Second Report

International Research Institute of Disaster Science (IRIDeS)

14 March 2015

“IRIDeS Fact-finding missions to Philippines”

TOHOKU University
2015

Republic of the Philippines
Tacloban City
Office of the City Mayor

FOREWORD

First of all, I would like to express my sincere appreciation to the International Research Institute of Disaster Science (IRIDeS) of Japan's Tohoku University for all their efforts in compiling such a comprehensive report of their fact-finding mission in the Philippines.

From its humble beginnings as a fishing settlement, Tacloban City has grown to be the premiere city of Eastern Visayas – the regional hub for commerce, industry, culture, education, communication and tourism. Participatory, gender-responsive, and inspiring governance has fostered a dynamic economy and a competent human capital.

However, in November 2013, Super Typhoon Haiyan – with its Category 5 hurricane winds and the most destructive storm surge in recent history – devastated our city and our region. We lost not only homes and possessions, but also neighbors, co-workers, friends, and family. Registered deaths reached 2,474, and 633 persons are still missing in Tacloban city as of November 6, 2014.

Tohoku University's IRIDeS, being located in Sendai City, experienced the 2011 Great East Japan earthquake and tsunami. Based on lessons learned from that catastrophe, IRIDeS conducted scientific research and surveys on the impact of Haiyan in Tacloban City, and now presents their findings and recommendations in this report. IRIDeS's support will definitely contribute to Tacloban City's ongoing recovery and reconstruction efforts, as well as help prevent or mitigate the effects of future typhoons, storm surges, and other disasters.

Finally, I would like to express my deepest gratitude and appreciation to all the love and support that poured into Tacloban City from all over the world in our desperate time of need. Now, more than a year after Haiyan, we are on the best possible path to build back better, thanks to numerous organizations and individuals who helped us forge a new path toward a brighter, safer future.

ALFRED S. ROMUALDEZ
Mayor, Tacloban City

I ❤ TACLOBAN

FOREWORD

At 4:40 AM on November 8, 2013, Super Typhoon Yolanda made first landfall over Guiuan, Eastern Samar and caused immediate destruction in wide area of central Philippines. Over the course of a few hours, it massive damages, with more than 6,000 individuals reported dead and thousands more accounted missing in the aftermath of remarkably strong winds, storm surge and large waves induced by the tropical cyclone.

As early as three days before landfall, the Philippine government made necessary preparations of the historic super typhoon. Assessing forecasts from various numerical models, the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), one of the attached agencies of the Department of Science and Technology (DOST) under its Scientific and Technical Services Institutes, officially issued Weather Advisory #1 for Tropical Cyclone Yolanda (Haiyan) at 11:00 AM of November 5 to serve as a public warning for the imminent danger. Two days after, on November 7, the Weather Bureau issued Severe Weather Bulletin #3, raising the alarm and informing the public that storm surges may reach up to seven meters in wave height along the coastal areas of Samar, Leyte, Biliran, Bantayan and Camotes islands, Northern Cebu -- including Cebu City and Bohol. However, in spite of the efforts of the government to reduce and mitigate the disaster's effects, Yolanda still caused widespread destruction and an alarming number of casualties in the Philippines.

Because of this, PAGASA has taken a proactive approach to prepare for future occurrences of such devastating tropical cyclones. As PAGASA is mandated to "provide protection against natural calamities and utilize scientific knowledge as an effective instrument to insure safety, well-being and economic security", we must scientifically evaluate the reasons for the magnification of the damage brought by this super typhoon in order to improve our products and prevent another disaster of this magnitude. "Our mission is protecting lives and properties through timely, accurate and reliable weather-related information and services" and therefore, we must improve on our current policies and strategies to come up with better products for the Filipino people.

The International Research Institute of Disaster Science (IRIDeS) at Tohoku University, one of PAGASA's counterparts in Japan, conducted several on-site surveys regarding the damage of Yolanda and shared important lessons learned with our local weather agency. Without a doubt, these kinds of scientific surveys and research, in general, will contribute to future disaster mitigation in the Philippines.

Taking this opportunity, I would like to extend my sincerest gratitude and appreciation to all the assistance provided by IRIDeS and other organizations from all over the world. We hope this report on the "IRIDeS fact-finding missions in the Philippines" will be beneficial to us all and serve as a guideline and reference for the future in our quest to resolve the chaos that our atmosphere brings.

Vicente B. Malano, Ph.D.
Acting Administrator, PAGASA

Second Report of IRIDeS Fact-finding mission to Philippines

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Asian Disaster Reduction and Response Network (ADRRN)
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Kawit Barangay Office
Municipality of Guiuan
Municipality of Daanbantayan
Municipality of Basey

We owe special gratitude to the late Dr. Susan Espinueva, chief of the Philippine Atmospheric, Geophysical and Astronomical Services Administration Hydro-meteorological Division (PAGASA). Dr. Espinueva's support of the IRIDeS survey made this work possible. Her kindness and passion were a gift to the scientific community, and she will be sorely missed.

Contents

1. Executive Summary

Super Typhoon Haiyan, called Yolanda in the Philippines, devastated the Eastern Visayas and part of the Central Visayas on November, 8, 2013. Haiyan caused over 7,000 casualties, displaced over 4 million people, and damaged or destroyed over 1 million houses due to remarkably high wind speed, storm surge and large waves.

The International Research Institute of Disaster Science (IRIDeS), at Tohoku University in Sendai, Japan dispatched several investigating teams from December, 2013 through February, 2015 to gather information from governmental, hospital and research organizations in Philippines. In addition, the teams assessed damage in several areas on Leyte and Samar islands with local counterparts. The name of the mission was the “IRIDeS fact-finding mission,” and the IRIDeS survey team consisted of 4 teams; 1) Hazard and Damage Evaluation team, 2) Warning and Evacuation Assessment team, 3) Disaster Medical Science team, and 4) Disaster Recovery team.

The Hazard and Damage Evaluation team first conducted the damage interpretation using satellite images in order to identify severly damaged areas and to provide important information to focus the activities for the on-site field survey (**Chapter 3**). This kind of rapid damage assessment can contribute actively to emergency response and relief effort allocation and management when disasters impact a large area. In addition, a numerical simulation of the storm surge and large waves using Delft-3D and SWAN with a parametric hurricane model was promptly conducted for Leyte and Samar Islands in order to understand the magnitude and features of surges and waves induced by Haiyan (**Chapter 4**). From the simulation results, it was found that the water levels were dominated by wind-driven storm surge near Tacloban and by waves in eastern Samar.

During the on-site survey in Leyte and Eastern Samar on January 16 – 24, 2014 and other additional surveys, inundation heights of storm surges and large waves were measured, and a detailed inundation map in Tacloban was developed (**Chapter 5**), mainly based on local interviews with eyewitnesses. For example, storm surge heights up to 6 m were measured near the shoreline in Tacloban and wave runup of up to 12 m were measured in Eastern Samar. In addition, typical damage to houses and seawalls by strong wind, storm surge and high waves in Leyte and Eastern Samar were investigated throughout the survey. Based upon the initial analysis and on-site survey, several problems and recommendations are presented in this report. Data analysis and numerical simulations are still ongoing.

The Warning and Evacuation Assessment team aimed at examining and recording evacuation behavior and information notification in the area affected by Haiyan. A questionnaire survey in Tacloban city and Palo and Tanauan municipalities on Leyte Island was implemented from March 14, 2014 to March 22, 2014 and in total 642 samples were taken. The survey shows that the ratio of evacuation away from home was about 70%. Patterns of evacuation behavior differ with location, gender and age. Although all survey sites are located in the same coastal area, preliminary analysis shows that reasons and clues for evacuation are different at each site (**Chapter 6**).

The Disaster medical science team (**Chapter 7**) investigated the immediate medical and long-term public health response, domestic and international medical aid, outbreak of infectious diseases, psychosocial problems and mental health of the affected people in collaboration with medical and public health researchers in the Philippines, WHO, the Department of Health (DOH) and others to promote collaborative research and publicizing of the results. According to the geographical mapping of the possible hospitals and health related facilities in the affected area, individual visits to health facilities and interviews were very effective for understanding the structural, non-structural and functional damage of health related facilities. They observed the sanitary and health condition of the affected people and also visited international humanitarian assistance agencies. They established and extended the collaborative relationships between IRIDeS and San Lazaro Hospital, DOH, WHO and WPRO, Univ. Philippines Manila and Angeles Univ. to exchange information and knowledge about disaster medicine and public health. They shared their experience of the Great East Japan Earthquake and made recommendations at DOH in a technical discussion to establish safe hospitals as a building last standing in a disaster. Basic concept and strategy of psychosocial interventions at post-disaster settings has been shared between Japanese and Philippine mental health workers, and cultural and social differences in mental health between two countries and perspectives in international collaboration on disaster mental health has been depicted.

In addition to the Disaster Medical Science team's activity, simple construction practices for health facilities safe from typhoons and storm surges are summarized in **Chapter 8** by Prof. Cristopher Stonewall P. Espina, University of the Philippines, Diliman.

Research on post-disaster recovery needs to track several areas affected by the typhoon in the Philippines for a long time. The Disaster Recovery team organized three groups according to timing of surveys and topics.

The first group (**Chapter 9**) was in charge of data acquisition necessary to understand the social context of the Philippines, to study long-term recovery phenomena, and to obtain basic information. They obtained statistic data, maps and geospatial data from the Government for IRIDeS's study. They also conducted field surveys, including building damage records and interviews of affected people and local governments, in Daanbantayan in Cebu, and in Basey on Samar Island. Although some analysis of building damage is in progress, several regional specific problems facing recovery were clarified by the surveys.

The second group (**Chapter 10**) conducted a collaborative field survey between UCL-IRDR and Tohoku University-IRIDeS four months after the typhoon. Interviews and accompanying structural engineering surveys of the respondents' dwellings were conducted for 160 households in 12 coastal barangays. Regarding evacuation, the system of using barangay leaders to disseminate warnings appeared successful in terms of reaching people, although in many cases the severity of the storm surge was underestimated. Almost all interviewees knew about the 40m no-build zones, but this policy does not reflect variations in hazard associated with variable coastline topography. Even though the idea of prohibiting development along the shore existed before typhoon Haiyan, those within these zones seemed to have little idea about relocation plans while most households outside these zones wanted to stay in place. It appears that cash distributions from an NGO, despite likely causing price inflation, were useful in allowing the purchase of reconstruction materials. Property insurance is sparse in the Philippines and the surveys highlighted the lack of awareness about it. More than half of the temporary shelters examined were built without the aid of professional advice or help leading to people living in precarious, makeshift conditions.

Therefore, training programs are needed in the early stages of the transitional phase of recovery to ensure lower vulnerability to future natural disasters.

The third group (**Chapter 11.**) focused their research investigation on community resilience, post-disaster planning and policies as well as role of local stakeholders in disaster risk reduction (DRR). The aims for the two field visits were to learn: i) how governments (both national and locals), Civil Society Organizations (CSOs), private sectors and communities had prepared against disasters in the past, how they responded after Typhoon Haiyan; and ii) what were the emerging issues related to resettlement and livelihood rebuilding in the first few months after the disaster, and how recovery was progressing in the following year. Based on the first field mission in March 2014, when the team visited Manila, Tacloban, and Ormoc, interviews and observations verified that land use along the seashore was been seriously discussed after typhoon Haiyan, and local governments are planning land use measures to reduce risk, including relocation of communities.

Although the national government became less persistent with the control of hazardous areas, in February 2015, Tacloban City was continuing with their "no-build-zone" policy, with a main aspect of recovery focusing on the relocation of residents from vulnerable coastal areas to relocation sites in the northern part of the City, where housing construction is progressing quickly. Support from and involvement of the national government, private sectors, and non-governmental organizations inside and outside the Philippines enabled Tacloban City to secure almost all land areas and housing units that are currently counted. Barangay members are also aware of the government efforts, and are still hope to benefit from this program. Many members are even willing to change their means of living, if that supports their long-term survival in new relocation area.

In addition to the above main 4 team's activities, a geological survey and disaster education workshop were conducted. Geological traces were observed as the 2013 storm deposit in Tanauan and Tolosa on the Southeast coast of Leyte Island, Philippines (**Chapter 12.**). Inundation extent of the storm event ranged from 1.4 km to 3.1 km inland in these areas. On the other hand, maximum inland extents of the sand layer distributed by the storm ranged from 0.13 to 0.18 km (7-8% of inundation extent) and the relationship between inundation extent and maximum sand extent were significantly different from those of other recent tsunamis. Maximum inland extent of the sand layer may be key evidence to differentiate deposits formed by tsunami and storm events. Although the survey team could not locate paleo-storm deposits, our findings are critically important to estimate the size of storm events from geological evidence.

Disaster education workshops (**Chapter 13.**) were conducted in four elementary schools. Disaster education for children is a main disaster-prevention topic in the education. The purpose of disaster education is to guide people to a discovery of their own solutions and their own capabilities. This idea is consisted with The Hyogo Framework for Action 2005–2015 (HFA). In this project, we specifically assessed group activities, Quizzes and disaster drills as educational tools because games might enhance learner motivation and because previous studies showed the beneficial effects of games on education. We derived two main preliminary results. First, this disaster education program, which can reduce negative feelings related to storm surges, presents the possibility that disaster education can help to improve mental health in the Philippines. Second, after disaster education, the students had a positive attitude about disaster education. The positive attitude for the disaster education might increase motivation to participate in disaster education programs, which can increase the capacity to address disasters.

The results of these fact finding surveys are presented in this report. Priority proposed activities for investigating the disaster caused by Typhoon Haiyan are listed below.

1. A rapid response Task Force Team is formed within IRIDeS

2. The Task Force Team will consider conducting the following activities:

1) Setting clear objectives and deliverables of the Task Force Team and giving assignments to each Division Chief and volunteer
2) Gathering information on the identified subjects and setting up a website to share information within IRIDeS and beyond
3) Dispatching research missions to the affected area to gather on-site information for better analysis and provide useful guidance to the authorities and communities
4) Publishing IRIDeS reports based on the findings of the Task Force
5) Sharing lessons learnt from the disaster in an international symposium

3. Proposed subjects to be pursued and confirmed by IRIDeS researchers are as follows:

1) Hazard perspective: investigation of storm surge, flooding, landslides, and wind.
2) Structural and engineering perspective: survey of buildings damaged by storm surge and strong wind
3) Non-structural measures: early warning system, public awareness and education.
4) Social, human and behavioral perspective: impacts on socially vulnerable communities including illegal settlements, gender and other social issues, review of evacuation and shelter options, management of shelters.
5) Environmental perspective: land use.
6) Public health and medical perspective: epidemiological survey of victims, management of transmittable diseases, mid-term to long-term medical assistance, psychological impacts.
7) Economic perspective: investigation of damages and losses, recovery processes, business continuity plans.
8) Others

4. Interaction with exchange students from the Philippines

5. Jointly organize supporting events

2. Summary of Typhoon Haiyan

A powerful tropical cyclone, named as Typhoon Haiyan, struck some areas of Southeast Asian countries. The Philippines was one of the most affected regions due to high winds and storm surges. Thousands of people are feared dead or missing after Typhoon Haiyan swept across the central Philippines on November 8, 2013. The details of Haiyan are described below.

