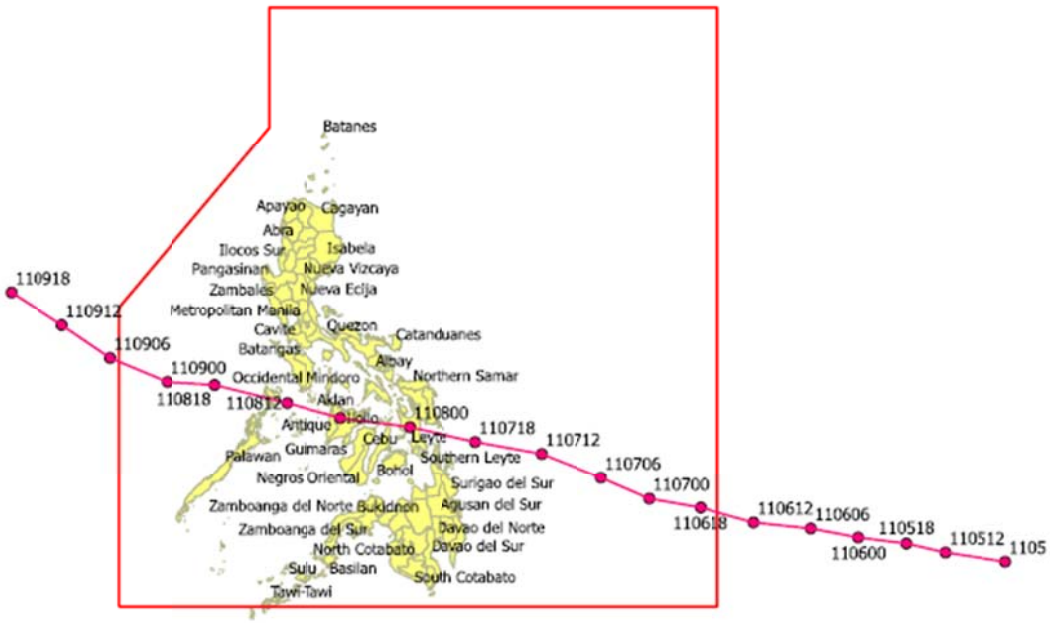


Fig. 1 - Track of Haiyan (number: month/day/hour)

5 November

- Issued initial Weather Advisory.
- Visayas PRSD (PAGASA Regional Services Division) alerted the media and Provincial Governors of Cebu & Bohol of approaching TY.

6 November

- Issued Regular Severe Weather Bulletin although the TY was still outside PAR (Philippine Area of Responsibility).
- Presented in the NDRRMC meeting the forecast track of TY Haiyan and possible impacts.
- Press conference - PAGASA emphasized that PSWS (Public Storm Warning Signal) No. 4 will be issued and storm surge is expected.
- Assigned a meteorologist at the NDRRMC Operations Center.
- Dispatched 2 meteorologists to Iloilo.
- Dispatched 2 radar technicians to Hinatuan Radar operation.

7 November

- Deployed STRIDE (Severe Tropical Weather Disturbance Reconnaissance, Information Dissemination and Damage Evaluation) Team to Sorsogon.
- Emphasized that a storm surge of **5-7 meters** is expected over the coastal areas in provinces of Surigao, Dinagat, **Samar and Leyte**, Sorsogon, Masbate, Northern Cebu and Bohol.
- Conferred with the President who called for a nationwide preparation for the strong TY and stressed the occurrence of storm surge particularly in areas along its path.
- Provided hourly updates on the location and intensity of Haiyan.
- Press conference/press briefings every 6 hours until November 9.
- [TY Haiyan intensified and accelerated as it moved closer to landmass].

8 November

- Auxiliary bulletin was issued at 2 a.m. to include other areas in Central Visayas and Southern Luzon under PSWS#4 due to acceleration of Haiyan.
- 4:40 a.m., Haiyan made landfall over Guiuan, Eastern Samar.
- 11 p.m., Haiyan exits the landmass of Northern Palawan after crossing Central Visayas and Southern Luzon area.

9 November

- PSWS #3 and #4 were lowered after Haiyan crossed Visayas islands and continued to move away from the country
- Final bulletin was issued at 3:30 p.m. as Typhoon Haiyan exits PAR.

2. Early Warning System in the Philippines: Overview of Hazards and Associated Risks and Impacts; Roles and Responsibilities

2.1 The Philippines is one of the most disaster-prone countries in the world, and faces multiple hazards including, but not limited to, typhoons, storm surges, flooding, landslides, volcanic eruptions, earthquakes and tsunamis. Typhoons and the related risk of storm surges represent a particular challenge, as the Philippines is affected by 20 typhoons/tropical cyclones per year, on average. Traditionally, the north-eastern parts of the country are particularly affected by typhoons; however in recent years southern parts such as Mindanao have also experienced strong typhoons, causing large-scale loss of lives and material damage. Meanwhile, rapid urbanization, often located in coastal areas, is putting new populations at risk.

2.2 The hazard profile of the Philippines makes disaster management, including early warning, a national priority. The National Disaster Risk Reduction and Management Council (NDRRMC), formerly known as the National Disaster Coordinating Council (NDCC), is the highest policy-making, coordinating and supervising body for disaster management in the Philippines. It is administered by the Office of Civil Defense under the Department of National Defence, and brings together all the relevant parts of the government in order to ensure coordination. The NDRRMC model is replicated at the provincial and local levels. The networks and the information flow of NDRRMC are given in **Appendix X**.

2.3 In terms of early warning, PAGASA (for hydro-meteorological and climatological hazards) and the Philippine Institute of Volcanology and Seismology (PHIVOLCS) (for geophysical hazards) transmit forecast and warning information to the NDRRMC, which in turn consolidates information from various parts of the Government and disseminates it to the members of the NDRRMC as well as provincial and local councils and the general public. PAGASA's information is also made available directly to the public at the national level. The provincial and local councils play a key role in ensuring that warnings reach the populations at risk and that appropriate actions (e.g. evacuations) are taken.

3. Role of PAGASA in Supporting the EWS: Meteorological and Hydrological Facilities and Services

3.1 PAGASA's observing systems and networks, given in **Appendix XI-1**, are composed of:

- Synoptic stations 58
- Agro-meteorological stations 25
- Satellite data receiving facilities 5
- Wind profiler 1
- Meteorological buoys 2
- Upper-air stations 6
- Automatic Weather Stations (AWSs) 157
- Automatic Rain Gauges (ARGs) 180
- "Flood Forecasting Warning System Centers" 5
  (Telemetered hydrological networks - major river basins)
- Weather radars 10

3.2 PAGASA's data-processing concept, telecommunication logical framework, flood forecasting network; and advisories and warnings, information dissemination flow and mode of dissemination are given in **Appendix XI-2** and **Appendix XI-3**, respectively.

4. Identification of Strengths, Challenges and Gaps, Opportunities and Threats for Enhancing Early Warning System (EWS) in the Philippines

4.1 The mission team identified (i) **strengths**, (ii) **challenges and gaps**, (iii) **opportunities** and (iv) **threats** for enhancing early warning system (EWS) in relation to Typhoon Haiyan (Yolanda) related to policy, institutional and human resources, and capacity development as follows:

(i) Strengths

PAGASA

(1) Integrity, commitment and patriotism are strong attributes of PAGASA and partners in the discharge of their duties.

(2) A dedicated and hardworking team in PAGASA at national and provincial level, culture of openness and commitment to improve skills and operations.

(3) Good forecast of track and intensity of Haiyan was supported by modern technologies such as Doppler weather radars, meteorological satellites, numerical weather prediction (NWP) outputs and official TC forecasts from RSMC Tokyo and other National Meteorological and Hydrological Services (NMHSs).

(4) Continuity of service at PAGASA is normally assured through redundant data transmission and power supply, but due to exceptional circumstances of Haiyan, one of the radar sites as well as the basic instruments were totally destroyed and the communication links were cut at Guiuan and Tacloban, and other stations in a lesser

extent. In such situations, short wave (SSB) radio sets were effective to maintain the minimum communication with its headquarters.

(5) PAGASA has started a pilot project of its localized warning service against thunderstorm and heavy rainfall for Metro Manila, which could be a good showcase of its capability to do detailed service to the public. This is already being done in Visayas and Mindanao.

(6) PAGASA is well represented at the command operation center of NDRRMC and its staff are embedded in the center at the onset of severe weather situations. In the case of Haiyan, they were present at the Command Centre 2 days before the landfall.

(7) PAGASA is regarded as a credible and well-respected organization by its partners and the public, and this proved an important asset.

Government and local authorities

(8) TC warnings, including the statements on the potential risks of floods, landslides, and storm surges at the provincial level, were issued with sufficient lead time. Engagement and commitment of the Government at the highest level was evident.

(9) Effective leadership and coordination at the local level were demonstrated before, during and after Haiyan.

(10) Good set of policies, laws and protocols exist to guide to work of PAGASA and the disaster management.

(11) Spirit of community cooperation and resilience was amply demonstrated during Haiyan.

(12) Flexibility of emergency responders to assume roles and responsibilities beyond their mandate was evident.

(13) A policy framework at the DRRM office of the Department of Education has been formulated to provide guidance and advice to schools on how to prepare to respond to warnings issued by the Local Government Units (LGUs) based on information from PAGASA. Actions are taken based on this framework to provide specific advice on school preparedness policy; improvements in the design of school infrastructure; and school hazard mapping to raise awareness.

(14) Quick actions were taken by emergency responders to address and minimize to the extent possible spread of disease, e.g., through removal and burial of corpses.

(15) There is willingness in all parties involved - PAGASA, NDRRMC, national and local media and NGOs to cooperate in improving the Standard Operating Procedures (SOP) and learn from their and other countries' experience.

Mass media

(16) Vibrant media community existed during Haiyan.