2.1 Track of Typhoon Haiyan

According to the National Disaster Risk Reduction and Management Council (NDRRMC), at 4:40 am on November 8, 2013 at Philippine time, Haiyan made its first landfall over Guiuan, Eastern Samar with the maximum wind speed of 125 kt and central pressure of 895 hPa (Category 5 on the Saffir-Simpson Hurricane Scale). Haiyan kept the same maximum wind speed and made the 2nd landfall over Tolosa, Leyte at 7:00 am and its 3rd landfall over Daanbantayan, Cebu at about 9:40 am. At 10:40 am, Haiyan made its 4th landfall over Bantayan Island, Cebu and by 12:00 its 5th landfall over Concepcion, Iloilo. In the afternoon, it maintained its strength as it approached the Calamian Group of Islands, and it made its 6th landfall over Busuanga, Palawan at 8:00 pm. Haiyan weakened as it continued to traverse over the West Philippines Sea. **Fig. 2-1** shows the track of Haiyan at the Philippines local time: UTC + 8 hrs (Unisys Weather, 2013). **Fig. 2-2** shows the track of Haiyan in a large domain with the time series of the central pressure (NII, 2013). A rapid decrease of the central pressure of Haiyan can be seen from **Fig. 2-2**.

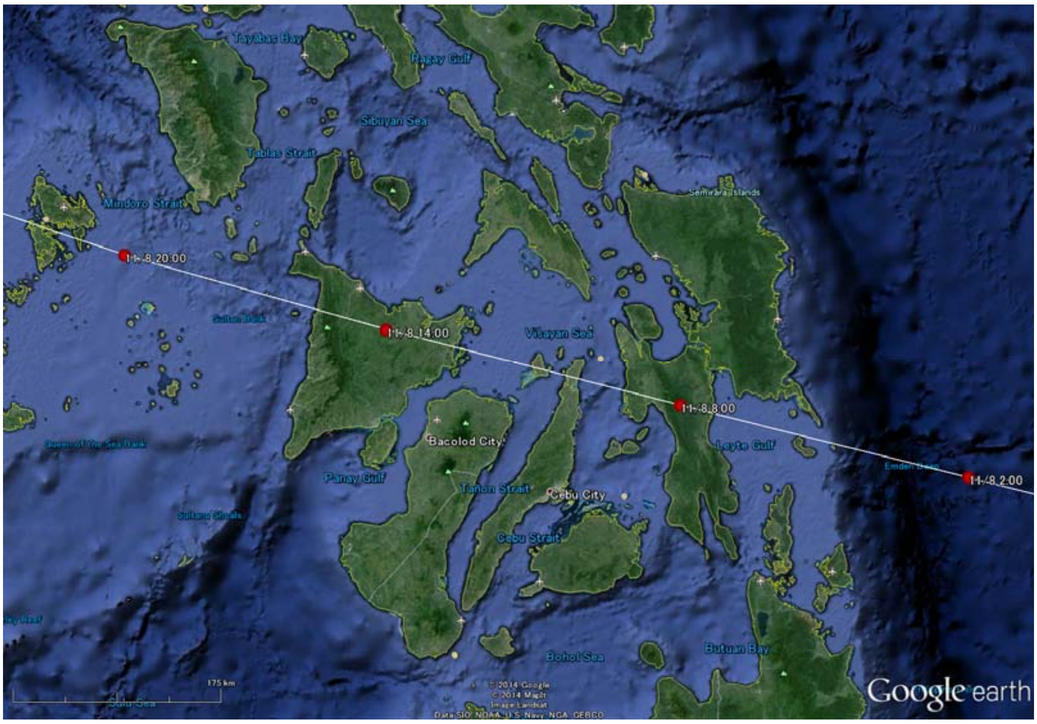


Fig. 2-1. Track of Haiyan shown by white line and red circles (Google earth). The time indicating along the track is based on the Philippines local time (UTC + 8 hrs).

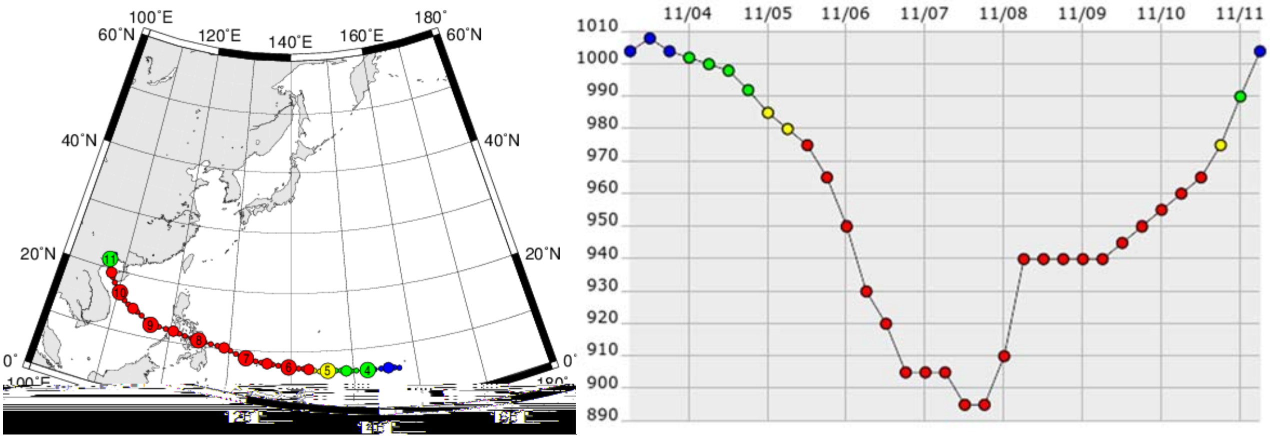


Fig. 2-2. Track of Haiyan (left) and time series of the central pressure of Haiyan (right), UTC (National Institute of Informatics [NII], Digital Typhoon: Typhoon 201330 [Haiyan]).

2.2 Ground observations and satellite data

Fig. 2-3 shows the time series of the observed wind speed and mean sea level pressure at Tacloban weather station in Leyte and Guiuan station in Eastern Samar. The data was provided by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). The rainfall data is also measured at Tacloban station. The landfall time is around 8:00 am in Tacloban and 5:00 am in Guiuan on November 8. A rapid increase of wind speed and rainfall and a decrease of mean sea level pressure toward the peak landfall time can be clearly seen from **Fig. 2-3**. It should be emphasized that the observation equipment was totally destroyed due to the high wind and/or storm surge inundation and data recordings stopped around the peak time, so that the observation may have missed the peak values of the wind speed and pressure. These incidents prove that the wind speed on the ground and storm surge were enormously strong during the Haiyan event.

Fig. 2-4 shows the time series of the predicted astronomical tide at Tacloban and Guiuan. The data was also provided by PAGASA. The tide levels are based on the average mean sea level. It is noted that the tide level data at Tacloban in **Fig. 2-4** is based on the linear interpolation of the predicted peak tide level data. It can be seen from the figure that the tide level was not so high during the landfall of Haiyan. If the landfall had occurred during the high tide, the damage by storm surges and high waves would have been more serious.

Fig. 2-5 shows 24-hr rainfall depth during the Haiyan event (13:00, Nov. 6 – 12:00, Nov. 9, UTC) over the Philippines obtained from GSMaP data (JAXA). GSMaP (e.g. Kubota et al., 2007) developed by JAXA is based on satellite-derived rainfall data. From this figure relatively high 24-rainfall more than 150 mm was observed in several regions during the Haiyan event. **Fig. 2-6** also shows 3-hour rainfall depth with the plots of the typhoon center (Blue circle) during the Haiyan event. These heavy rainfalls may have caused flooding in rivers and landslides in the mountainous regions. However, it should be noted that satellite-driven rainfall data provided by GSMaP may have some uncertainties and biases.

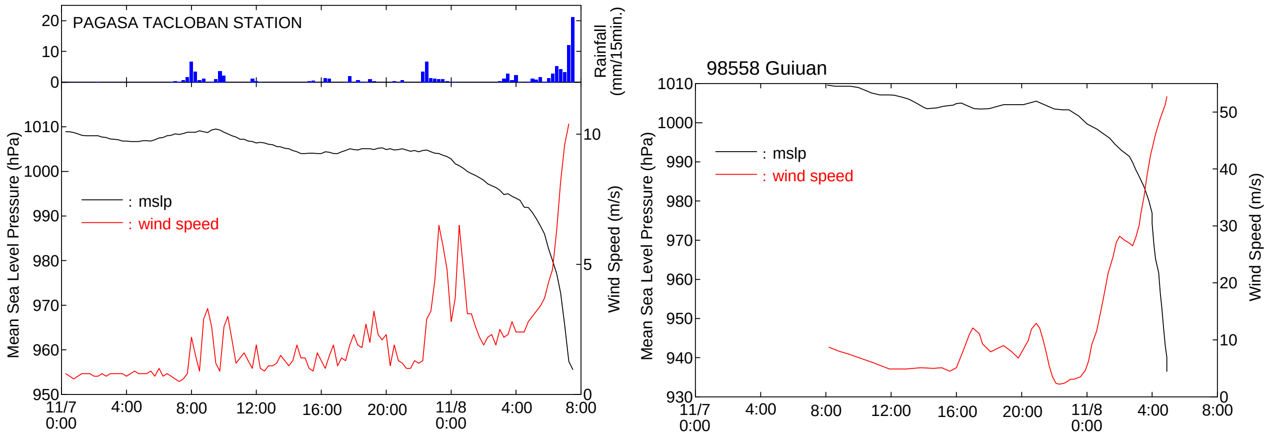


Fig. 2-3. Time series of wind speed and mean sea level pressure at Tacloban station in Leyte Island and Guiuan station in Eastern Samar from 0:00 on November 7 through 8:00 am on November 8.

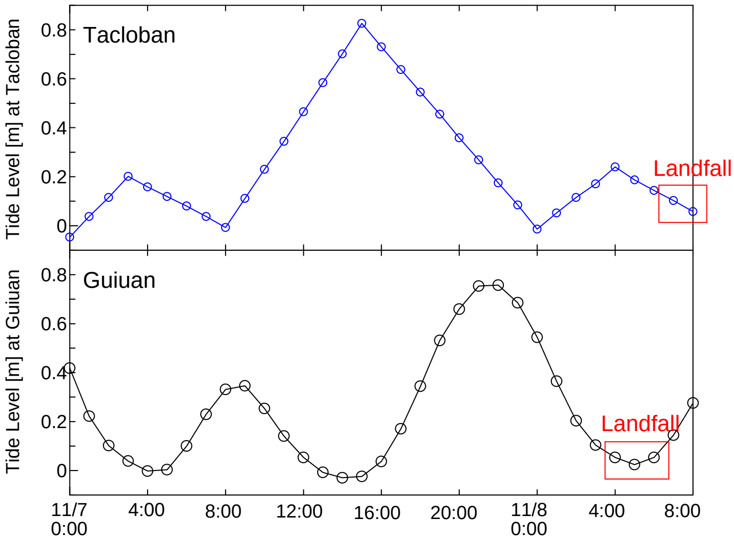
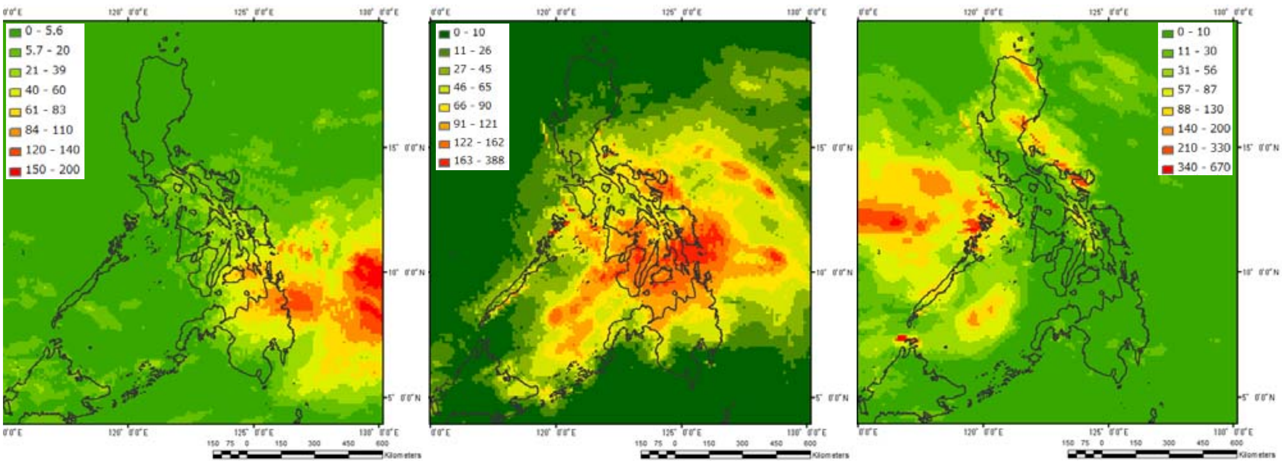


Fig. 2-4. Time series of the predicted astronomical tide level at Tacloban and Guiuan from 0:00 on November 7 through 8:00 am on November 8.



13:00, 11/6 – 12:00 11/7 (UTC) 13:00, 11/7 – 12:00, 11/8 (UTC) 13:00, 11/8 – 12:00, 11/9 (UTC)

Fig. 2-5. 24-hr rainfall depth [mm] during the Haiyan event over Philippines obtained from GSMaP data.