Box 3 Evacuation saves whole island from Typhoon Haiyan

The tiny island of Tulang Diyot, which lies just off the island of San Francisco

(UN-ISDR News Archives: http://www.unisdr.org/archive/35524)
By Andy McElroy

GENEVA, 15 November 2013 – The prompt evacuation of 1,000 people from a tiny island that had all 500 houses destroyed by Typhoon Haiyan saved the entire population according to a local leader who has been a long-time champion for disaster risk reduction.

The former Mayor of San Francisco, Cebu Province, Alfredo Arquillano, said years of work to strengthen community preparedness and reduce disaster risk prevented a catastrophe for the residents of Tulang Diyot. San Francisco is officially recognized as a role model by the UN Office for Disaster Risk Reduction (UNISDR) in a highly hazard-prone part of the world.

"The day before, when it was clear how bad the typhoon would be, we decided to evacuate all 1,000 people. Because we've done so much work on disaster risk everyone fully understood the need to move to safety," Mr. Arquillano said. He is still referred to locally as Mayor Al.

"My goodness, it was a good decision; it's fair to say it saved everyone's life. There is not one house left standing on the island, everything was wiped out.

"It just shows that preparedness pays. We have been working for years on early warnings, evacuations. The awareness level of the community was so high that it went well. We have worked hard to localize the international agreement on disaster risk reduction, the Hyogo Framework for Action."

Tulang Diyot is about 1.5km long and 500 metres across at its widest and lies about 1km off San Francisco island, part of the Camotes Islands which are sandwiched between the larger neighbouring islands of Leyte to the east and Cebu to the west

Mr. Arquillano who is a Champion of the UN Office for Disaster Risk Reduction's Making Cities Resilient Campaign, said it was important now to work towards reducing future disaster risk.

"We're already talking with the islanders that they should relocate to the main island (of San Francisco). They shouldn't go back. While most people understand the risk because Tulang Diyot is so low-lying it is very hard for them not to return as this is their home.

"It will be a challenge to try to relocate them somewhere safe and where they can rebuild their livelihoods as fishermen or farmers."

Under his leadership San Francisco won the UN's Sasakawa Award for Disaster Risk Reduction in 2011 for its community work based on what is known as the 'Purok system', an indigenous method of self organization within villages.

As part of the 'Capital Build Up' programme, the community deposits agreed amounts as initial capital for post-disaster assistance.

(ii) Challenges and gaps

PAGASA

(1) The Bulletins are manually made by the forecasters and naturally prone to human errors and delayed issuance.

(2) Radar data from 10 sites provided a reasonable coverage of the Philippines and was used by the forecasters to comprehend mesoscale phenomena. However, some of the sites have not been functioning due to hardware troubles for certain length of time. Lack of quality assured radar composite maps makes it difficult for the forecasters to monitor whole pictures of on-going severe weather phenomena over the Philippines.

(3) Shortage of tide gauge observation due to non-existence of data sharing framework with other governmental agencies prevented PAGASA from monitoring storm surges in real time.

(4) Insufficient use of deterministic and ensemble guidance products for TC track and intensity from other NMHSs results in reliance on official TC forecasts of other centers. Also, it is difficult to convey information on uncertainty of TC track forecasts to users appropriately, due to lack of effective use of such guidance.

(5) Very high-resolution model data could not be ingested at PAGASA due to limited technical capacity. Those weather models that were available on PAGASA's visualization system tended to underestimate the detailed mesoscale structure of Haiyan (the pressure in the eye, and the strength of the core winds at the local level).

(6) The unavailability of current level of skill and capacity to fully couple the meteorological (NWP and ensemble) models with other hazard models and hazard mapping meant that the severity, timing and extent of the associated hazards (storm surge, landslides and flooding) were underestimated.

(7) Spatial distribution of observing meteorological networks in the whole country is not even, especially in Mindanao and some parts of the Visayas. In the case of hydrological observation, only 5 out of 18 major river basins have monitoring network. For those 5 rivers basins, flood forecasts may be issued by PAGASA. For the other 13 rivers basins without monitoring network, only advisories are issued which may engender immediate action. Equipping all major rivers with telemetry systems will enable flood warnings to be issued for all of the river basins, leading to greater portion of population taking protective action.

(8) Inadequate scheme for the retention of technical expertise (e.g., due to high turnover of staff) and limited provision of cross-training to officers involved in the early warning systems and services across different relevant organizations may have had a negative impact on the preparation and response to Haiyan.

(9) Limited tailored services for different sectors, e.g., land transport.

(10) Current status of damaged observatories, especially in Tacloban, is vulnerable to the possible next hazard. The location and condition of observatory's temporary building, installation environments of meteorological instruments and lack of sufficient communication equipment could easily lead to malfunction of the observatory in next severe weather event.

(11) The loss of life of one of the PAGASA staff in Tacloban Station during Haiyan raises questions about the internal safety procedures. They have to be reinforced and backed up by regular safety drills.

(12) Some TV crews disrupted PAGASA's operations at the headquarters and the Tacloban station due to the lack of its internal non–access policy.

(13) Lack of objective verification of forecasts may have resulted in lack of knowledge of the quality and reliability of forecasts and warnings.

Government and local authorities

(14) Lack of scientific and technological capacity to translate hazard information into impacts meant that the impacts were underestimated.

(15) A combination of possible lack of appreciation and utilization of available hazard maps at the local level for exceptionally severe storm surge resulted in evacuation to unsafe shelters that got destroyed. The current official hazard maps for the storm surges provided by PAGASA only estimated inundation areas for the storm surge heights of up to 4 meters and invalid for this case.

(16) Potential inconsistency in the interpretation of the information from different sources delivered through multiple channels may have contributed to the public and responder confusion.

(17) Use of the current return period methodology may be inappropriate for building a resilient Philippines since the past is no longer the best guide to the future events. Historical return periods no longer adequately represent the occurrence of severe events, and rather than being generated statistically from historical information alone; they need to be complemented by projecting future changes based on seasonal and climate models while the performance of the models must be strictly validated.

(18) Lack of a service evaluation framework may have contributed to misunderstanding by the public of the hazard warning messaging and taking appropriate response action.

(19) Limited number of shelters and lack of adequate resources and services (power, sanitation and safe water) to keep people comfortable and safe to encourage the population to evacuate when ordered to do so seems to be an important factor in refusing to evacuate by the population.

(20) Loss of communication facilities following Haiyan led to limited information for a number of days leading to lack of situation awareness. NDRRMC situation report number 11 issued on 10 November 2013 stated the casualties as 229 dead, 45 injured and 28 missing. This indicated that the full scale of the disaster was not yet known and therefore did not elicit appropriate response. A corresponding report attributed to the Red Cross gave the number of dead as 1200. These two reports highlight the inconsistency in establishing the truth about impact of such an event.

Interface with public

(21) Warnings were not communicated in layman's language and in such a way as to trigger life-saving actions, for example quantifying the height of the storm surge with tangible reference points such as the height of known landmarks or buildings, the speed of the surge and the extent of the inundation.

(22) The inundation distance of the storm surge was mostly 1 km or two, so that people could have been able to evacuate within an hour if weather should have permitted doing so. However, due to the stormy conditions they should have evacuated hours before the storm surge. Thus timely information is essential for successful evacuation.

(23) The information on the storm surge is vital for the safety of the people in the coastal area. It should be more easily understandable information specifying potential affected areas, expected inundation heights or storm tides, and the occurrence time. The graphical information is preferable for people to understand disaster crisis by storm surges clearly.

(24) Unfamiliarity of the term "storm surge", lack of short memory/knowledge of past storm surge events, the past experiences of not having been affected by TCs in spite of TC warnings, led to people being caught unawares of or underestimated the extent of the risk and severity of the impact of the typhoon and the resulting storm surge event.

(25) Inconsistency in effective leadership and coordination at the local level may have led to inadequate response.

(26) The non-existence of an organized body of community-based volunteers to establish the link between the LGUs and fishermen and other communities, in the last mile warning dissemination, prevented the warnings from reaching the addressees in some areas affected by Haiyan.

(27) Delayed effective response to manage the distribution of food and water supplies and restoring law and order, due to slow deployment of army and police and other personnel engaged in keeping peace and order.

(28) Lack of understanding the warnings by the public due to the use of scientific jargon, vague language failing to communicate the severity and urgency in the warnings may have led to inadequate response by the public. In addition, cultural habits and beliefs may have contributed to non-action on the part of the recipients. Both these issues

need to be addressed through organizing educational campaigns at all levels of society.

(29) The warnings should be stated in a manner that for whom the warnings are intended to urge the people at risk, to take necessary actions effectively. The nationwide information may be used to raise the attention of the entire nation but might be short of this objective.

(30) Lack of engagement of social sciences to understand behaviors and decision making processes of the population has a role in lack of proper response.

(31) The heavy emphasis on using electronic means to disseminate emergency warnings leaves out big number of people who do not have access to Internet or mobile phones. There is an overwhelming need to look at low-tech solutions to reach these people.

(32) There is no evidence of any stakeholder in the chain of communications making special effort to reach the most vulnerable groups – women, children, people with disabilities and elderly. These groups need to be targeted through different channels of communications then radio and TV and with specialized TV messages.

(33) There is no concentrated effort on behalf of the agencies issuing the signal to educate the end-users of what the warnings mean and how to react if the warning is issued.

Mass media

(34) There is no regular communications and coordination between media on one hand and PAGASA and NDRRMC.

(iii) Opportunities

PAGASA

(1) A regional or sub-regional WMO Integrated Global Observing System (WIGOS) project on Capacity Building in Radar Techniques in Southeast Asia could provide PAGASA with opportunities to enhance its capacity in Radar data techniques in effective and efficient manners, through cooperation with the ASEAN (Association of Southeast Asian Nations) countries and other advanced WMO Members.