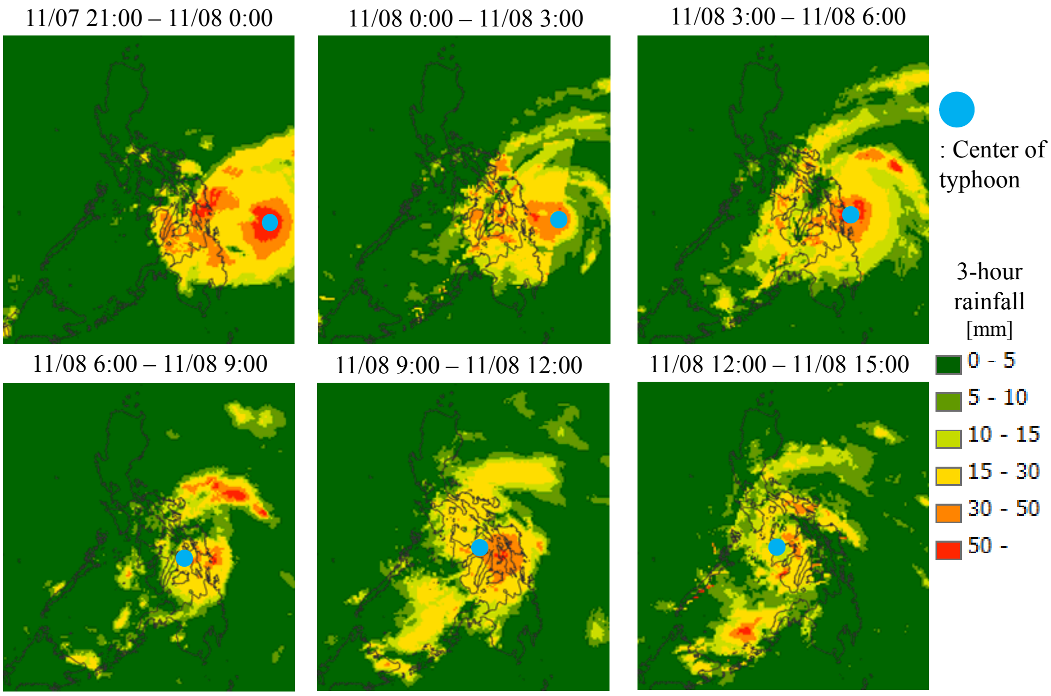


Fig. 2-6. 3-hr rainfall depth [mm] with the plots of the typhoon center during the Haiyan event over Philippines obtained from GSMaP data (Kure et al., 2015).

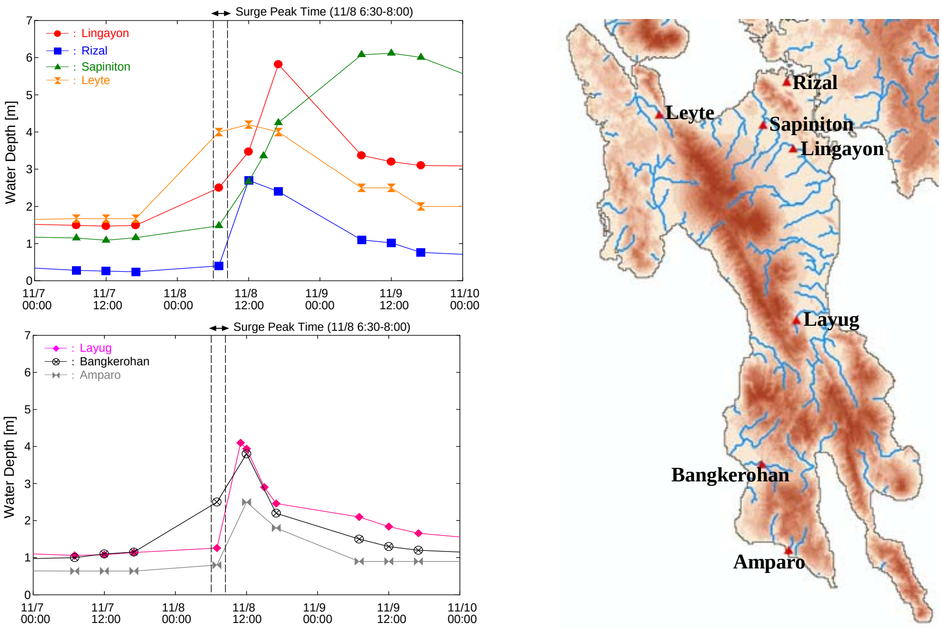


Fig. 2-7. Observed water depth data at river gauge stations in Leyte Island (left side) and the location of the gauge stations and river names (right side) [Kure et al., 2015].

Fig. 2-7 shows flood runoff responses to the Haiyan induced heavy rainfall in the seven rivers in Leyte Island. The locations and names of the rivers can be found in **Fig. 2-7** (right side). It can be seen from **Fig.2-7** that the water depth is increased by the increase of the rainfall induced by Haiyan. These water depth data was recorded at river gauge stations by members of the DPWH regional office by visual measurements at 7:00 am, 12:00 noon and 5:00 pm every day. Through the local interviews by the IRIDeS team, it was confirmed that the typhoon induced heavy rainfall caused river flood inundation in the midstream area of the Lingayon River, and the flood water flowed down to the municipal district of Palo. It should be emphasized that there is a time difference between the rainfall-induced flood peak and the storm surge peak. It was confirmed based on several numerical simulations and local interviews that the storm surge occurred in the San Pedro bay around 6:30-8:00 am on November 8, 2013, but the rainfall induced flooding in the rivers show the peak flood time in the afternoon. If the peak flooding in the rivers had occurred during the storm surge peak time, the damage by storm surges and river flooding would have been more serious because of the storm surge-flood coupling effects on water levels in the downstream of the Lingayon River.

2.3 Summary of Damage

Haiyan caused massive damages in Philippines. As of 6:00 am on March 14, 2014, 6,268 individuals were reported dead, 28,689 injured and 1,061 are still missing. A total of 3,424,593 families (16,078,181 persons) were affected in 12,139 barangays in 44 provinces, 591 municipalities and 57 cities of Regions IV-A, IV-B, V, VI, VII, VIII, X, XI, and Caraga in Philippines. The number of damaged houses was 1,140,332 (550,928 totally and 589,404 partially). The total cost of damage is PHP 39,821,497,852.17 with PHP 19,559,379,136.11 for infrastructures and PHP 20,262,118,716.06 for agriculture in Regions IV-A, IV-B,V,VI, VII, VIII, and CARASA (NDRRMC, 2014).

Especially, human casualties in Tacloban city and Palo and Tanauan municipalities of Leyte were very high. The locations of those places and DEM of Leyte and Samar are shown in **Fig. 2-8**. The number of deaths and missing people are 2,603 in Tacloban, 1,101 in Palo and 859 in Tanauan (as of February 25, 2014) according to the information provided by each municipality. It means that more than 60 % of human casualties from Haiyan were concentrated in those 3 cities in Leyte. **Fig. 2-9** shows the population, the number of deaths and missing people due to Haiyan and fatality ratio [%] in each barangay in Tacloban, Palo and Tanauan of Northern Leyte Island. A barangay is the smallest administrative division in the Philippines. Each barangay population data of Palo and Tanauan was obtained from the Census of Population and Housing 2010 data (NSO, 2014). However, in Tacloban City, the current barangay boundaries and numbering systems used at Haiyan event are different from 2010 data, so that each barangay population (as of March, 2014) was provided from Tacloban City. It should be noted that the population data at each barangay and precise barangay boundaries in Tacloban City are not yet finalized and thus there may be minor changes in the near future. Also, some barangay population data was directly provided through barangay offices because Tacloban City's population survey did not cover those barangays as of March, 2014.

Barangays with more than 10 % of the fatalities can be found along the coastal zones in three cities, and the damage clearly indicates the massive external force of the storm surge during the Haiyan event and the vulnerability of those coastal areas.

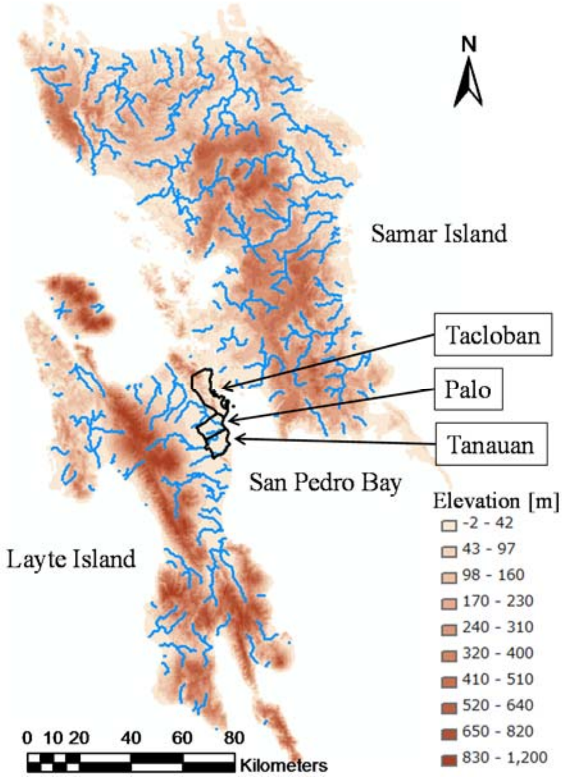


Fig. 2-8. Locations of Tacloban, Palo and Tanauan and DEM of Leyte and Samar Islands (Kure et al., 2014).

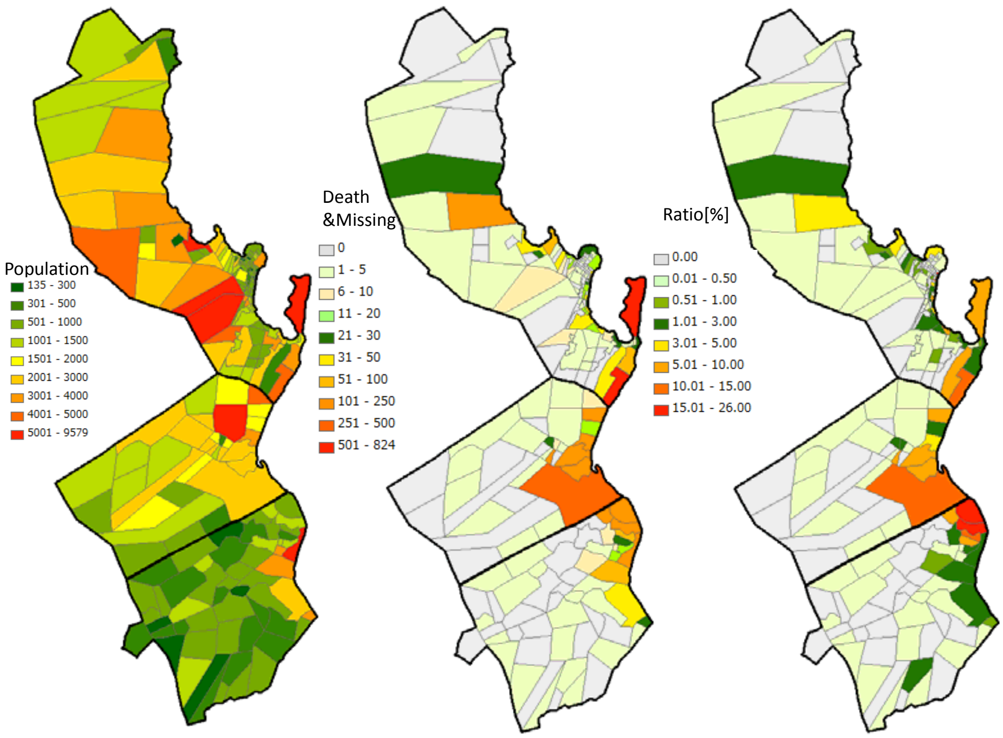


Fig. 2-9. Population (left), number of deaths and missing people (middle) due to Haiyan and fatality ratio [%] (right) in each barangay of Tacloban, Palo and Tanauan (Updated figures from Kure et al., 2014 based on the latest information).

2.4 Evacuation Warning

Warning Record

A tropical storm spotted over the Caroline island in the Pacific Ocean on November 4 and it was named as Haiyan at 8:00 am at the Philippines local time. PAGASA officially announced the Weather Advisory #1 as the warning of Haiyan at 11:00 am on November 5. The Joint Typhoon Warning Center (JTWC) assessed the system as a Category 5 super typhoon on the Saffir-Simpson hurricane wind scale on November 6. Accordingly PAGASA upgraded the warning to the Sever Weather Bulletin #1 at 11:00 am on November 6. The Japan Meteorological Agency (JMA) estimated the system's one-minute sustained winds to 315 km/h and gusts up to 378 km/h at 3:00 am on November 7. At 11:00 am, PAGASA announced the Sever Weather Bulletin #3, warning that the storm surges might reach up to a 7-meter wave height in the coastal areas of Eastern Samar, Samar, Leyte and Southern Leyte in Visayas. Then, as explained in **Section 2.1**, Haiyan made its first landfall over Guiuan, Eastern Samar with the peak intensity at 4:40 am on November 8. President Aquino declared the state of "National Disaster" from the damage of Haiyan on November 11.

It should be emphasized that PAGASA estimated and warned the 7-meter wave height in the coastal areas with the leading time of about 18 hours before the first landfall in Guinuan. This estimation was based on the numerical simulations technically supported by the JMA and historical records of the waves that PAGASA has. It was found from the survey after the Haiyan event that the estimation of 7 m wave height of PAGASA was appropriate, and the storm surge of about 6 m high attacked Tacloban city in Leyte.

Disaster Information Transfer System

A disaster information transfer system in Philippines is shown in **Fig. 2-10** (Miyamoto et al. 2014). The figure was provided by Dr. Mamoru Miyamoto (International Centre for Water Hazard and Risk Management [ICHARM]). Disaster information from PAGASA is transferred to the NDRRMC, National Media, and the public departments concerned such as the Department of Public Works and Highways (DPWH). The NDRRMC transfers the information to the Barangay through the Regional, Provincial and Municipality Disaster Risk Reduction Management Councils (DRRMC). Then, the disaster information is conveyed to a house to a house in local barangays. As explained in the previous section, PAGASA warned the 7-meter wave height in the coastal areas before the landfall. Thus, it is important to assess whether this information transfer system worked well or not during the Haiyan event and how long it took for the houses to receive this disaster information.

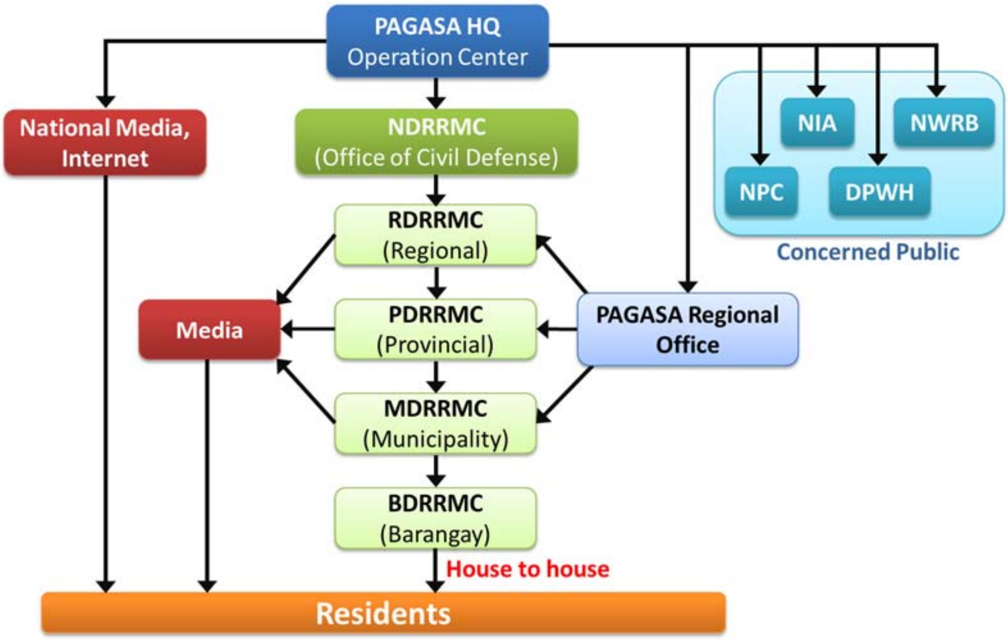


Fig. 2-10. Disaster information transfer system in Philippines (Miyamoto et al., 2014).

Problems for Evacuation

Several problems related to the evacuation to prepare for Haiyan were found through the on-site survey and local interviews by the IRIDeS team, as discussed in later chapters. Main problems were lack of education, poverty and inappropriate evacuation facilities. It is a famous story that many people did not understand what a storm surge is. During the local interview by the IRIDeS team, many people claimed that they did not understand the meaning of the storm surge that was used in the evacuation warning from PAGASA and local DRRMCs. They also claimed that if the warning had been made by using the word "tsunami," they would have evacuated. This incident clearly indicates the importance of disaster education and also the importance of the method to transfer the disaster-related information to the local people.

Another problem is the poverty. Young strong men had to stay in their houses during the Haiyan event in order to protect their properties from being stolen by somebody during the evacuation. This kind of social problem should be seriously considered by the government, and some kind of insurance system or a guarantee system from the government should be discussed.

It is also a famous story of Haiyan that the evacuation facilities were not appropriate against the storm surges and enormously strong wind. For example, the Tacloban City Convention Center in Tacloban is located near the coastline as shown in **Fig. 2-11** (left). About a thousand people evacuated to the center, and the center was inundated by the storm surge induced by Haiyan. Again, this incident shows the importance of disaster education. Another example is the Leyte Convention Center located in Palo. About 400 people evacuated to this center but this center was completely destroyed by the strong wind as shown in **Fig. 2-11** (right). It was very fortunate that nobody died from Haiyan in those centers because people who evacuated to the Tacloban City Convention Center could escape upstairs after the center began to be inundated by the storm surge, and those who went to the Leyte Convention Center could evacuate to another facility before it collapsed. We confirmed this with local offices. For future typhoons, evacuation facilities should be evaluated and selected considering their strength and appropriateness. However, the population of Tacloban is more than 200,000, so that it is not easy for the government to provide appropriate evacuation facilities for all the people living in Tacloban. It is highly recommended to establish and promote a project to re-build, find, and/or newly construct appropriate evacuation facilities and to develop an evacuation plan in Leyte Island against typhoons with storm surges. The Japan International Cooperation Agency (JICA, 2014) developed a detailed storm surge hazard map based on a numerical simulation, and conducted a location and capacity assessment of evacuation centers based on the developed hazard map. This kind of project should be announced widely and the hazard map developed by JICA is strongly encouraged to introduce and explain to local people so that they can understand the situation and find an appropriate evacuation facility.

Fig. 2-11. Tacloban City Convention Center in Tacloban city (left) and Leyte Convention Center in Palo city (right).

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3. Initial damage mapping by satellite images

3.1 Rapid Damage Assessment

Introduction

After the impact of Super Typhoon Haiyan to the coast of Tacloban city, a set of satellite images was obtained to grasp the extension of the damage using visual interpretation of pre- and post-event satellite optical images. Satellite imagery has been used to assess the extent and level of damage in areas with limited access and on need for support and quick emergency response (Wegscheider et al., 2013).

Manual visual interpretation method was used following the first steps described on the methodology to develop tsunami fragility functions (Koshimura et al., 2009; Suppasri et al., 2011; Mas et al., 2012). It is one of the most accurate methods when using very-high-resolution (VHR) imagery (Wegscheider et al., 2013).

Satellite Image Data

The pre-event data used for the damage interpretation was obtained directly from Google Earth, retrieved by November 8, 2013; while the post-event image was acquired on November 13, 2013 through Digital Globe in Google Earth. A zoom into the Anibong area in Tacloban city is shown in **Fig.3-1**.

Methodology

For the visual inspection we classified the damage interpretation into two levels according to the following criteria:

a. High damage or destruction. Here, roofs that had been reduced by more than 50% between pre- and post-event images are included together with structures that had been washed or blown away.

b. Low damage or survival. These are structures where only a small variation on its geometry or roof shape could be observed. Structures in areas near the coastline where flood was expected are also considered into this classification of low damage and survival.

Results

Fig.3-2 shows the area of Tacloban city and the damage interpretation resulted in this area. As shown in the figure, the areas to the north and the south near to the coastline presented high damage, while the center of Tacloban, the downtown area was less damaged by the winds or surges in comparison.

Following the remote sensing approach, the field survey observations confirmed qualitatively the damage in these areas (Mas, E. et al., 2014). Reasons for the distribution of such damage in the areas were confirmed during the field survey and can be summarize as follows:

a. The structures to the north and to the south of downtown Tacloban city were built based on lightweight material and very near to the shoreline. Thus, high vulnerability to wind and storm surge was confirmed. Structures in downtown Tacloban are mainly of concrete frame buildings and brick walls with corrugated galvanized iron sheets for houses with one or two stories.

b. The topography of downtown Tacloban is higher at some points compared to its northern and southern areas. In addition, to the north, in the Anibong area, following the low-lying flat area a immediate steep slope could be observed. This slope might have caused refraction of waves and wind damaging and triggering slope failures.

c. At the Anibong area, ships were found stranded inland. The storm surges carrying these ships inland caused more damage to the urban settlements.

Conclusion

The damage interpretation using satellite images provided important information to grasp the damage in the areas and, in our field survey team case, focus the activities for our field survey. A rapid damage assessment such as the one developed here can contribute actively to the emergency response and relief effort allocation and management when disasters impact on wide areas.

Fig. 3-1. Close view of the Anibong area in Tacloban city from pre- and post-event satellite images used on the visual damage interpretation.

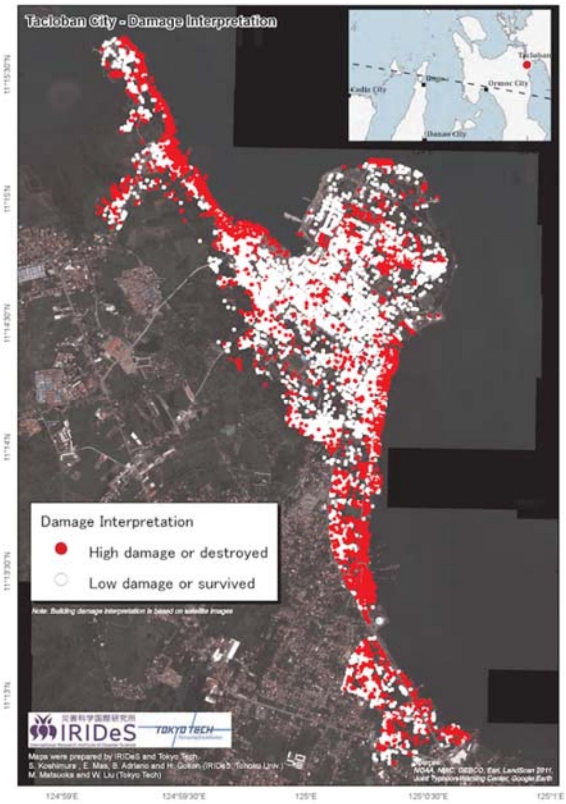

Fig.3-2. Result of the visual damage assessment using pre- and post-event satellite images of Tacloban city.

3.2 Rapid Inundation Mapping

Introduction

In response to the Super Typhoon Haiyan event, a rapid inundation mapping was conducted (Adriano, B. et al., 2014a). Here, visible near-infrared (VNIR) imagery from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor was used to infer the extent of the possible flooded areas. Using the Normalized Difference Water Index (NDWI), the presence of water features can be enhanced and then observed as a result of image processing.

Satellite Image Data

ASTER data was used, where the pre-event VNIR image was taken on June 1, 2008 and the post-event VNIR image was taken on November 15, 2013.

Methodology

The index analysis of ASTER's VNIR images using NDWI was performed using ArcGIS software. To enhance the water features and discover wetland areas, the following equation is applied during image processing:

$$NDWI = (Green - NIR)/(Green + NIR)$$

Where "Green" refers to the green band from the color band spectrum of the VNIR image; and "NIR" stands for the near-infra red band of the VNIR image.

The equation is applied to both, the pre- and the post-event, images and finally the difference of post- minus pre-event image is applied to obtain the new wetland areas presenting the post-event image condition, as shown in blue in **Fig.3-3**.

Results

The blue areas presented in **Fig.3-3** correspond to areas with high probability of presence of water. A preliminary estimation of flooded areas by the typhoon was observed from the shoreline to the inland following the blue colored areas. However, field survey observations and measurements were needed to differentiate the cause of the flood, either by storm surge, rainfall or river.

Conclusion

A rapid assessment of possible inundated areas form the storm surges in Super Typhoon Haiyan event was conducted using satellite imagery. The NDWI analysis of pre- and post-event images provided a preliminary estimation of areas possibly flooded and where damage could occur. Field survey was necessary to confirm the origin and intensity of the flood at each location.

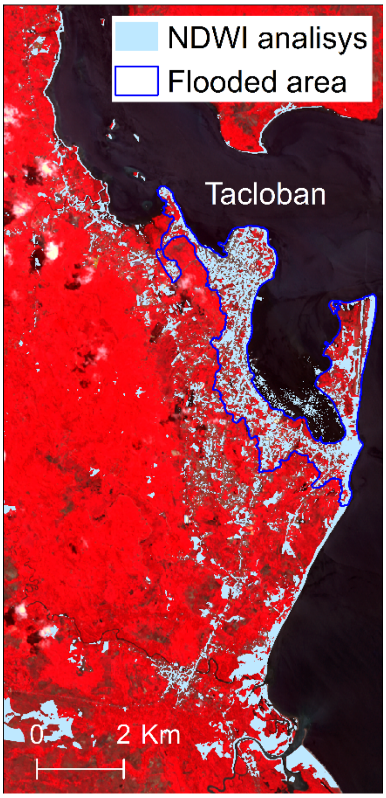

Fig.3-3. Result of the NDWI analysis of pre- and post-event satellite images. The blue areas represent areas which experienced flooding. Areas where storm surge was responsible for the flooding can be inferred by connectivity with the shoreline.

3.3 Damage interpretation from radar images

Introduction

The manual visual interpretation method explained in section 3.1 is suitable to estimate the damage of elements by observation and comparison. However, as a limitation of the method, it requires good optical image resolution data, visibility can be affected by cloud condition and it depends on the user experience for image interpretation. On the other hand, to grasp a wide image of the disaster condition in affected areas, image processing can be use to conduct damage interpretation. Moreover, to avoid restrictions by cloud conditions that affect visibility in optical images, other type of sensors can be used. In this case synthetics aperture radar (SAR) sensors were used to obtain images without weather disturbance (Adriano, B. et al., 2014b, 2015). Characteristics of radar signature were used to define and estimate the changes between pre- and post-event scenes. These changes can be considered as possible damages.

Satellite Image Data

Two synthetic aperture radar (SAR) images from the COSMO-SkyMed (CSK) system were used. One image is a pre-event scene from August 19, 2013 and the second image is a post-event scene acquired on November 20, 2013 over the city of Tacloban in the Leyte Island of the Philippines (Fig. 3-4).

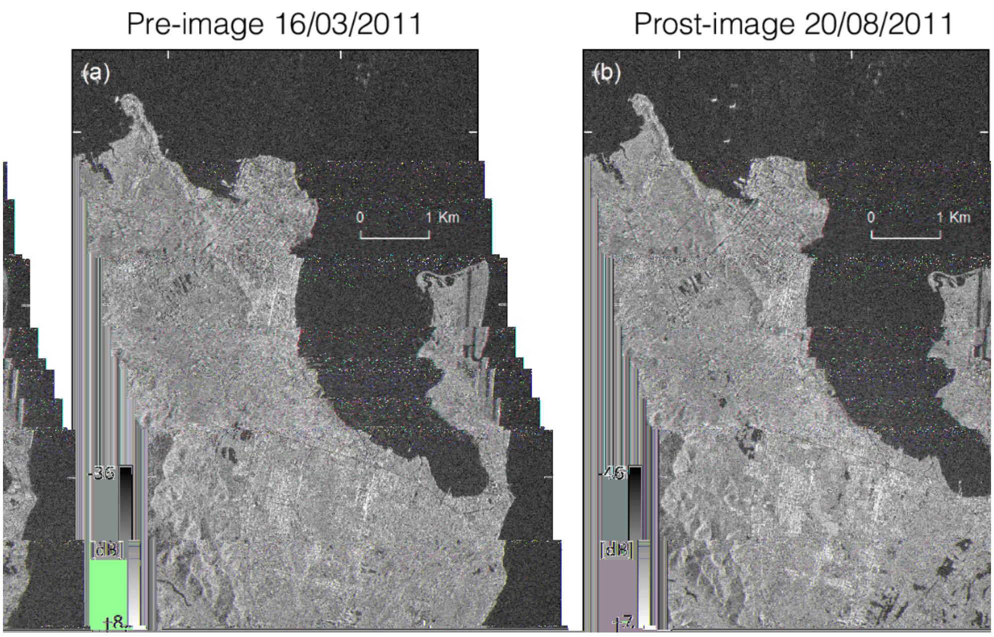

Fig.3-4. COSMO-SkyMed (SAR) images of pre- and post-event in Tacloban city, the Philippines.

Methodology

Comparison between pre- and post-event images is straightforwardly made by the calculation of the difference (*d*) and the correlation (*r*) coefficients of average values of digital numbers from pixels in a local window moving across the entire area of study. The following relations are used to calculate *d* and *r*.

Difference

$$d = \overline{I}a_i - \overline{I}b_i$$

Correlation

$$r = \frac{\sum_{i=1}^{N} Ia_i Ib_i - \sum_{i=1}^{N} Ia_i \sum_{i=1}^{N} Ib_i}{\sqrt{\left[N\sum_{i=1}^{N} Ia_i^2 - \left(\sum_{i=1}^{N} Ia_i\right)^2\right]}\sqrt{\left[N\sum_{i=1}^{N} Ib_i^2 - \left(\sum_{i=1}^{N} Ib_i\right)^2\right]}}$$

Where *i* is the sample number, and *Iai* and *Ibi* are digital numbers with their corresponding overlines or vinculums as the averaged digital numbers within a local window in the post- and pre-images, respectively. *N* is the total number of pixels within the local window.