(2) Strengthening of impact-based forecasting and risk–based warnings to engender more effective response from the recipients of such information.

(3) Transforming PAGASA into a world class service provider in order to fulfill its mission which is “to protect lives, properties and livelihood through accurate, timely and reliable weather-related information services”.

(4) Improving the availability and quality of observation data (e.g., hydrometeorological and atmospheric composition) through the effective implementation of WIGOS-related ongoing and future projects.

(5) Developing a seamless meteorological model across all time scales (nowcasting, short term, medium term, seasonal and climate).

(6) Developing, implementing convective scale high-resolution deterministic and ensemble-based prediction models.

(7) Creating, providing and visualizing diagnostic products for a range of hazards such as flooding, storm surge, landslides and health-related hazards derived from these new models.

(8) Developing quality assured (verification evaluation and customer service), tailor-made services for different sectors through the most cost-effective methods.

(9) Training highly skilled motivated staff who will provide excellent and high-quality services and advice through the implementation of the above actions.

(10) To be recognized as a world leading center and establish a two-way collaboration with regional and global centres.

Government and local authorities

(11) The creation of a multi-hazards one-stop shop early warning service could be achieved through optimization of the existing and future capabilities in the Department of Science and Technology (PAGASA and partners)

(12) To synergize the efforts of all stakeholders involved in early warnings and disaster communications – PAGASA, NDRRMC, media, LGUs, NGOs, community etc. and improve Standard Operating Procedures (SOPs) not only of the different agencies but also the SOPs for communications between the agencies especially before the natural hazard hits.

(13) To provide media and communications training to PAGASA and NDRRMC.

(14) The disaster and the devastation brought by Haiyan/Yolanda fury is an unique chance to rebuild the whole area in a sustainable way and make it a showcase for DRR management in all aspects from construction to fishery and farming.

(15) Further raising awareness of hazards and their impacts by engaging the local officials, communities and schools through campaigns by PAGASA and other partners such as the Office of Civil Defense, the Department of Interior and LGUs, and the Department of Education as well as a number of NGOs.

Interface with public

(16) Availability of high density of mobile phones in most regions and social media could be better utilized for dissemination of warnings and related emergency information during the time leading to the event but should not be the only means of communication during and after the event due to destruction of cell towers etc. Mobile technology is particularly helpful in advising the population on the location of shelters and also to observe and record hazard impacts through crowd sourcing technologies.

(17) To establish joint training programmes and public educational campaigns for and by government agencies, media and NGOs.

Mass media

(18) To engage media in more formal way and make it an integral part of the emergency warnings by using the broadcast networks for disseminating timely, clear and understandable warnings and information.

(iv) Threats

(1) Increased frequency and intensity of severe weather-related events and impacts.

(2) Increased reliance on technology that may be vulnerable to extreme events.

(3) Global economic crises and resulting fiscal austerity leading to less resources for providing prediction and warning services at the national level and less funding through donor agencies and partners, including those for observing system networks.

(4) Competition from non-competent and/or multiple service providers leading to public confusion during times of crises.

(5) Loss of operational capacity at PAGASA and emergency responders and their respective centres due to a very severe event.

(6) Loss of contact with the neighboring countries during extreme events leading to lack of data and information for generating forecasts and warnings.

(7) Weak coordination between local and national governments can be a big hurdle for reconstruction and improving the work of all agencies

5. Recommendations

5.1 Based on the above analysis, the mission team made the following recommendations:

PAGASA

(1) Support **PAGASA's mission** to become a world class Hydrometeorological center that will provide multi-hazard official authoritative warning services.
(Action: **WMO/SWFDP, UKMO, JMA, KMA, NDMI, ADPC and other partners**)

(2) Support the enhancement of the implementation of **impact-based forecasting and risk-based warning services** by PAGASA. This will be achieved by building on the existing methods and skills, ensuring the use of plain and unambiguous language in warnings and developing in partnership with social science practitioners an understanding for decision making processes by the public.
(Action: **PAGASA, NDRRMC, academia, NGOs, Typhoon Committee, WMO, UKMO, JMA practice after tsunami, and other partners**)

(3) Create a **framework** to allow the successful implementation of project plans to install and manage new **observing networks** across the Philippines.
(Action: **PAGASA and WMO**)

(4) Recruit and make every effort to retain **highly skilled and motivated staff** to support delivery of early warning services, encourage secondments and scholarship opportunities with international partners.
(Action: **PAGASA, UKMO, Typhoon Committee and other partners**)

(5) Review the arrangements for the **provision of meteorological information before, during and after a severe weather event** based on the experience of Haiyan and also the feedback from the UN's response to this report.
(Action: **WMO/Commission for Basic Systems**)

(6) Develop and implement a **comprehensive media communication plan** to include the following components: media management, communications with the public for disasters, writing clear and understandable messaging for disasters etc.
(Action: **ABU and PAGASA**)

(7) Train PAGASA Senior Management and Public Relations Unit in **communication skills and media management**.
(Action: **ABU and PAGASA**)

(8) Train selected weather forecasters of PAGASA in **presentational skills** to do national and local TV weather forecasts.
(Action: **ABU and PAGASA**)

(9) Train all forecasters of PAGASA in **writing in a layperson language** emphasizing on impact of the hazard rather than technical parameters.
(Action: **ABU and PAGASA**)

(10) Assist PAGASA to **visualize the impact of the coming hazards**.
(Action: **ABU and PAGASA**)

(11) Assist PAGASA to **sustainably operate and maintain its observational networks**.
(Action: **PAGASA, WMO and partners**)

(12) **Further enhance observational networks**, and to make **more effective use of the observational data** in an integrated manner, particularly to develop quality assured radar composite maps from all the radar sites at PAGASA.
(Action: **PAGASA, WMO and partners**)

(13) **Develop disaster specific warning services** at the local level for effective DRR activities by LGUs. Priority should be put on developments of quantitative precipitation estimate from the radar data calibrated by using AWS and ARG data and utilization of NWP data in a more advanced way, such as production and use of statistical guidance. Establishment of a forecast supporting computer platform enabling forecasters at national to local levels to work on the same platform is needed to provide timely and consistent local warning services across the nation.
(Action: **PAGASA, NDRRMC, Typhoon Committee and WMO**)

(14) Extend **localized warning services**, through warning coordination with DRR authorities, particularly Governors and Mayors in charge of emergency responses based on the outcomes of the pilot project against heavy rain and thunderstorm for Metro Manila.
(Action: **PAGASA and NDRRMC**)

(15) Develop a **national database on past cases** which can help to grasp the risk of a similar case.
(Action: **PAGASA and NDRRMC**)

(16) Create a **framework to share tide gauge observation** in real time
(Action: **PAGASA, National Mapping and Resource Information Authority (NAMRIA), PHIVOLCS and other governmental agencies**)

Government and local authorities

(17) Urgently review and test **country-wide resilient infrastructure and business continuity plans** for PAGASA and emergency responders to withstand major threats to service provision.
(Action: **PAGASA and NDRRMC**)

(18) Scale up **local level risk mapping and public education** to increase awareness of hazards and their impacts and appropriate response, particularly at the community level.
(Action: **Government, media, NGOs, UN-ESCAP and UNDP**)

(19) International partners including the UN to improve the **uptake and use of early warning information** issued by authoritative organizations for preparedness and early action.
(Action: **UN-OCHA and UNDP**)

(20) Develop **special messaging and channel of communications** to reach the most vulnerable groups – children, women, persons with disability and elderly people.
(Action: **PAGASA, NDRRMC and media**)

(21) Continue, intensify and expand to the whole country the measures already taken in the province of Cebu, in the second quarter of 2012, which consisted of training 940 **community-based volunteers** from the municipalities of Borbon, Sogod, Carmen, Catmon and Moalboa, in the aftermath of Washi/Sendong (17 December 2011) and the 6.9 magnitude earthquake in Negros (6 February 2012).
(Action: **PAGASA, NDRRMC and local authorities**)

Mass media

(22) Establish **more formal information and coordination structures** for media, PAGASA and NDRRMC to exchange information, updates and joint activities.
(Action: **mass media, PAGASA and NDRRMC**)

(23) Explore the possibility of developing a **depository of video clips from past disaster events in Asia**. Effective use of such materials for education and publicity in emergency situation allows the public to immediately understand the risk of the natural hazards unfamiliar and less frequent, such as storm surge.
(Action: **ABU**)

Typhoon Committee

(24) To make **multi-stakeholder expert missions** such as the one conducted for Typhoon Haiyan common practice, following major disasters caused by tropical storms in the region covered by the Typhoon Committee, in the interest of facilitating collective learning, sharing of good practices and strengthening of early warning systems.
(Action: **Typhoon Committee**, **WMO** and **UN-ESCAP**)

Box 4 Community-based volunteers

Despite the good performance of the dissemination of the warnings, it seems that it failed between the Local Government Units and some communities, including fishermen and rural communities. According to explanations given by PAGASA, the mode of dissemination is done using telephone/fax/SMS; media (radio, TV and newspapers); website/e-mail alerts; social media (Facebook, Twitter); mobile Apps; signs; billboards; bells and drums (in indigenous communities). Nevertheless it seems that these means are not fully efficient at the last-mile of the process. Situations of this type have also recently happened when the severe tropical storm Washi/Sendong caused flash floods with the dramatic consequence of a death toll of more than 2,000 (17 December 2011), and when the Typhoon Bopha/Pablo (3 December 2013) caused more than 600 fatalities, both in Mindanao, region that was considered up to 2011 not significantly prone to tropical cyclones.

One way of trying to solve this gap could be to continue, intensify and expand to all over the country the actions already taken in the province of Cebu, Philippines, in the second quarter of 2012, which consisted of training 940 community-based volunteers from the municipalities of Borbon, Sogod, Carmen, Catmon and Moalboa, in the aftermath of Washi/Sendong and the 6.9 magnitude earthquake in Negros.