Results

Difference and correlation coefficients are calculated for the whole area and changes can be identified based on higher or lower values. Still resolution and accuracy needs to be improved, however the difference coefficient in SAR image gave better results which can be observed in Figure 3-5. The areas in blue show negative difference values that can be interpreted as high changes between pre- and post- scenes, as confirmed with optical imagery.

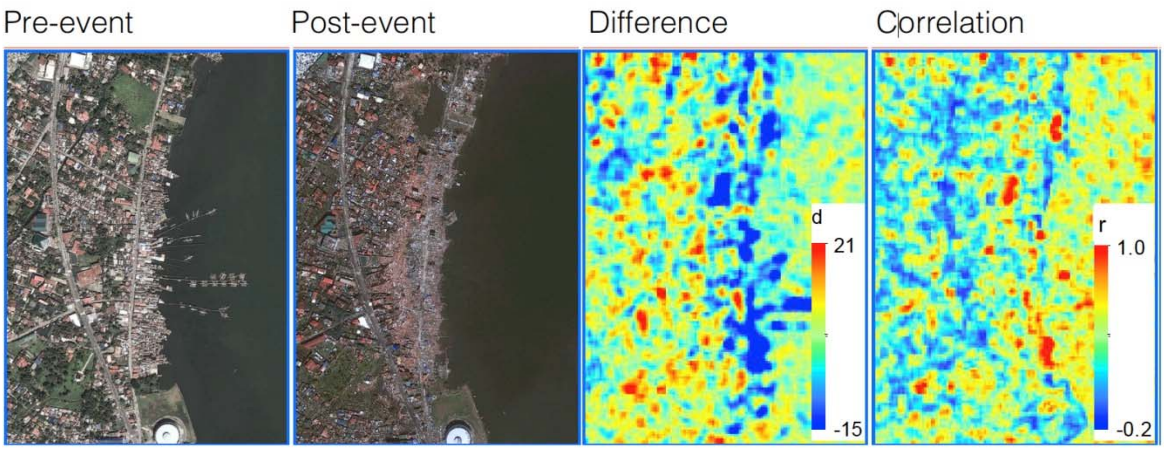

Fig.3-5. On the left, pre- and post-event optical images were clipped from the study area for reference and comparison with results shown on the right side of the figure. Values towards zero denote no difference or correlation, while extreme upper and bottom values can be interpreted as changes or possible damage areas.

Conclusion

SAR images can be used to detect the extensive damage after disasters. We are developing methods to better detect and grasp the damage conditions in affected areas by typhoon or tsunami. Accurate interpretation of damage in affected areas will support the decision and resource allocation during relief and support activities post-disaster.

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4. Storm Surge Simulation

Damage near Tacloban was mainly due to storm surge resulting from wind-induced setup of the water surface, together with large waves in some places. These processes are sufficiently modeled by a phase-averaged wave and storm surge model. However, much of the damage in Eastern Samar was due to the infragravity (long period) wave processes of surf beat, which phase-averaged wave and storm surge models cannot reproduce. Therefore, storm surge and waves near Tacloban were hindcast with Delft-3D/SWAN, a phase-averaged wave and storm surge model. The behavior of the flood in Eastern Samar, however, was modeled with OpenFOAM, a phase-resolving computational fluid dynamics model, and also with BOSZ, a phase-resolving Boussinesq wave model.

4.1 Methodology of phase-averaged storm surge and wave simulation

The behavior of Typhoon Haiyan was hindcast by Bricker et. al. (2014) using typhoon track data from the Japan Meteorological Agency (2013), which was input into a parametric hurricane model (Holland, 1980) for air-pressure field estimation, followed by the moving-typhoon model of Fujii & Mitsuda (1986) as described in Veltcheva & Kawaii (2002) for estimation of the wind field. The typhoon track data included data on location of the center of the storm, surface-level air pressure at the storm center, and maximum sustained wind speed v_{max} [m/s]. However, it did not contain information on the radius to maximum winds r_m [m], so the relation of Quiring (2011) is used to estimate this (Eq. 4-1).

$$r_m = 1852(49.67 - 0.47v_{max}) \tag{4-1}$$

The hindcast pressure and wind fields are input into a combined hydrodynamic and wave model to hindcast the water level and wave heights induced by the typhoon. The hydrodynamic model used is Delft-3D (Deltares, 2011), and the spectral wave model used is SWAN (Booij et al., 1999). Delft-3D and SWAN are run together, with the hydrodynamic model repeatedly passing water level and current fields to the wave model, which calculates the wave field including the effects of currents and storm surge. The wave model in turn passes the radiation stress field back to the hydrodynamic model, which uses this information to calculate wave-induced setup and nearshore currents. Tides are included using the Global Tide database TPXO (2014) as a boundary condition to the hydrodynamic model.

Rough bathymetry was taken from GEBCO (2014) and topography from SRTM (NASA, 2014). Detailed bathymetry of Leyte Gulf was digitized from a nautical chart (NAMRIA, 1980) by Associate Prof. Hiroshi Takagi of the Tokyo Institute of Technology, and topography of downtown Tacloban and Tacloban Airport were surveyed during the January 2014 IRIDeS site visit. Nearshore coral reef topography east of Samar is not available, so the horizontal extents of reefs were digitized from Google Earth images, and a depth of 1 m relative to mean sea level was assumed. Model resolution is 2.5 km for the large domain (**Fig.4-1**), 100 m for the Tacloban domain (**Fig.4-2**), and 50 m for the Guiuan (**Fig.4-3**) and Hernani (**Fig.4-4**) domains. Manning's *n* was assumed to be 0.025 everywhere, though for more detailed inundation analysis in the future, this will need to be adjusted for land use.

An important adjustment to the default SWAN setup was the use of an air-sea drag coefficient limiter of 0.003 (Powell, 2006; Dietrich et. al., 2011) imposed on the drag law of Wu (1982). This drag coefficient limiter is the result of multiple airborne sonde drop measurements in hurricanes (Powell, 2006), and is necessary to prevent the development of unphysical wave heights in the model.

4.2 Results and Discussion of phase-averaged storm surge and wave simulation

The water levels shown in **Fig.4-1** were dominated by wind-driven storm surge near Tacloban and waves in eastern Samar (Bricker et. al., 2014). **Fig.4-1** (right) shows maximum (in time) hindcast significant wave heights during the storm, reaching up to 20 m off Eastern Samar, and decreasing to less than 5 m in Leyte Gulf near Tacloban. **Fig.4-2** shows the storm surge (wind-dominated) near Tacloban, including inundation of downtown Tacloban and Tacloban Airport. The 5-m surge extends up the San Juanico Strait to Bogulibas, then rapidly dissipates where the strait narrows. Damage along Tacloban's shoreline (**Fig.4-2c**) indicated waves atop the surge (**Fig.4-2b**) were strong enough to wreck RC structures, and to cause erosion near building foundations. Inland from the shoreline (**Fig.4-2d**), damage resembled that of a slow, deep flood. In Eastern Samar (**Fig.4-3** and **4-4**), wind- and pressure-driven storm surges were small (**Fig.4-3a** and **4-4a**), but wave-induced setup over the broad coral reefs in these areas generated a surge up to 5 m high (**Fig.4-3b** and **4-4b**). Waves on top of this wave setup (**Fig.4-3c** and **4-4c**) together with bore-like surf beat (**Chapters 4.3** and **4.4)** wrecked structures (**Fig.4-3d** and **4-4d**) and transported concrete and coral debris up to 50 m inland.

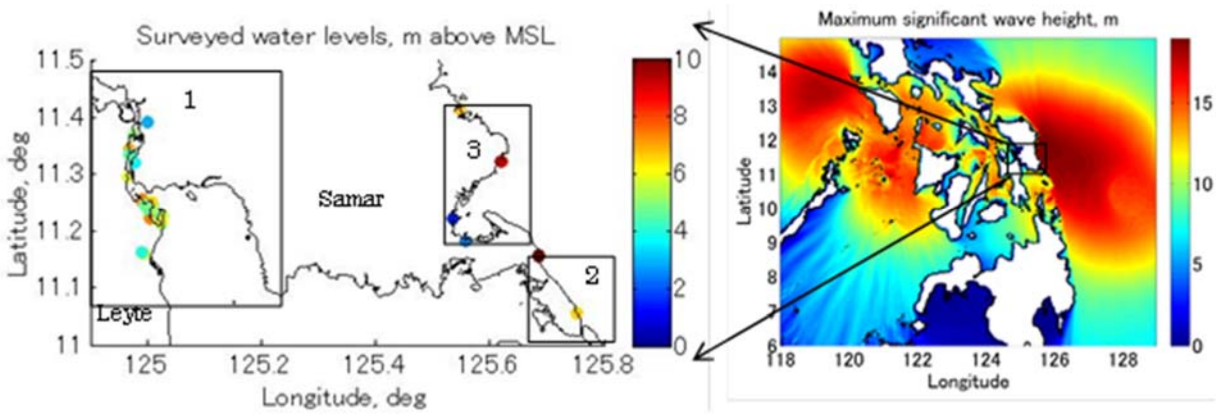

Fig.4-1. (left) Maximum water level (including both surge and waves) measured by the IRIDeS survey team (**Chapter 5.2** and Mas et al., 2014). (right) Maximum significant wave height hindcast by SWAN.

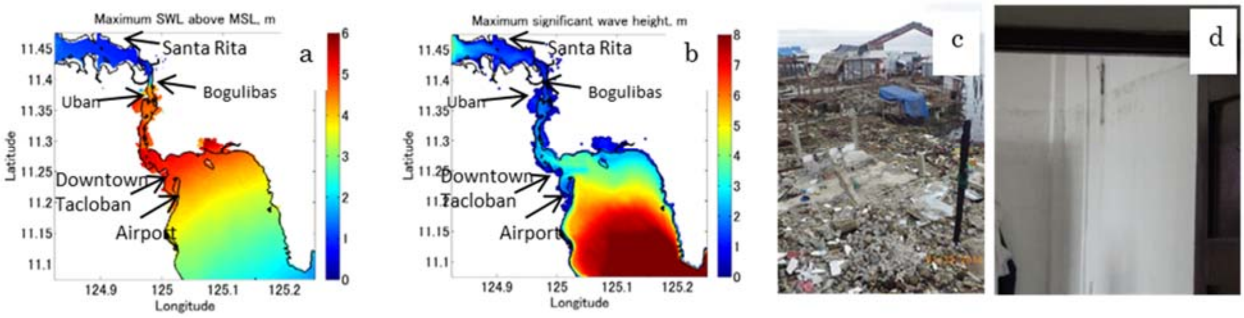

Fig.4-2. (a) Maximum storm surge for small domain (1) of **Fig.4-1**. (b) Maximum significant wave height. (c) Typical damage along the coast of downtown Tacloban. (d) Typical water line in inland downtown Tacloban.

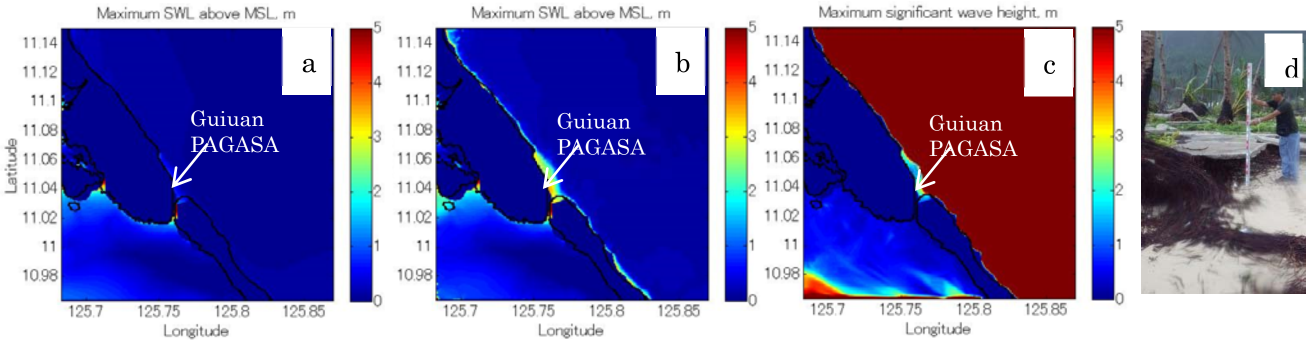

Fig.4-3. (a) Maximum storm surge neglecting wave setup for domain (2) of **Fig.4-1**. (b) Maximum storm surge including wave setup. (c) Maximum significant wave height. (d) Damage along coast near Guiuan PAGASA station.

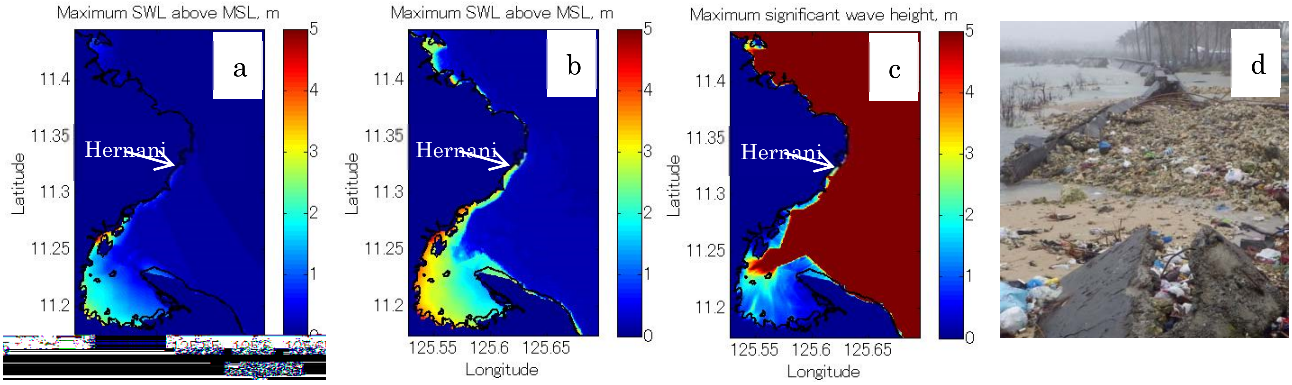

Fig.4-4. (a) Maximum storm surge neglecting wave setup for domain (3) of **Fig.4-1**. (b) Maximum storm surge including wave setup. (c) Maximum significant wave height. (d) Damage to seawall in Hernani.