Some countries have already taken similar measures with great success. It is the case of Bangladesh where, in the aftermath of a cyclone that caused about half million victims in 1970, the Cyclone Preparedness Programme (http://www.cpp.gov.bd) was established in 1972 by the request of the United Nations and the help of the then League of Red Cross. This programme is still considered a very successful initiative nowadays and was awarded with the “Smith Tumsaroch award-1998” for its Outstanding Performance in disaster management. This Programme has 203 officers/staff and 49,365 volunteers, 32% of which are females.

6. Proposed Projects and Actions

6.1 The mission team proposed the following projects and actions:

PAGASA

(1) Rehabilitation of damaged synoptic stations, with priority for calibrated instruments and communication equipment (SSB), through WMO/Voluntary Cooperation Programme (VCP) and other possible support programs.
(Action: **PAGASA**, **WMO and other partners**)

(2) NWP delivery and optimization, seasonal capability, impact forecasting and corresponding human resource development.
(Action: **UKMO**)

(3) Building resilience to climate extremes (providing assessment of impact of climate extremes, understanding risks, and development of high resolution regional climate scenarios)
(Action: **UKMO**)

(4) Full development and implementation of the WMO Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia.
(Action: **WMO and partners**)

(5) Development of impact forecasting with full utilization of the observational networks and NWP products available.
(Action: **PAGASA, NDRRMO, WMO, UKMO and other partners**)

(6) Development of localized warning services through warning coordination with DRR partners including LGUs.
(Action: **PAGASA, NDRRMO, WMO, UKMO and other partners**)

(7) Further improvements of forecasting accuracy of typhoons/tropical cyclones and associated severe weather phenomena including storm surges.
(Action: **PAGASA, NDRRMO, WMO/UKMO and other partners**)

(8) Organize and implement a Programme for secondments and scholarships.
(Action: **UKMO, WMO and partners**)

(9) Review current project plans to ensure effective management of installation of observing networks. Specific recommendations are given in **Appendix XII**.
(Action: **PAGASA, WMO and partners**)

(10) Development of a framework to share tide gauge observation in real time.
(Action: **PAGASA, NAMRIA, PHIVOLCS and other governmental agencies**)

(11) Develop a comprehensive media plan for PAGASA, so that their officers can handle media enquiry efficiently and build up the public reputation of the organization as a reliable official source of information for hazards.
(Action: **ABU and WMO/PWS**)

(12) Organize in-country training courses for PAGASA staff on media relations etc.
(Action: **ABU and WMO**)

(13) Develop/strengthen internal PAGASA Standard Operation Procedure (SOP) on safety of staff in emergency situations and introduce regular drills and exercises.
(Action: **ABU, WMO and partners**)

(14) Develop Media Manual for issuing warnings and covering different hazards in different local languages.
(Action: **ABU and WMO/PWS**)

<u>Government and local authorities</u>

(15) Risk mapping and public education.
(Action: **Government, media, NGOs and UN Organizations**)

(16) Develop a national database on past typhoon/tropical cyclone disaster cases in the Philippines.
(Action: **ABU, WMO, PAGASA and partners**)

(17) Training of community-based volunteers on Disaster Risk Reduction and Management (DRRM) to warn the people and help the evacuation in the last mile warning dissemination
(Action: **Typhoon Committee, PAGASA and partners**)

(18) Development of Standard Operating Procedures for the EWS, with particular focus in the last-mile of warning dissemination of coastal hazards, at neighborhood level.
(Action: **UN-ESCAP and partners**)

(19) Organize workshops on writing messages for early warnings and communications for DRR for PAGASA, NDRRC and media to focus the structure and language of the messages on information of the impact of the coming calamity rather than their scientific characteristics.
(Action: **ABU, UN-ESCAP and WMO**)

(20) Organize a workshop in Tacloban for all local agencies involved in the process of communications for early warnings and communications for disasters.
(Action: **ABU, UN-ESCAP and PAGASA**)

Mass media

(21) Explore the possibility of developing a depository of video clips on past disaster events in Asia to be offered rights free to National Meteorological and Hydrological Services in the region and broadcast with the warnings to reinforce the severity or urgency of the warnings
(Action: **ABU, WMO, PAGASA and partners**)

7. Acknowledgement

7.1 The mission team would like to acknowledge with appreciation the strong support provided by Dr Vicente Malano, Permanent Representative of the Philippines with WMO and Acting Administrator of PAGASA and his staff, in particular Dr Esperanza Cayanan, Focal Point of the mission in PAGASA. The mission team would like to express its sincere appreciation to Dr Susan Espinueva of PAGASA who initially arranged this mission but passed away right after the mission. The mission team would also like to acknowledge the significant contributions by all individuals and groups who participated in the meetings and discussions during the mission.

Appendix I: List of the members of the mission team

Asia-Pacific Broadcasting Union (ABU)		
Ms Natalia Ilieva	Executive Assistant to the Secretary – General	natalia@abu.org.my
RSMC Tokyo – Typhoon Center/Japan Meteorological Agency (JMA)		
Mr Tsukasa Fujita	Head, RSMC Tokyo - Typhoon Center	fujita.tsukasa@met.kishou.go.jp
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Typhoon Committee (TC)		
Mr Olavo Rasquinho	Secretary	olavo@typhooncommittee.org
United Kingdom Met. Office (UKMO)		
Mr Paul Davies	Executive Head, Chief Meteorologist	paul.davies@metoffice.gov.uk
United Nation Economic and Social Commission for Asia and the Pacific (UN-ESCAP)		
Mr Alf Ivar Blikberg	Programme Officer, Trust Fund for Tsunami, Disaster and Climate Preparedness, Information and Communications Technology and Disaster Risk Reduction Division	blikberg@un.org
World Meteorological Organization (WMO)		
Mr Kuniyuki Shida	Senior Programme Manager for Regional Coordination, Development and Regional Activities Department	kshida@wmo.int
Ms Haleh Kootval	Chief, Public Weather Services Division, Weather and Disaster Risk Reduction Services Department	hkootval@wmo.int
Mr Luis Filipe Nunes	WIGOS Scientific Officer, Observing and Information Systems Department	lfnunes@wmo.int

Appendix II: Terms of Reference

In close collaboration with the national counterpart authorities, the mission will perform the following tasks:

1. Assess the setup and configuration of the meteorological and hydrological facilities and services, in particular:
   (a) meteorological and hydrological observing networks;
   (b) communication facilities and coordination mechanisms for data transmission and reception on national and regional levels, including the reception of data and products from meteorological and environmental satellites, and if necessary, set up new coordination mechanisms at global and regional levels for meeting future needs;
   (c) data processing activities and facilities; data utilizations in disaster risk reduction (DRR) areas;
   (d) weather, flood and storm-surge forecasting activities and facilities in use; its technical capacity and capabilities;
   (e) public weather services including all possible forms of communication and dissemination with the public in urban as well as rural and remote areas;
   (f) early warning systems, including, capacities for:
      i. Monitoring, detection and forecasting of hazards
      ii. development of risk information and risk-based warning
      iii. communication systems and mechanisms to ensure that warnings reach the authorities in charge of emergency preparedness and plan at local and national levels and at-risk population
      iv. Emergency plans are available and can be activated with the issuance of warnings
      v. Policies, legislation and institutional coordination, standard operating procedures and roles for agencies involved in the systems
   (g) mechanisms, formal and informal agreements, and linkages to authorities at all levels from national to district level, involved in disaster preparedness and early warning;
   (h) available human resources and competences;
   (i) the need to put in place proper awareness and education programmes for the emergency response and disaster reduction authorities as well as the public, on the expected impacts of severe weather events and in particular damage due to wind, water and storm surge (for coastal areas)
   (j) the need to educate all relevant authorities and the public on the possibility of occurrence of severe events (and their consequent impacts) in areas where such events had not previously occurred.

2. Assess the risks associated with specific contexts of storm surges, typhoon tracks/intensity, exposure and vulnerability vis-à-vis gaps in meteorological, hydrological and early warning services;

3. Identify the requirements of the emergency response and disaster reduction authorities for meteorological and hydrological services in order to provide timely and proper response to severe weather hazards.

4. Trace the flow of information from the observations to warning generation and dissemination as well as the ‘last mile’ from the local authorities to the communities.

5. Assess the range of meteorological and hydrological products and services currently provided and the coordination with other relevant authorities responsible for the warning dissemination.

6. Identify the gaps and the corresponding short-term, medium-term and long-term requirements at policy, institutional and human resources levels with the key priorities, including implications for international/regional cooperation and support.

7. Discuss with the government authorities, and other partners/funding institutions, the possible measures to address the priority gaps for the improvement of meteorological and hydrological services as well as early warning.

8. Submit a mission report to WMO, UN-ESCAP, the Typhoon Committee and the Government with specific recommendations and, as appropriate, a project proposal to address specific aspects identified by the gap analysis.