4.3 Methodology of phase-resolving storm surge and wave simulation

In Hernani, Eastern Samar, the phase-averaged storm surge model discussed above is not sufficient to reproduce the violent tsunami-like bore that was observed to strike the town by Gensis (2013) during Typhoon Haiyan (**Fig.**

4-5). To determine what was responsible for this damaging event, Bricker and Roeber (2015) carried out a field survey of topography and bathymetry in Hernani, and applied a phase-resolving model (which models individual ocean waves).

Land surface elevation in Hernani was measured from May 25-26, 2014 via walking and driving surveys with two Ashtech ProMark 100 GPS units, in base/rover differential configuration (**Fig. 4-6**). The base station was left in place for 4 hours, in order to ensure vertical accuracy on the order of centimeters. DGPS data were post-processed for vertical accuracy with GNSS Solutions software, to correct the rover-measured elevations to the base-station accuracy. The base station elevation was surveyed with respect to local instantaneous sea level at the beginning of each measurement day with a LaserTech TruPulse 200 rangefinder, and this was related to local mean sea level (MSL) using the TPXO (2014) global tide database.

Water depth seaward of the coral reef crest (**Fig. 4-6**) was measured from a hired fishing canoe, using a Hondex PS-7 handheld digital sounder. Sounder readings were photographed with a Canon PowerShot D20 GPS camera to record the location of each measurement.

Since the elevation of the coral reef flat in Hernani was not measured during the May 25-26 field campaign in Hernani, the reef flat elevation of a similar reef in Guiuan (35 km southeast of Hernani) was measured during low tide on May 27, using the same DGPS base/rover configuration as described above, and corrected to local MSL using TPXO (2014). The measured reef flat elevation was flat and uniform, varying from MSL to about 10 cm below MSL. Therefore, for the storm surge modeling to follow, the reef flat in Hernani was assumed to have an elevation of 5 cm below MSL in the area surrounded by the topography and bathymetry measurements show in **Fig. 4-6**.

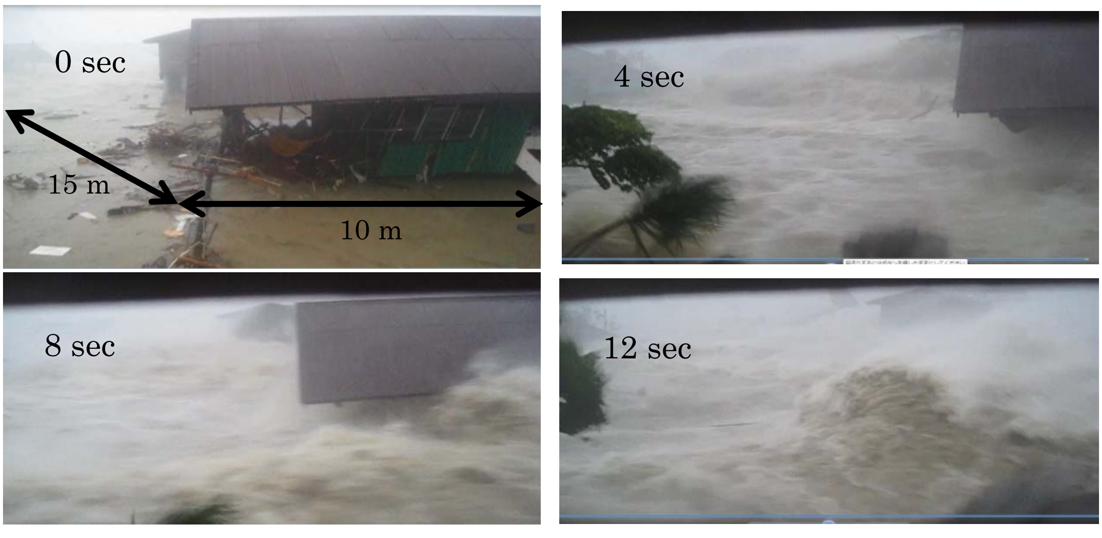

Fig. 4-5. Frames from the video of Gensis (2013), showing a house being swept away by an infragravity wave. Onshore-directed flow lasted at least 20 seconds (the duration of the film). The base of the house is located 3 m above mean sea level (MSL). Images courtesy of Plan International.

In order to evaluate the potential for infragravity motion (surf beat and resonance) to create the bore seen in **Fig. 4-5**, the InterFOAM phase-resolving Volume of Fluid (VOF) Navier Stokes Solver, part of the OpenFOAM CFD package, was used. OpenFOAM was applied along a 1-dimensional transect (**Fig. 4-6**) passing through the house seen washed away in Gensis' film, with a variable grid size reducing to a minimum of 0.5 m in the vertical and 2 m in the horizontal within the region of wave breaking and runup. A uniform roughness height of 1 cm was assumed for both the seabed and coral/land surface. The upper and right-hand boundaries of the domain were assumed to be open to the atmosphere. Turbulence was modeled with the RANS standard k-epsilon model. The PISO algorithm was used for transient Navier-Stokes solution. First order-implicit Euler differencing was used for differencing the unsteady term, second-order Gaussian for the pressure gradient, second-order upwind for momentum advection terms, first-order upwind for turbulence advection, and second-order Gaussian for the diffusion term. Quantities on grid cell faces were determined using linear interpolation. Enhanced interface compression (anti-diffusion) was enacted in order to maintain a sharp air-water interface. The model time step was variable, to keep the Courant number below 0.5. Typically, this resulted in a time step on the order of 0.001 sec.

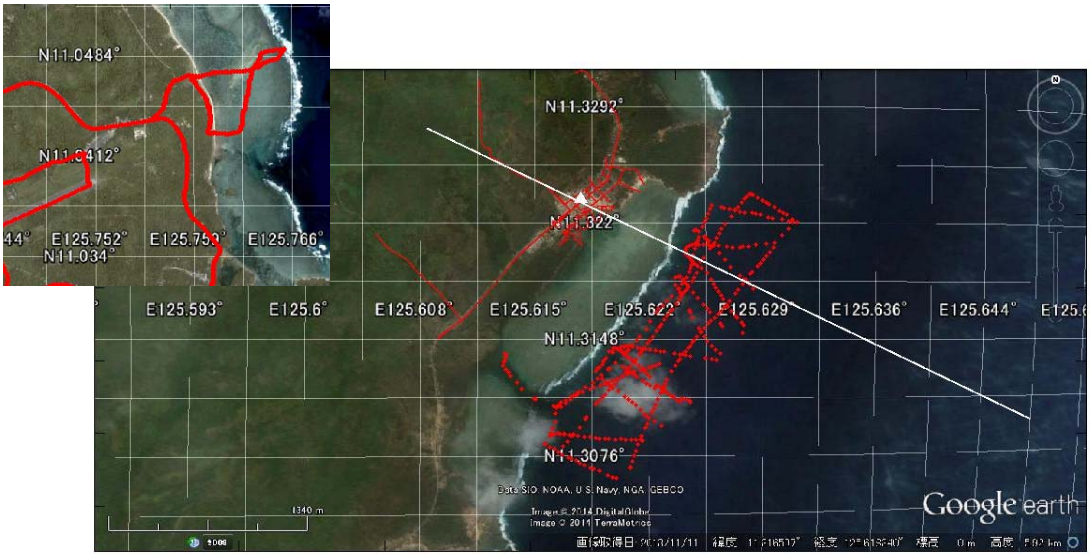

Fig. 4-6. Overview of Hernani. Red lines indicate DGPS field survey locations, red dots indicate bathymetric survey locations, the white triangle indicates the location of the house in **Fig. 4-5**, and the white line indicates the transect used for phase-resolving modeling. Inset at the top left shows DGPS survey locations from Guiuan 35 km to the southeast.

The left-hand boundary of the OpenFOAM model (located at a distance x=290 m in **Fig. 4-7**) was a smooth-surface piston-type wavemaker, implemented via the dynamic mesh capability of the InterDyMFOAM model. To generate the motion of the piston, the SWAN wave spectrum output at the peak of the storm (**Fig. 4-8**, with significant wave height 19 m and peak wave period 18 sec, at 6:30 am JST) was extracted in 150 m water depth offshore of Hernani. The variance of each spectral frequency component was converted to a corresponding piston stroke length via the complete wavemaker theory of Dean and Dalrymple (1991) shown as Eq.(4-2)

$$\frac{H}{S} = \frac{2(\cos(2kh)-1)}{\sinh(2kh)+2kh} \tag{4-2}$$

where H is wave height (proportional to the square root of the variance), S is stroke length, h is water depth, and k is wavenumber determined via the full dispersion relation for each frequency component. The piston stroke length spectrum was then inverse Fourier transformed into a time series of piston position via an assumption of random initial phase for each individual frequency component. The spacing between frequency bins df was small enough to avoid creating artificial wave envelope beating (which occurs at a return period of 1/df) during the 1-hour time series for which the OpenFOAM model was run. This piston position time series was used to drive the left wall of the model as a wavemaker. Waves were then allowed to propagate freely and break over the reef and shoreline.

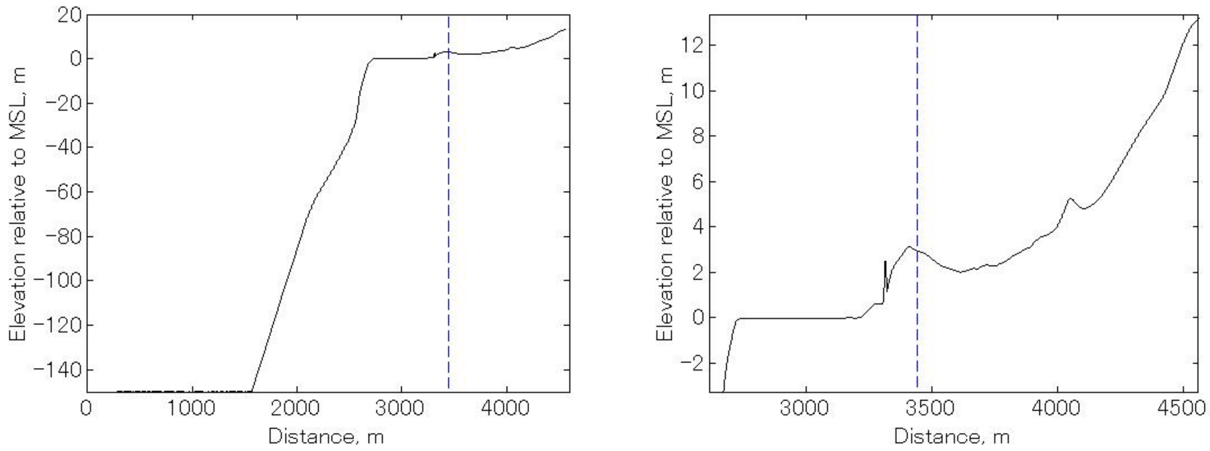

Fig. 4-7. Left: bathymetry and topography of transect used in 1-D OpenFOAM simulation, as a function of distance x along the transect. Right: Zoomed in topography of the reef and onshore region. Dashed line indicates the location of the house swept away by the tsunami as seen in **Fig. 4-5**. The spike seaward of the house is the town's seawall.

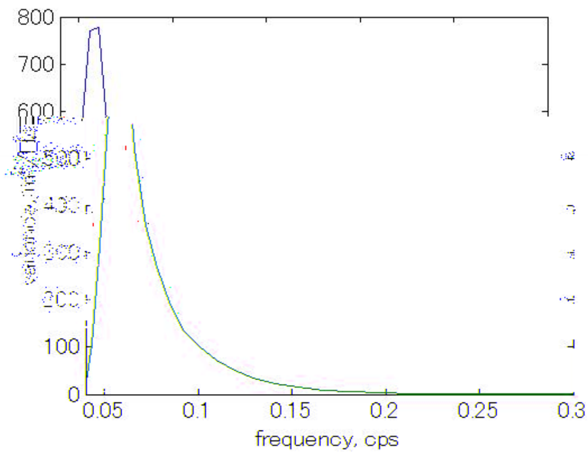

Fig. 4-8. Wave variance spectrum output from SWAN in 150 m water depth offshore of Hernani, and used to drive the wavemaker at x=290 m (left boundary) in the OpenFOAM domain of **Fig. 4-7**.

In addition to the OpenFOAM simulation, a 1-dimensional BOSZ (Roeber and Cheung, 2012) Boussinesq wave simulation was run over the same model domain with the same input wave timeseries. This allowed the direct comparison of results from two completely different types of numerical models. Phase-resolving storm surge and wave model setup is described in detail in Bricker and Roeber (2015).

4.4 Results of phase-resolving storm surge and wave simulation

Fig. 4-9 shows the time series of water level hindcast by OpenFOAM at the house in **Fig. 4-5**, and **Fig. 4-10** shows flow velocity. Both OpenFOAM and BOSZ give similar results, with the exception of the arrival time of the initial wave. This is due to the difference in wave breaking processes resolved over the reef. OpenFOAM resolves the physics of wave breaking, and so reproduces the distortion of waves as they plunge and collapse. BOSZ, though correctly reproducing the energy loss due to breaking, represents all breakers as a shock front. Regardless of this difference, both models produce similar results for water level and flow speed at the house, giving confidence in each model's result. In both models, individual short-period swell (10-20 sec period) are not prominent at this location. Rather, infragravity oscillations with periods of hundreds of seconds are visible. The flow depth (up to 3 m above the ground level at the house), flow speed (up to 6 m/s), and landward flow duration (on the order of minutes) are in close agreement with the video of Gensis (2013), in which a flow depth of approximately 2 m, flow speed of greater than 5 m/s, and landward flow duration of at least 20 seconds (before the video ceased) were observed. Also in agreement with the video, each of these modeled infragravity oscillations strikes the location of the house as a sharp bore of 1 m to 2 m height. This is the same phenomenon generated in the laboratory by Nakaza and Hino (1991) and modeled by Nwogu and Demirbilek (2010), and which these authors termed "bore-like" or "tsunami-like" surf beat.