Appendix III: Programme of the Mission

Monday, 7 April 2014

Morning

- Coordination Meeting with PAGASA

Afternoon

- Meeting with the Secretary, Department of Science and Technology
- Meeting with PAGASA and Stakeholders
- Visit to forecasting centers (weather and hydrological)

Tuesday, 8 April 2014

Morning

- Meeting with PAGASA

Afternoon

- Meeting with NDRRMC
- Meeting with the UNDP Office
- Meeting with PAGASA personnel involved in observing systems/networks

Wednesday, 9 April 2014

*Group A**

- Travel from Manila to Tacloban; Technical visit to affected areas in Tacloban

*Group B***

- Identification of strengths, challenges and gaps, opportunities and threats for enhancing early warning system (EWS) in the Philippines
- Meeting with PAGASA personnel involved in observing systems/networks

Thursday, 10 April 2014

*Group A**

Morning

- Meeting with Stakeholders in Tacloban

Afternoon

- Travel from Tacloban to Manila
- Visit to some technical facilities at PAGASA headquarters, including calibration laboratory, meteorological station, wind profiler and radiation center

*Group B***

- Identification of strengths, challenges and gaps, opportunities and threats for enhancing early warning system (EWS) in the Philippines (continued)

Friday, 11 April 2014

Morning

- Meeting with PAGASA on conclusions and recommendations

Afternoon

- Individual discussions with technical experts of PAGASA
- Meeting with the JICA Office

Saturday, 12 April 2014

Morning

- Wrap-up discussions

*Group A: Ilieva (ABU), Fujita (JMA), Koide (JMA), Kohno (JMA), Hosomi (JMA), Motoyama (JMA), Moon (NDMI), Kim (NDMI), Olavo (TC), Shida (WMO)

**Group B: Choi (NEMA), Lee (NEMA), Shin (NEMA), Davies (UKMO), Bilkberg (UN-ESCAP), Kootval (WMO), Nunes (WMO)

Appendix IV: List of Persons Consulted

Mr Mario G. Montejo	Secretary, Department of Science and Technology

Meeting with Stakeholders held at PAGASA HQ, 7 April 2014

Stakeholders

Major Reynaldo B. Balido, Jr.	Chief Operation Center, National Disaster Risk Reduction and Management Council (NDRRMC), Office of Civil Defense
Mr Allan Tabell	Chief, Central Office Disaster Coordinating Center, Department of Interior & Local Government (DILG)
Ms Jocelyn Villaflor	DILG
Ms Joy Juanite	DILG
Ms Esther L. Geraldoy	Social Worker IV, Department of Social Welfare & Development (DSWD)
Ms Akiko Yoshida	Humanitarian Affairs Officer, UN-OCHA
Ms Grace Palacio	UN-OCHA
Mr George Gamayo	Panahon TV
Mr Nathaniel Cruz	GMA 7
Mr Mario Garcia	former Radio Station Manager
Ms Adelina Alvarez	Disaster Risk Reduction Net Philippines
Mr Hayato Nakamura	Japan International Cooperation Agency (JICA) Philippines

PAGASA

Dr Vicente B. Malano	Acting Administrator
Engr. Catalino L. Davis	Acting Deputy Administrator, Administration & Engineering Services
Dr Landrico U. Dalida Jr.	OIC, Deputy Administrator, Operations & Services
Dr Cynthia P. Celebre	Chief, Research and Training & Development Division (RDTD)
Dr Esperanza O. Cayanan	OIC, NCR PAGASA Regional Services Division
Eng. Edwin F. Manresa	OIC, Engineering and Tech. Services Division (ETSD)
Ms Edna L. Juanillo	OIC, Climatology &Agrometeorology Division
Dr Bonifacio G. Pajuelas	Research and Training & Development Division (RDTD)
Engr Arnel R. Manoos	ETSD
Ms Ma. Cecilia A. Monteverde	RDTD
Mr Edino Nonato L. Nolasco	RDTD
Mr Roy A. Badilla	Hydromet Division
Mr Renito B. Paciente	Weather Division
Mr Ferdinand Y Barcenas	Instrument Research & Development Unit
Ms Rosalina G de Guzman	Chief, Climate Data Section
Ms Parfila E. Gica	Chief, Met Guides and Standard Section
Mr Socrates Paat, Jr.	Senior Hydrologist, Hydro-Met Division
Mr Roberto Celebre	Basic Meteorological Instruments

Meeting with the United Nations Development Programme (UNDP), 7 April 2014

Ms Luiza Carvalho	UN Resident Coordinator and UNDP resident Representative
Ms Amelia Supetran	Team Leader, Environment and Energy Unit

Meeting with Stakeholders, Tacloban City, 10 April 2014

Stakeholders

Mr Paul P. Mooney	Provincial Disaster Risk Reduction Coordinating Office (PDRRMO), Leyte Province
Mr Val R. Aguilar	Head of Operations, Philippine Red Cross
Mr Allan E. Mosqueda	Philippine Red Cross
Mr Christopher Mock	Philippine Red Cross
Mr Edwin A. Pamonag	OIC, Administration, Philippine Red Cross
Mr Rey M. Gozon	Regional Director, Office of Civil Defense, Region VIII
Ms Melanie Bingco	Reporter, ABS-CBN Tacloban
Mr Dwayne Pedrosa	Cameraman, ABS-CBN Tacloban
Mr Olaf Neussner	GIZ, Disaster Management

PAGASA

Mr Oscar C. Tabada	OIC, Visayas Regional Services Division
Dr Esperanza O. Cayanan	National Capital Region, Quezon City
Mr RenitoPaciente	Weather Division, Quezon City
Mr Roy Badilla	Hydromet Division, PAGASA, Quezon City
Mr Marion A. Peñaranda	Chief Met. Officer, PAGASA Tacloban Station
Mr Carlito Arias	PAGASA Guiuan Radar

Meeting with the Japan International Cooperation Agency (JICA) Office, 11 April 2014

Mr Masahito Miyagawa	Disaster Management Division 1, Global Environment Department, JICA HQ
Mr Hayato Nakamura	JICA Philippines

Appendix V: Report on the Field Visit to the Area Around Tacloban City, Leyte Island, 9-10 April 2014

Ten (10) out of 17 members of the mission team visited damaged areas in and around Tacloban City. After almost half a year since the Typhoon Haiyan disaster, most of coastal regions remain damaged or under reconstruction, although some areas have recovered. This report briefly highlights some lingering effects of the disaster and outlines the current situation.

- **Tacloban Airport**

Tacloban Airport was completely inundated and most of its facilities were heavily damaged. During the storm surge, airport staff evacuated to the rooftop. Although airport operation has been recovered, basic equipment in the terminal building remains non-functional. The temporary Tacloban Synoptic Station is located several kilometers from the airport. Meteorological observation and reporting for the airport are carried out by the Civil Aviation Authority of the Philippines (CAAP).

The peninsula on which Tacloban Airport is located was also completely inundated, and most of it has yet to be restored. A large population of refugees lives in UNHCR tents near the airport.

Tacloban Airport and the damaged area
Baggage is passed by hand. Many people still live in tents.

- **Downtown Tacloban**

Most of buildings were inundated by the storm surge to the second-floor level. Extensive damage to windows remains, but this may be a result of storm winds. Building deterioration is widespread, although not all of this is attributable to the typhoon. About half a year after the disaster, the bustling shops and markets seen downtown indicate that people there have almost returned to normal daily life. However, some refugees appear to be still staying in schools and other evacuation centers.

Some ships were washed ashore by inundation water in the northern part of Tacloban City, where the storm surge was massive. Trees along the coast were also heavily impacted by water.

Downtown and northern Tacloban
A crowded downtown market and a school with refugees' laundry drying in the windows

- **Tacloban residential area near the beach**

Coastal residential zones south of the downtown area experienced devastating damage due to inundation, which is thought to have caused around 1,200 fatalities. This is a relatively new area that only recently got became highly populated. Large numbers of people lived in small barracks vulnerable to strong winds and storm surges, which made the disaster worse.

Residence is prohibited in certain lowland areas at risk of storm surge disasters. Despite the presence of "**No build zone**" signs in these areas, many people have returned there and built shanty houses made of recycled materials from damaged residences. Residents favor these areas for their easy downtown access, and the previous situation of vulnerability has returned as a result.

Residential area near the beach
*Inundation water destroyed most houses, which have not yet been restored. People have started living in forbidden areas (the word "**NO**" has been removed from the "NO **BUILD ZONE**" sign here).*

- Tacloban Convention Center

The Convention Center facing the sea stands 1 – 2 m above sea level. As many people evacuated to its higher floors, there were no casualties in the building. Several such large structures located near the coast were not destroyed by the inundation and provided places for people to evacuate.

Tacloban Convention Center and large buildings near the coast
Many people evacuated to these buildings, where damage was limited to the first floor.

- San Antonio (Samar Island)

About 3,000 people live in San Antonio, which is located in the western part of Samar Island and faces Leyte in the south. Around 60 people were killed by storm surges that moved about 100 m inshore. One resident said that she had heard typhoon warnings before Typhoon Haiyan made landfall, but did not imagine how disastrous the storm surge would be. The same region experienced another less severe storm surge disaster in 1984. Some people underestimated Typhoon Haiyan's storm surge based on past experience and erroneously felt that simply evacuating to concrete houses would provide enough safety.

San Antonio

- **Temporary Tacloban Synoptic Station of PAGASA**

Based in the local office of the Department of Science and Technology (DOST) in Palo, PAGASA staff at temporary Tacloban Synoptic Station make manual weather observations with basic instruments and send observation reports via cellular phone. The station was originally situated at Tacloban Airport but now operates from Palo due to the complete destruction of its previous site by the storm surge.

Temporary Tacloban Synoptic Station of PAGASA

Appendix VI: Best Track Data of Haiyan and Storm Surge Forecast

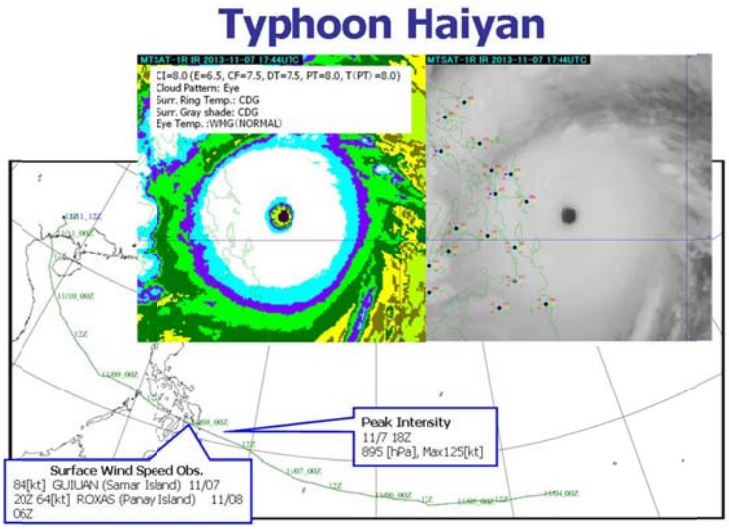

Fig. 2 –Satellite images and track of Haiyan, 7 November 2013

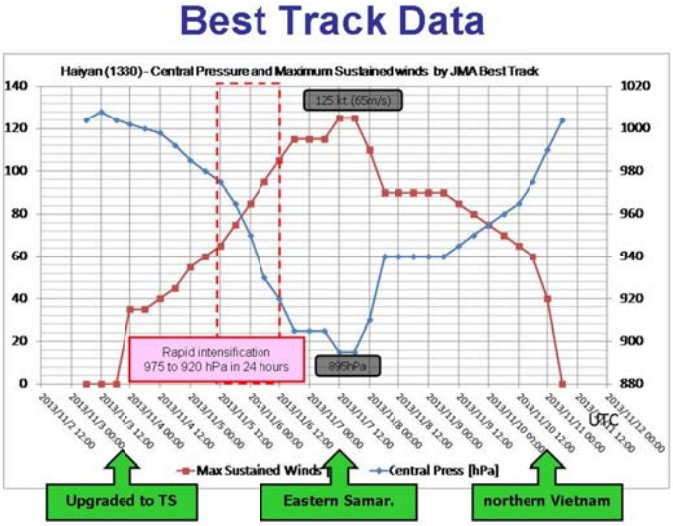

Fig. 3 – Central pressure and maximum sustained winds of Haiyan by RSMC Tokyo

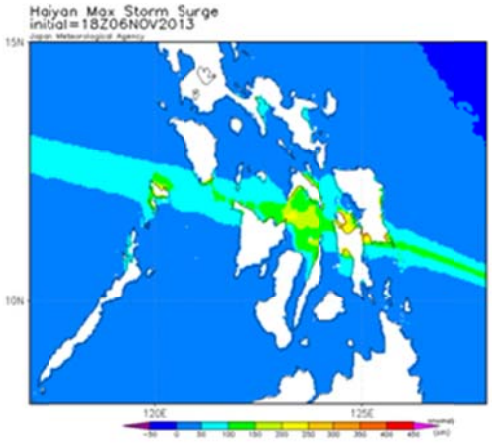

Fig. 4 – Storm surge forecast for Haiyan

Appendix VII: Damage Caused by Haiyan in Tacloban City

Fig. 5 - Damage caused by Haiyan in Tacloban City

Appendix VIII: Photos of the Guiuan Radar Station and Synoptic Stations in Guiuan and Tacloban after Haiyan

Fig. 6 – Damaged PAGASA Doppler radar in Guiuan

Fig. 7 – Damaged PAGASA synoptic stations

Appendix IX: List of PAGASA Stations/Facilities Damaged by Typhoon Haiyan (Yolanda)

Station/facility Type	**Damage**	**Remarks with inputs from WMO mission members *(italic), as a result of discussions***
1. Tacloban, Synoptic	Building and Equipment totally damaged	Operation suspended – 3 weeks after Hayan PAGASA send a set of basic instruments to be used temporarily at a different location (Palo, Leyte) the regional office of DOST, a few Km away from airport. There are 3 PAGASA observers performing observations 08am – 05pm. *There is a plan, ready for implementation, to build within 1 year a new and more resilient station near the site of the damaged Tacloban synoptic station (airport); This is in coordination with the national civil aviation authority; It is funded by the Government of the Philippines*.
2. Coron, Synoptic	Building and Equipment totally damaged (partially)	Operation temporarily suspended – *Station already repaired and operational, technicians from Central Office will be going to Coron to check the instruments.*
3. Guiuan, Radar and Synoptic	Old and new radar equipment totally damaged while buildings were partially/totally damaged; all basic meteorological instruments were totally damaged except standard 8" raingauge	Operation suspended for 1 week. Operation resumed for rainfall and visual observation. *Installed solar panel for temporary lighting system and radio communication – Synoptic station is operational now, but the building needs some more repairing. The Radar will be repaired under the cooperation with JICA.*
4. Catbalogan, Synoptic	Building partially damaged	Installed solar panel for temporary lighting system and radio communication. *Most damages already repaired, only the flooring is still to be repaired.*
5. Borongan, Synoptic	Broken glass windows	Operational but the building it's going to be repaired soon.
6. Maasin, Synoptic	No communication	Restored communication after a week – operational
7. Roxas, Synoptic	Observer quarter and station unroofed; power line and PLDT (telephone) connection cut down; thermometer shelter unroofed, antennae connection and wirings were lost.	Building is to be repaired soon, this year, all equipment is operational
8. Cuyo, Synoptic	Radio antennae mast bent down	Operational

9. San Jose (Occidental Mindoro), Synoptic	Thermometer shelter unroofed	Operational
10. Mambusao, Agromet	Perimeter shelter of station and thermometer shelter damaged, outside gutter fell down	Building damaged during Haiyan, it will be repaired soon this year.
11. Visca, Agromet	Thermometer shelter blown down, rain gauge damaged; sunshine instrument realigned.	Building damaged, repair is ongoing
12. Madridejos, Bantayan Is., Met Buoy	Totally damaged	All sensors were retrieved and brought to the Central Offices (P30M); The buoy itself is in Bantayan Island; *Due to high price of supplying new sensors and services to deploy the buoy, its rehabilitation is under revision.*

Cost estimates made by PAGASA:
PHP 74.24 million: PHP 44.24 million (building & equipment) + PHP 30 million (buoy)
≈**US$1.63 million:** USD 0.97 million (building & equipment) + USD 0.66 million (buoy)

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Appendix X: Networks and the Information Flow of NDRRMC