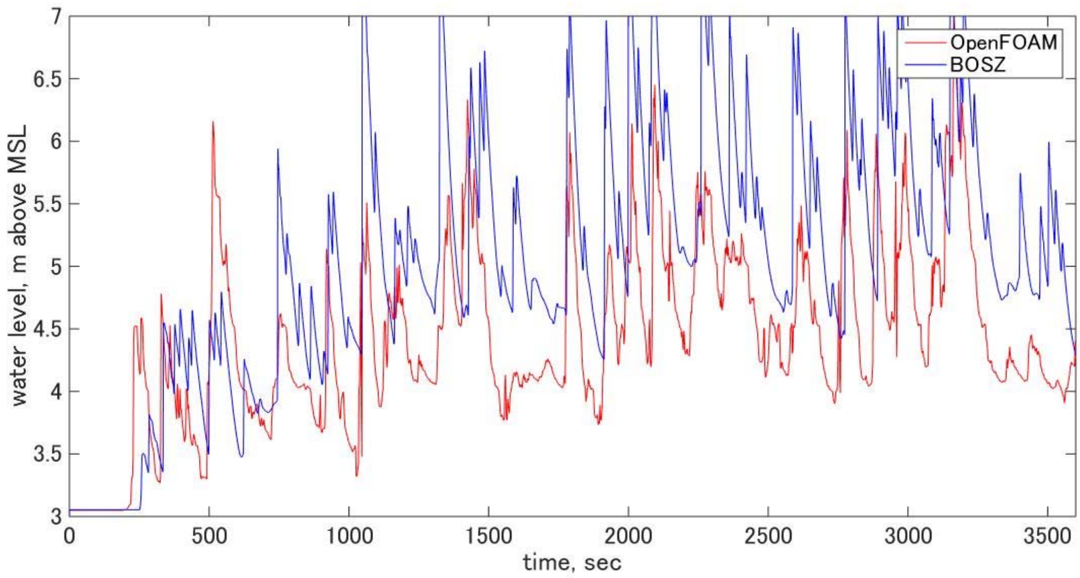

Fig. 4-9. Water level (above MSL) at the location of the house seen in **Fig. 4-5**.

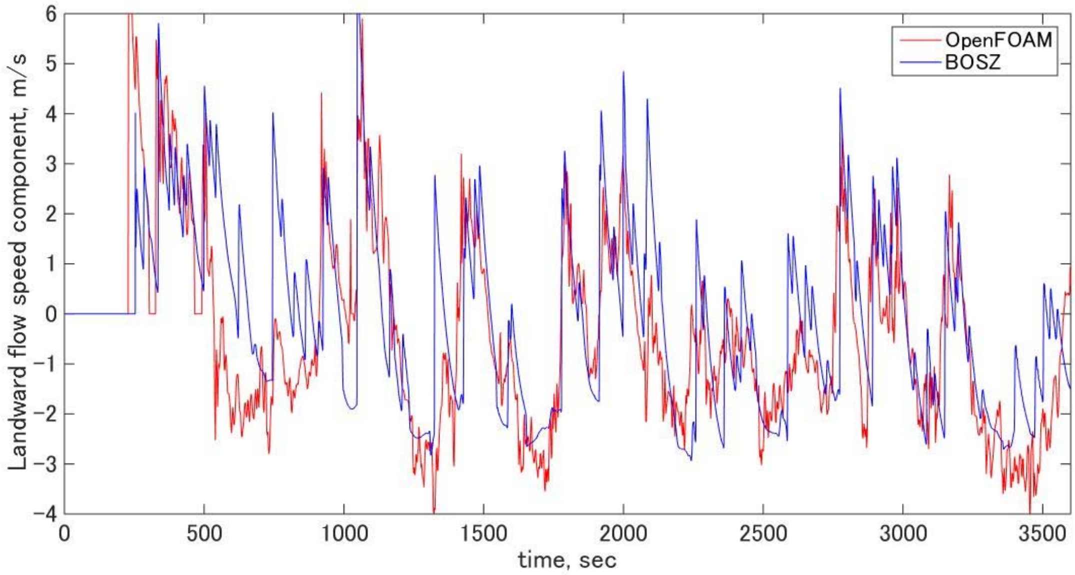

Fig. 4-10. Flow speed at the location of the house seen in **Fig. 4-5**. In the OpenFOAM case, the flow shown is extracted from the grid cell at an elevation of 3.5 m above MSL. In the BOSZ simulation, the flow is depth-averaged.

The physics responsible for the generation of tsunami-like surf beat can be understood by **Fig. 4-11**, which shows the spatial variation of the power spectral density of the water surface elevation signal along the transect of **Fig. 4-7**. Seaward of the reef crest (x<2700m), most of the energy is at a frequency f of about 0.055 Hz, which corresponds to the incident offshore wave spectrum of peak period 18 sec (**Fig. 4-8**). Shoreward of the reef crest (x>2700m), energy in the incident wave band is no longer present, and most of the energy is at lower (infragravity) frequencies.

The energy bands shoreward of the reef face are due in part to offshore wave groups incident on the shore as surf beat. For a given incident wave spectrum, Longuet-Higgins (1984) showed the minimum wave envelope (group) return period $T_{envelope,min}$ is given by Eq. (4-3)

$$T_{envelope,min} = \sqrt{2\pi e \frac{\mu_0}{\mu_2}} \tag{4-3}$$

where $\mu_0 = m_0$ and $\mu_2 = m_2 - m_1^2/m_0$. The spectral moments m_r are given by Eq. (4-4)

$$m_r = \int_0^\infty f^r E(f) df \tag{4-4}$$

where f is frequency (Hz), E is spectral energy density (m2/Hz), and r is an integer. For the SWAN spectrum used as input to OpenFOAM (**Fig. 4-8**), Eq. (4-4) results in an offshore wave group (envelope) return period of approximately 230 sec (corresponding to a frequency of f=0.004 Hz). This signal is most visible shoreward of the breaking location in **Fig. 4-11**, as the breaking process frees this infragravity wave envelope from the short-period swell it had been bound to in deep water, and allows it to propagate onto shore as surf beat (Masselink, 1995). Some energy is also present over the reef and land in **Fig. 4-11** at two superharmonics of this signal (f=0.008 Hz and f=0.012 Hz). These superharmonics are due to steepening of the surf beat, the process responsible for the bore-like shape of the observed and modeled surf beat.

The lowest-frequency energy band is due to the excitation of resonance over the reef. The resonant period of a quarter-wave oscillator is given by Eq. (4-5)

$$T = \frac{4L}{(2n-1)\sqrt{gh}} \tag{4-5}$$

where T is resonant period, L is cross-shore length of the reef, g is acceleration due to gravity, h is mean water depth, and n is a positive integer. For the reef of **Fig. 4-7**, the length of interest is the distance between the location where the waves begin to break (approximately x=2700 m, according to **Fig. 4-11**), and the seawall (at x=3310 m), leading to L=710 m. The average water depth over the reef during the simulation is h=4m. This results in a quarter-wave oscillator period of T=450 sec, corresponding to a frequency of approximately f=0.0022 Hz. Landward of the breaking region, **Fig. 4-11** shows that most of the infragravity energy is present at this quarter-wave oscillator frequency, indicating that resonance over the reef played a large role in exacerbating damage in Hernani.

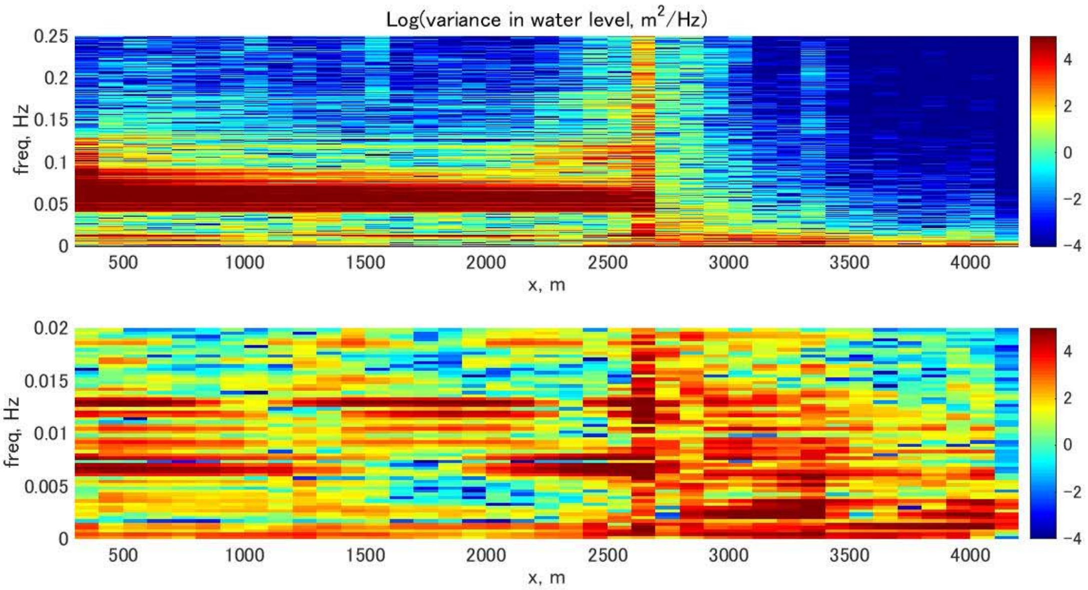

Fig. 4-11. Power spectral density of water surface elevation extracted at 100 m intervals along the OpenFOAM transect. Top plot shows the entire spectrum, while bottom shows only infragravity frequencies.

4.5 Conclusions regarding storm surge and wave hazard modeling

The numerical model results of Bricker and Roeber (2015) show that the tsunami-like bore which struck Hernani, Eastern Samar during Typhoon Haiyan was generated by infragravity energy released from wave groups overlapping closely in the spectral domain with the natural resonant frequency of the reef. This is the same phenomenon recreated in the laboratory by Nakaza and Hino (1991) and modeled numerically by Nwogu and Demirbilek (2010). In the present work, similar results were obtained using two entirely different types of phase-resolving models: the OpenFOAM Volume-of-Fluid (VOF) model and the BOSZ Boussinesq wave model. The agreement between these models corroborates the validity of each model's result.

The failure of the phase-averaged Delft-3D/SWAN model to reproduce this event underscores the importance of phase-resolving modeling for coastal disaster assessment in regions protected by fringing reefs. Phase-resolving models (which simulate individual ocean waves) are not commonly used in coastal disaster planning in the US, Europe, or elsewhere. As such, the phenomenon that struck Hernani is not being accounted for. In the US, FEMA and the National Flood Insurance Program determine the coastal wave hazard zone (V-zone for flood insurance rate map assessment) by use of a shallow water model together with a phase-averaged wave model (commonly the Delft-3D/SWAN or ADCIRC/SWAN coupling, which estimate statistical wave properties, but do not resolve individual ocean wind waves). For places near shallow water (such as Tacloban, New Orleans, Bangladesh, and Nagoya), this is sufficient, but the hazard potential is being underestimated for places fronted by fringing reefs (such as Hernani, Hawaii, Puerto Rico, and Okinawa). This is also important for areas being developed for oil and gas terminals. For these places, coastal hazard must be assessed with a phase-resolving model such as BOSZ or OpenFOAM.

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5. IRIDeS fact-finding mission, Hazard and Damage Evaluation Team

5.1 Missions and local collaborators

IRIDeS sent the Hazard and Damage Evaluation Team to conduct an on-site field survey to collect general information including evacuation response, inundation time and depth, emergency response by local government, etc. and obtain spatial data, statistical data and documents related to the damage caused by Typhoon Haiyan. And discussed with local authorities about possible collaborations to mitigate typhoon-related disasters in the future.

Name of the mission
IRIDeS Fact-finding mission to Philippines

Hazard and Damage Evaluation team

1. Ass. Prof. Shuichi Kure (Team Leader, Disaster Potential Study)
2. Assoc. Prof. Jeremy D. Bricker (Technology for Global Disaster Risk)
3. Ass. Prof. Erick Mas (Remote Sensing and Geoinformatics for Disaster Management)
4. Ass. Prof. Carine J. YI (International Strategy for Disaster Mitigation)
5. Mr. Bruno Adriano (Remote Sensing and Geoinformatics for Disaster Management)

Philippines counterparts

1. Dr. Maritess S. Quimpo (Bureau of Research and Standards, DPWH)
2. Prof. Cristopher Stonewall P Espina (College of Architecture, UP)
3. Mr. Karl Taberdo (College of Architecture, UP)
4. Mr. Paul Tupaz (BS Economics Student, UP)
5. Mr. Christer Kim Gerona (BS Political Science Student, UP)

Tasks of the Hazard and Damage Evaluation team, IRIDeS

Target Area:
1) The city of Tacloban, Municipality of Palo, Municipality of Tanauan, and rural areas around rivers and mountains on Leyte Island
2) Coastal areas on Eastern Samar Island

Task 1. Verification of satellite image analysis using ground truth data and understanding the damage characteristics of buildings due to typhoons:

- Measurement of inundation levels
- Classification of buildings damaged by storm surge and strong wind

- Taking of photos with GPS information of damaged places and buildings

Task 2. Data measurement and collection for detailed storm surge and wave modeling:

- Measurement and/or collection of bathymetry data of Tacloban Bay and the straight that connects Tacloban Bay to Carigara Bay
- Collection of fine-resolution topographic data of Tacloban city and other areas that experienced significant inundation and storm surge damage
- Cataloging of coastal defenses (seawalls, levees, gates, if any) that existed before the storm, as well as their condition after the storm

Task 3. Investigation of other hazards (flooding, landslides, wave intrusion along the river, etc.) induced by Haiyan:

- Collection of hazard maps and hydro-meteorological data such as wind speed, rainfall, river discharge, tide level data, etc.
- Travel around rivers and mountainous regions to identify flooding and landslide damage induced by the typhoon
- Modeling of the flood due to heavy rainfall with high tide level induced by the typhoon.

5.2 Inundation map

The main objectives of the mission were to collect spatial data, statistic data and documents and measure the inundation heights from storm surge and waves to inspect the damage and magnitude of Haiyan, and to conduct and verify the numerical simulation and satellite image analysis results. In order to make an inundation map of Haiyan, we conducted an on-site survey in Tacloban city and towns on Leyte and Samar Islands.

The survey was mainly conducted based on local interviews to obtain inundation heights and reliable information because it was difficult to find clear water marks of the storm surge and high wave inundation due to heavy rainfall during the Haiyan event and severe building damage induced by the strong wind. On the other hand, many residents around the coast stayed in their houses until inundation occurred, and witnessed the flooding event. Measurements were conducted using a portable laser rangefinder referenced to sea water level at the time of the survey. Examples scenes from the survey are shown in **Fig.5-1**.

Fig.5-2 shows the area of the city of Tacloban where the most of survey point data was taken by the team. The bottom left inset shows the inundation heights measured in downtown Tacloban. In the right inset an estimated inundation limit was drawn as a result of the Normalized Difference Water Index (NDWI) analysis explained in **Chapter 3** of this report; the measurements were available from the field survey and interviews with eyewitnesses and residents in Tacloban (Adriano et al., 2014; Mas et al., 2014). The Storm surge height was measured as high as 6m near the shoreline. The survivors reported waves up to 4 m high atop the surge. Wave runup up to 12 m high was observed in Eastern Samar (Mas et al., 2014; Bricker et al., 2014). For more details, please see Bricker et al. (2014), Mas et al. (2014) and Kure et al. (2014). Also, the JSCE-PICE[1] joint survey team reported detailed inundation and run-up heights in Leyte and Samar (Tajima et al., 2014).