Fig. 8 – NDRRMC Networks

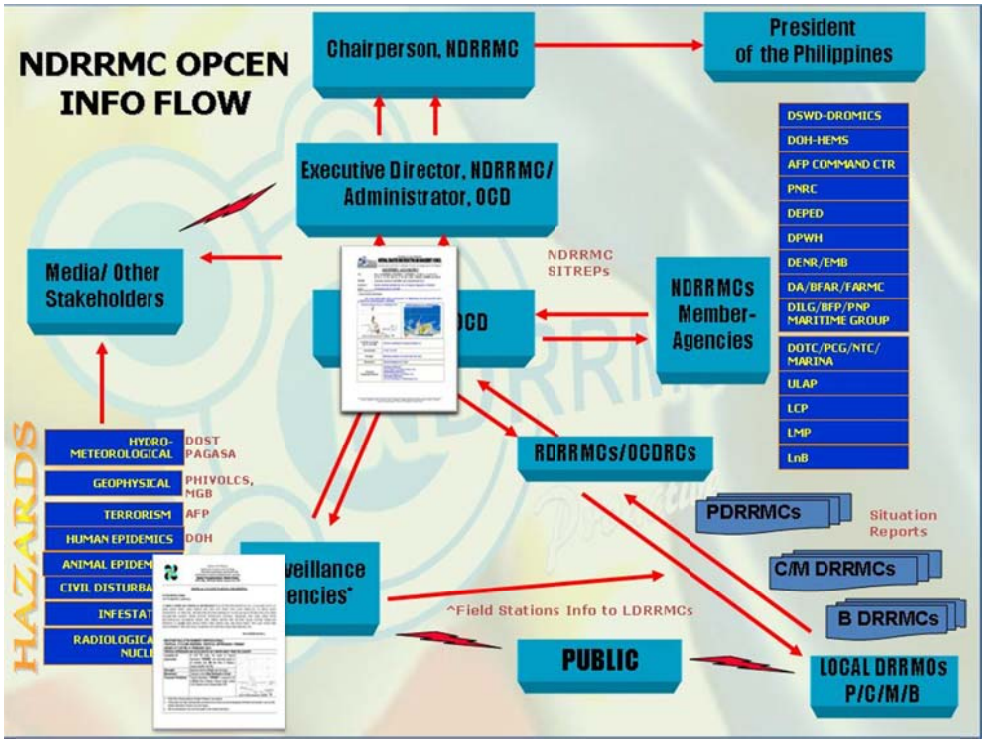

Fig. 9 – NDRRMC Information Flow

Appendix XI-1: PAGASA's Observing Systems and Networks

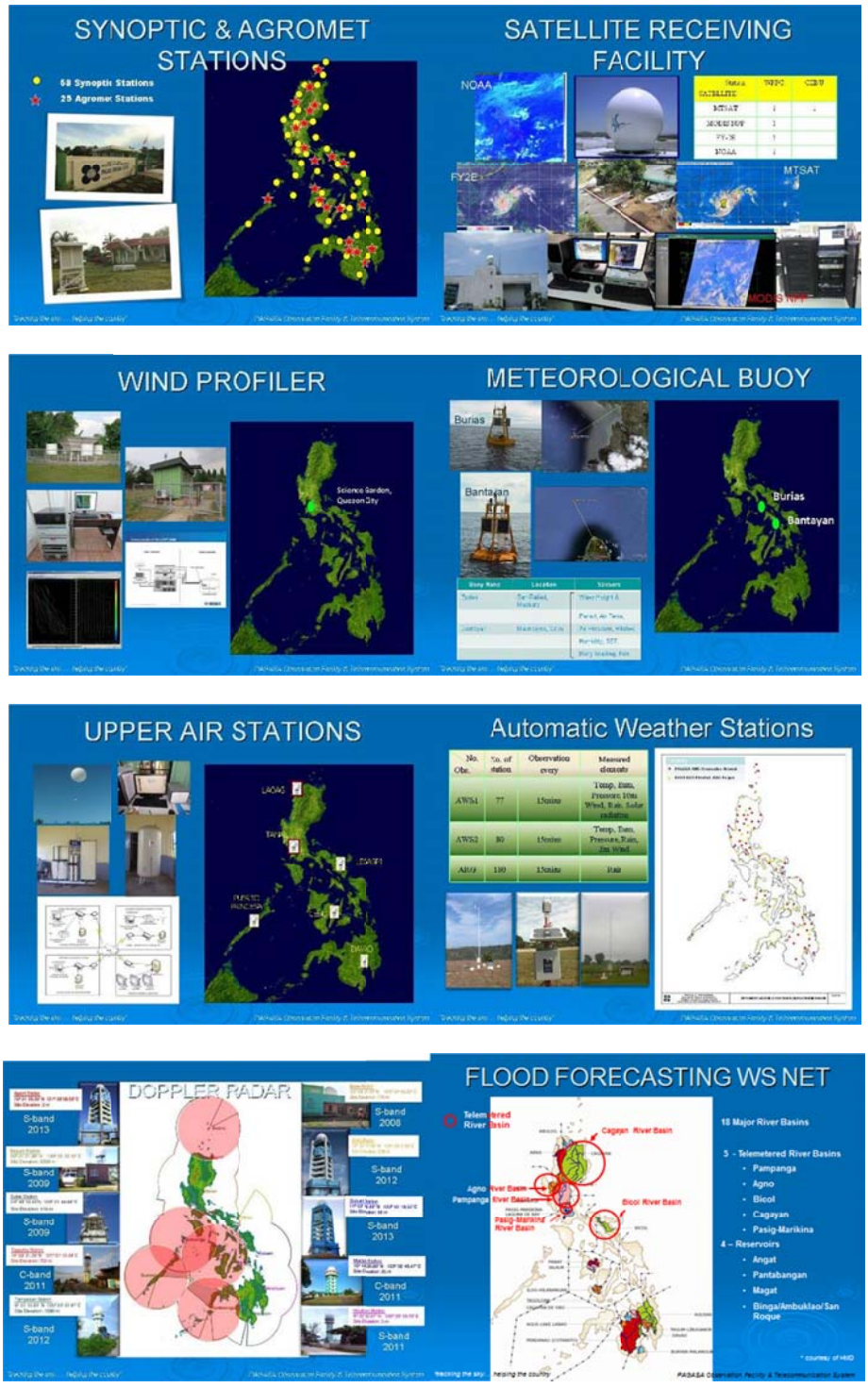

Fig. 10 – PAGASA's Observing Systems and Networks

Appendix XI-2: PAGASA's Data-processing Concept, Telecommunication Logical Framework and Flood forecasting Network

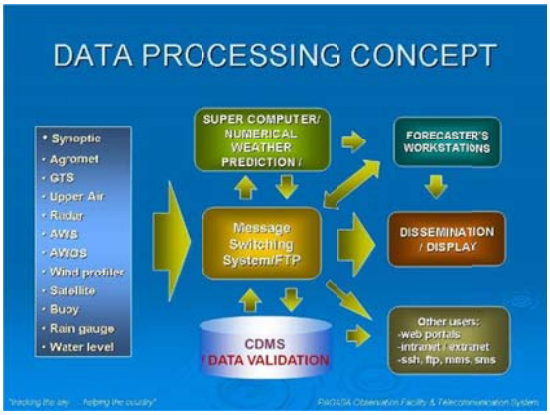

Fig. 11 – Data-processing concept of PAGASA

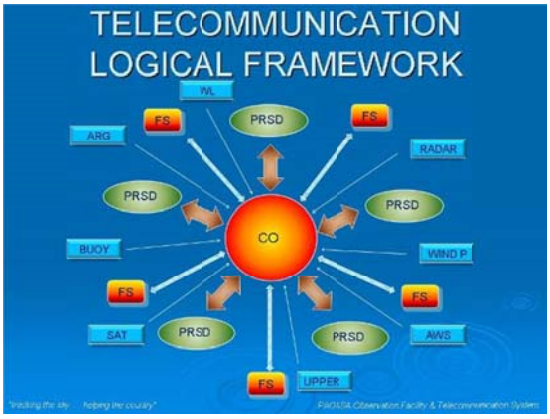

Fig. 12 – Telecommunication Logical Framework of PAGASA

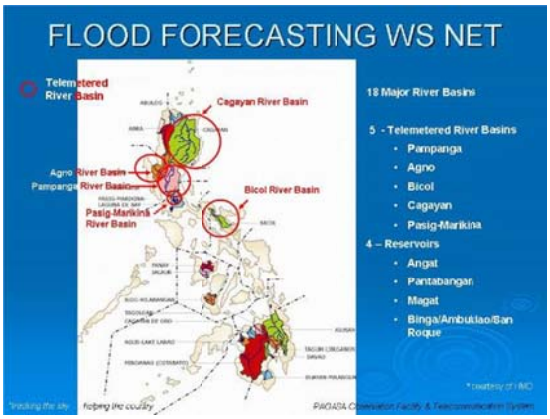

Fig. 13 – Flood Forecasting Network of PAGASA

Appendix XI-3: PAGASA's Advisories and Warnings, Information Dissemination Flow and Mode of Dissemination

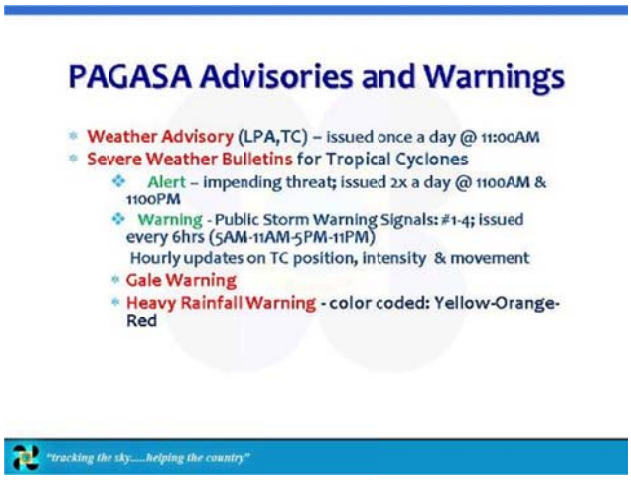

Fig. 14 - Advisories and Warning of PAGASA

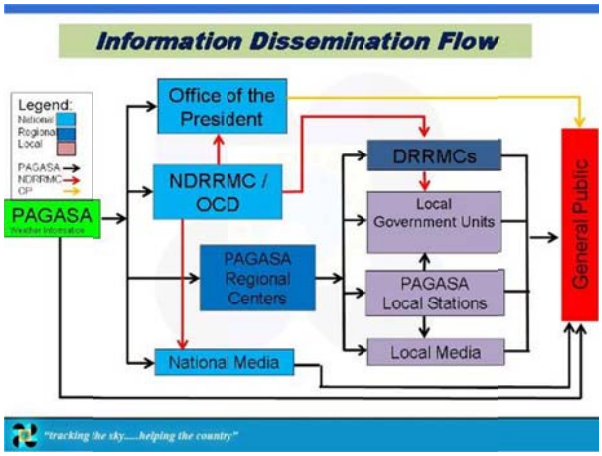

Fig. 15 - Information Dissemination Flow

Fig. 16 - Mode of dissemination

Appendix XII: Specific Recommendations for the Observing Systems and Networks in the Philippines

The existence of PAGASA's infrastructures across the country, including a central calibration laboratory and central and regional maintenance resources, is an important asset for the operational observing networks. The dedication of PAGASA personnel and their availability to perform temporary enhanced observing programmes, such as increased frequency of observations at surface and upper-air stations, e.g. at the request to PAGASA for research projects, is another important asset. The co-existence of various different projects related with the observing systems and networks in the country, both supported by national and international resources, is a great opportunity to develop those projects in an integrated way, following the WIGOS (WMO Integrated Global Observing System) approach.

The following recommendations for specific observing systems and networks are all under the WIGOS framework, and their design and evolution will benefit from a composite approach, either from a cost-efficiency perspective, or from a performance perspective regarding the improvement of quality and availability of observational data.

Weather radars

Recommendation 1a

Support the immediate **rehabilitation of the non-operational weather radars**, in particular the one at Guiuan, damaged by typhoon Haiyan/Yolanda, in order to resume operational observations of the current weather radars network, as soon as possible.
(Action**: PAGASA and international partners**)
(Priority/Urgency: **Highest/Very Short term)**

Recommendation 1b

Consolidate the project for the **installation of 5 new weather radars**, planned for 2014 and 2015, in order to ensure timely and successful expansion of the country's network, to have an integrated operational system with a better coverage of the weather phenomena across the Philippines territory and surrounding oceanic areas.
(Action: **PAGASA and partners**)
(Priority/Urgency: **Highest/Short term)**

Telecommunications

Recommendation 2

Review, consolidate and improve the existing telecommunication facilities at stations, to have more resilient backup systems; Consider to use VSAT or satellite phones at some major meteorological and hydrological ("river-centers") stations, such as airports and those located at the regions more prone to be impacted by hydro-meteorological events (floods, typhoons).
(Action: **PAGASA and national and international partners**)
(Priority/Urgency: **Highest/ Short term)**

Calibration *and* maintenance

Recommendation 3a

Ensure immediate action by PAGASA personnel regarding the **calibration and maintenance** of all instruments installed at stations affected by typhoon Haiyan/Yolanda.
(action: **PAGASA**)
*(Priority/Urgency: **Highest/Very Short term)***

Recommendation 3b

Consolidate and enhance the **maintenance programme** regarding corrective and preventive activities to all observing systems and instruments and ensure the necessary technical and human resources for that.
(action: **PAGASA**)
*(Priority/Urgency: **Higher/Short term)***

Recommendation 3c

Develop a simple **database for the spare parts and consumables** to be used at PAGASA's Central Offices and stations (meteorological, agro-meteorological, AWS, hydrological, upper-air, etc.) to ensure timely orders/purchase of needed spare parts and consumables and to facilitate management of those stocks.
(Action: **PAGASA**)
(Priority/Urgency: **High/Very Short term)**

Recommendation 4a

Support the plans of PAGASA for the replication of the **calibration laboratories** at regional level; Such replication for some types of instruments (e.g. pressure, temperature and humidity) at 2 more sites, in different regions of the Philippines, at sites where PAGASA personnel is available, will facilitate the logistics reducing time and costs; The proximity of the observers to the instruments to be calibrated (from their own station, or from neighboring stations) will be an additional advantage.
(Action: **PAGASA and partners**)
(Priority/Urgency: **High/Short to Medium term)**

Recommendation 4b

Support the expansion of the **calibration programme** to the AWS network, which will be facilitated by the regional replication of the calibration laboratories; Currently the AWS sensors are checked against a portable AWS by an outsourced company.
(Action: **PAGASA and partners**)
(Priority/Urgency: **High/Short to Medium term)**

Recommendation 5

Support the project for the **replacement of the wind tunnel** existing at PAGASA Central Offices, for the calibration of wind sensors, both from PAGASA meteorological stations and from the third party organizations. It is recommended that the operating conditions for the new wind tunnel, already ordered by PAGASA and expected to be delivered in July 2014, should be improved in comparison with the site conditions of the currently installed wind tunnel, particularly to ensure the safety and access conditions for the technicians, as well as to ensure a clean environment; Also the electric installation of the building could be reviewed/improved.
(Action: **PAGASA and partners**)
(Priority/Urgency: **High/Short term)**

<u>*Observing* networks</u>

Recommendation 6a

Review and update the list of stations in the Philippines integrated in the **Regional Basic Synoptic Network** (RBSN) and the **Regional Basic Climatological Network** (RBCN) published in WMO No. 9, Volume A - Observing Stations.
(Action: **PAGASA**)
(Priority/Urgency: **High/Very Short term)**

Recommendation 6b

Review and update, if appropriate, the following **names and contacts of focal points** of the Philippines: Volume A (Observing Stations), Regional Basic Synoptic Networks (RBSNs), GCOS and related Climatological matters (RBCNs), Weather Radar Metadata (WRM) and Implementation Plan for the Evolution of the GOS (EGOS-IP).
(Action: **PAGASA**)
(Priority/Urgency: **High/Very Short term)**

<u>National WIGOS *project*</u>

Recommendation 7

Prepare and develop a national WIGOS project for the design, integration and evolution of meteorological, climatological, hydrological and environmental related observing networks in the Philippines, in line with the Regional WIGOS Implementation Plan (R-WIP) approved by the WMO Regional Association V (South-West Pacific).

(Action: **PAGASA and national and international partners**)
(Priority/Urgency: **Highest/ Very Short to short term)**

Observing systems of *other* organizations/institutes

Recommendation 8

Collect updated and documented information on the current plans of the Advanced Science and Technology Institute (ASTI) (Department of Science and Technology) regarding the production and installation of **Automatic Weather Stations (AWSs)** and **Automatic Rain Gauges (ARG)**, including the locations and milestones. Also the Department of Agriculture and other governmental agencies are recommended to be contacted for the collection of updated and documented information on the current plans for the installation of new AWSs (locations, dates).
(Action: **PAGASA an national partners**)
(Priority/Urgency: **Higher/Very Short term**)

Recommendation 9

Confirm the status of the project with the Hokkaido University (Japan) regarding the installation of **lightning detectors** in the Philippines, as well as the approval status of the project with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), for which priority should be given to the nation-wide geolocation system. Confirm the availability of updated and documented information on the existing related projects of the National Grid Corporation of the Philippines (NGCP), including the technology, the number of detectors, locations and project milestones.
(Action: **PAGASA and national and international partners**)
(Priority/Urgency: **Higher/Very Short term**)

Recommendation 10a

Document in detail all the technical and planning information about the project for the installation of **meteorological buoys** in the Philippines, to allow for the revision of its number and location, in order to optimize the country's meteorological networks as a composite observing system for weather watch and early warnings; The involvement and engagement of relevant national oceanographic authorities, would allow for sustainable operation, such as data transmission and maintenance.
(Action: **PAGASA and partners**)
(Priority/Urgency: **Higher/Very Short term)**

Recommendation 10b

Collect information at national level, from different Governmental Departments, regarding the existing and planned **ocean observing related programmes**, e.g. measurements of sea level state, in the Philippines, including those under responsibility of foreign organizations.
(Action: **PAGASA and partners**)
(Priority/Urgency: **High/Short term)**

Recommendation 11

Prepare a national survey/questionnaire about the **third party observational data**, to be sent to the major national companies, particularly those already known as having meteorological observing systems (shipping, oil, etc.), as well as non-governmental organizations (NGOs) to collect information on the existing meteorological and environment-related observing equipment in the Philippines, also about their future plans.
(Action: **PAGASA**)
(Priority/Urgency: **High/Very Short term**)

Training for observers of PAGASA

Recommendation 12a

Train and motivate the observers to enable them to maintain all automatic equipment such as AWSs (including sensors, data acquisition systems and transmission devices) existing at or near the synoptic and agro-meteorological stations.
(Action: **PAGASA**)
(Priority/Urgency: **Higher/Short to Medium term)**

Recommendation 12b

Create mechanisms to allow observers at stations to access in real time (or near-real time) and use data collected by AWSs and ARG (existing and planned ones) for the benefit of data quality and data availability; For instance, using simple displays (or PCs) directly connected by cable to the data acquisition systems of AWS/ARG.
(Action: **PAGASA**)
(Priority/Urgency: **High/Short to Medium term)**

Climate data

Recommendation 13

Develop PAGASA's **project for the integration and management of climate data**, including data rescue, following WMO guidance, in a coordinated way, with the involvement of climate and observation experts, to ensure the ingestion and quality control of observational data from different sources and formats, as well as to ensure the use of appropriate detailed metadata.
(Action: **PAGASA**)
(Priority/Urgency: **Higher/Very Short to short term)**

Observations of atmospheric composition

Recommendation 14a

Support the **rehabilitation and operation of Mt. St. Thomas station**, to resume observations of traditional pollutants and precipitation chemistry in the region. All the former available data from that site should be submitted to the relevant Global Atmosphere Watch (GAW) Data Centers, if not yet done. The extension of the observational network to measure more GAW variables (e.g. aerosols and greenhouse gases) is also recommended, as well as Carbon Monoxide (CO) and Volatile Organic Compounds (VOCs), considering the biomass burning events in neighboring regions of the Philippines.
(Action: **partners**)
(Priority/Urgency: **Higher/Short to medium term**)

Recommendation 14b

Assess and document **all national activities related to observations of atmospheric composition**, through the Department of Environment and Natural Resources and the Universities of the Philippines, by collecting information on the existing and planned stations, including those under international agreements and projects.
(Action: **PAGASA and partners**)
(Priority/Urgency: **Higher/Short term**)

Aviation

Recommendation 15

Confirm PAGASA's **national authority for aeronautical meteorological observations**, through the Civil Aviation Authority of the Philippines (CAAP); It is considered beneficial and an advantage, considering its resources and expertise, if PAGASA could have authority over all the national aeronautical stations, so that the observing systems at some airports, which are not currently under the responsibility of PAGASA, would be integrated, in a standard, composite and interoperable way, in the national observing networks.
(Action: **PAGASA and national partners**)
(Priority/Urgency: **Higher/Very Short term**)

Notes:

1) Major references for such a project would be the WIGOS regulatory material and guidance, which are being developed for approval by the WMO Congress in 2015;
2) An example of guidance under development is the draft network design principles that can be found at: http://www.wmo.int/pages/prog/www/OSY/Meetings/IPET-OSDE1/documents/IPET-OSDE1-Doc-10.1-OSDW1-workshop.pdf

Appendix XIII: List of Acronyms and abbreviations

ABU	Asia-Pacific Broadcasting Union
ADPC	Asian Disaster Preparedness Center
ARG	Automatic Rain Gauge
ASEAN	Association of Southeast Asian Nations
AWS	Automatic Weather Station
CAAP	Civil Aviation Authority of the Philippines
CBS	Commission for Basic Systems (WMO)
DOST	Department of Science and Technology
EWS	early warning system
JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration (Republic of Korea)
LGU	Local government Unit
NAMRIA	National Mapping and Resource Information Authority (Philippines)
NDCC	National Disaster Coordinating Council (currently called NDRRMC)
NDMI	National Disaster Management Institute (Republic of Korea)
NDRRMC	National Disaster Risk Reduction and Management Council (Philippine)
NEMA	National Emergency Management Agency (Republic of Korea)
NGO	non-governmental organization
NMHS	National Meteorological and Hydrological Service
NWP	numerical weather prediction
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAR	Philippine Area of Responsibility
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PRSD	PAGASA Regional Services Division
PSWS	Public Storm Warning Signal
PTC	WMO/ESCAP Panel on Tropical Cyclones
RSMC	Regional Specialized Meteorological Center (WMO)
SOP	Standard Operating Procedure
SSB	single-sideband modulation (short-wave communication)
SWFDP	Severe Weather Forecasting Demonstration Project (WMO)
TC	ESCAP/WMO Typhoon Committee
TD	Tropical Depression
TS	Tropical Storm
TY	Typhoon
UKMO	United Kingdom Met. Office
UNDP	United Nations Development Programme
UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UN-OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNHCR	United Nations High Commissioner for Refugees
VCP	Voluntary Cooperation Programme (WMO)
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization

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Appendix XIV: Photos

Meeting with Stakeholders, Manila, 7 April 2014

Meeting with Stakeholders, Tacloban City, 10 April 2014