Fig.5-1. Pictures of the inundation survey in Leyte and Samar.

[1] JSCE: Japan Society of Civil Engineers / PICE: The *Philippine Institute of Civil Engineers*

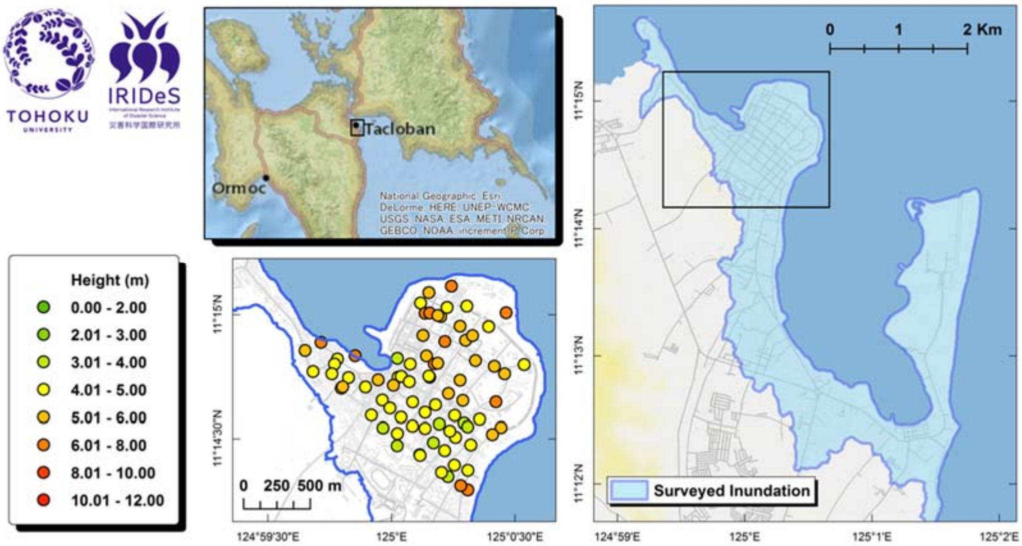

Fig.5-2. Measured inundation heights in Tacloban city based on survivors' interviews (left) and inundated area estimated from NDWI analysis (right) [explained in **Chapter 3**].

5.3 Northern extent of surge

The storm surge simulation hindcast a steep change in maximum surge elevation about 15 km north of downtown Tacloban, where the San Juanico Strait narrows and curves before widening again near Santa Rita to the north. **Fig.5-3** shows the result of the storm surge simulation near Tacloban. Between Tacloban Airport and Bogulibas, maximum storm surge height was about 5 m above Mean Sea Level. North of Bogulibas, storm surge elevation rapidly diminished to less than 1 m. In Santa Rita, the modeled storm surge elevation was less than 1 m, and during our team's field survey, interviewed residents reported no flooding in Santa Rita. **Fig.5-4** shows surveyed water levels, in close agreement with the simulated surge levels of **Fig.5-3** (since no flood was measured in Santa Rita, it is not included in **Fig.5-4**).

Fig.5-5 shows damage along the coast in Uban. The row of homes closest to the shore (near the seawall in the foreground of the photo) was destroyed, and one set of concrete stilts can still be seen amongst the wreckage. Homes further inland had been damaged, but already rebuilt. **Fig.5-6** shows wind waves up to 2 m high impacted Uban, and, atop the surge, these were likely responsible for destroying homes along the shoreline. Wind damage (i.e., missing roofing sheets) was not as severe in Uban as it was further south, and no wind damage was apparent in Santa Rita, indicating that the typhoon wind field diminished this far north. In addition to structural damage in Uban, surge flooded agricultural land tended by the town, destroying the season's rice crop due to salinization, and damaged the town's fishing industry because residents are hesitant to eat fish caught nearby the location of so many bodies (of the townspeople who drowned in the surge and whose bodies were not discovered on land).

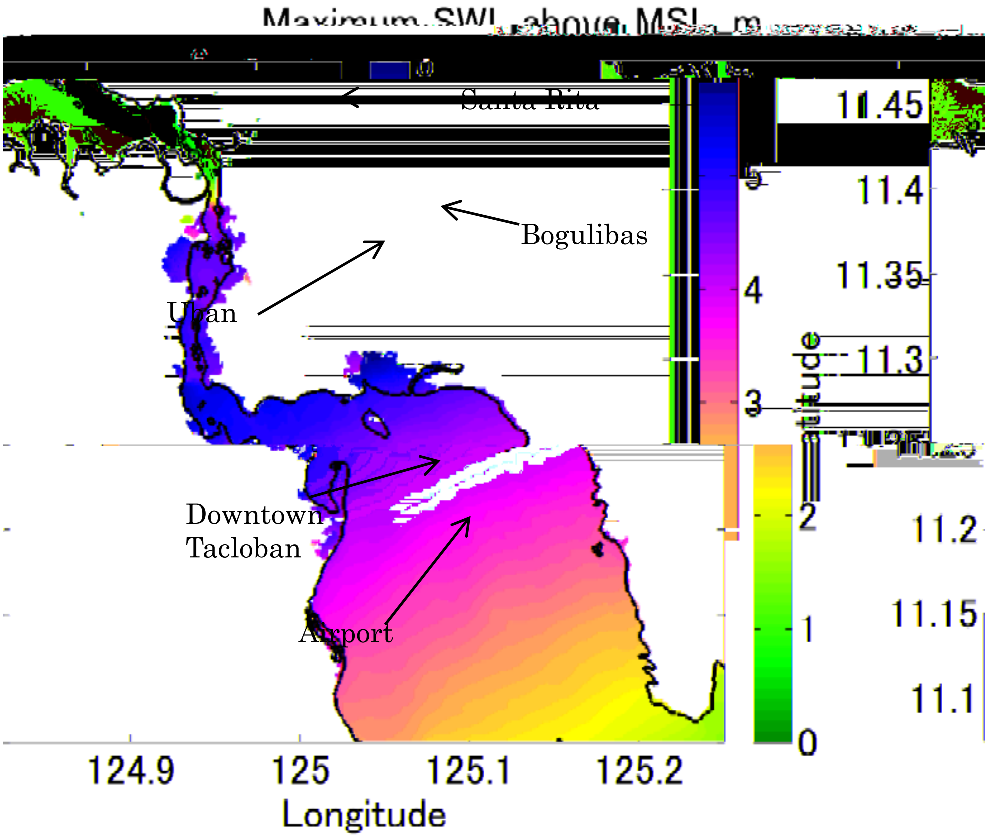

Fig.5-3. Simulated maximum water level due to storm surge near Tacloban.

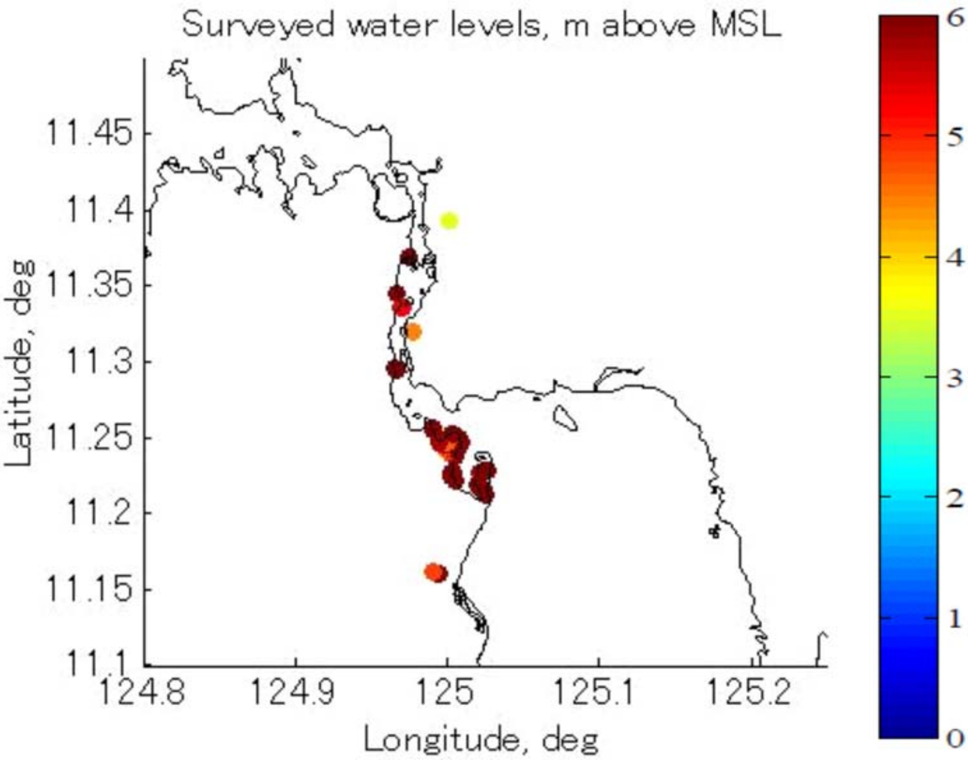

Fig.5-4. Measured maximum water levels near Tacloban.

Fig.5-5. Damaged and rebuilt homes in Uban.

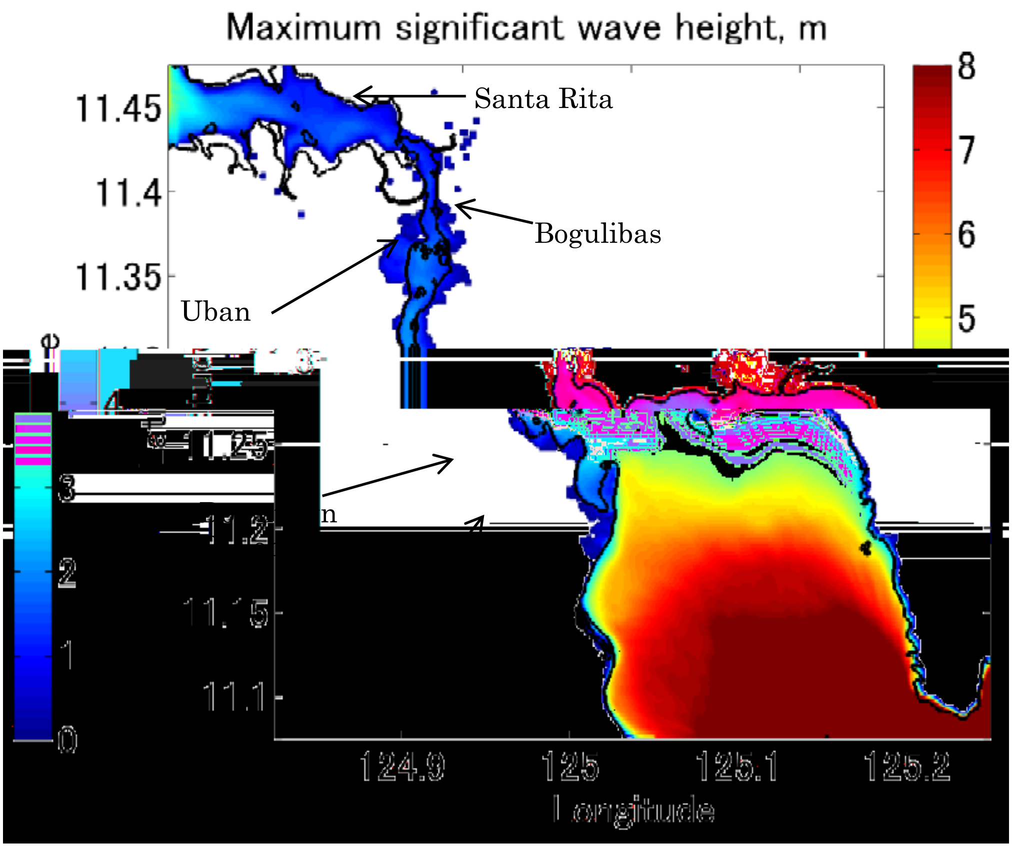

Fig.5-6. Maximum significant wave height near Tacloban.

5.4 Types of damage in Tacloban

Water-related damage in downtown Tacloban varied between two regions of the town: inland and coastal. In inland downtown Tacloban, buildings were dirtied by storm surge and by rain falling in through roofs that had been blown away. **Fig.5-7** and **Fig.5-8** show water lines inside buildings in inland downtown Tacloban. Most buildings are built of concrete or wood. While concrete buildings are concentrated in downtown Tacloban, poorly built and unsafe wooden houses are along the coastline. Typical houses are built with bricks and a longitudinal wire through the bricks whenever financial conditions allow for it. **Fig.5-9** is the typical brick house wall with only few longitudinal reinforced wires and this is common housing structure in Tacloban area. Soft walls and windows were broken out, equipment, furniture, and architectural elements inside these buildings were ruined by strong winds and rain. **Fig.5-10** shows a house in downtown Tacloban that was reconstructed using wooden studs and corrugated galvanized iron sheet. Houses along the coast in the Anibong area of Tacloban were also rebuilt with debris and distributed tents as shown in **Fig.5-11**.

Fig.5-3 shows the area of downtown Tacloban submerged by the storm surge, but **Fig.5-6** shows that waves in the same location were very small. Waves that were incident onto the city from the bay around it, were broken when they impacted structures on the shoreline. Unlike the damage seen in Japan after the 2011 Tsunami, buoyancy of structures did not seem to contribute to building failure; this is because in Tacloban most buildings are very porous, with water quickly flooding in through doorways and windows.

Along the coastline of downtown Tacloban, however, the presence of waves atop the wind-driven storm surge caused heavy damage. **Fig.5-12** shows the remains of a reinforced concrete building, with only its foundation and damaged columns still remaining. The rubble of its concrete walls is seen around the building’s floor. **Fig.5-13** shows scour around the foundation of a building along the coastline. This is probably the result of waves; as such scour did not exist inland. Another mechanism of damage to coastal buildings was debris impact. **Fig.5-14** shows the foundation of a house leveled by a ship that lost its moorings in Tacloban Harbor and was then blown onshore in a residential area. Many houses along Tacloban’s coastline were leveled by drifting ships.

Fig.5-7. Water line inside a building in inland downtown Tacloban.

Fig.5-8. Water line inside a building in inland downtown Tacloban.

Fig.5-9. Brick house wall with few longitudinal reinforced wire

Fig.5-10. A partially damaged house reconstructed its outer wall in downtown Tacloban.

a)  b) 

Fig.5-11. a) A house rebuilt with corrugated galvanized iron sheet and wooden studs, b) A house being rebuilt with debris.

Fig.5-12. Destruction of Reinforced Concrete building in coastal downtown Tacloban.

Fig.5-13. Scour of building foundation in coastal downtown Tacloban.

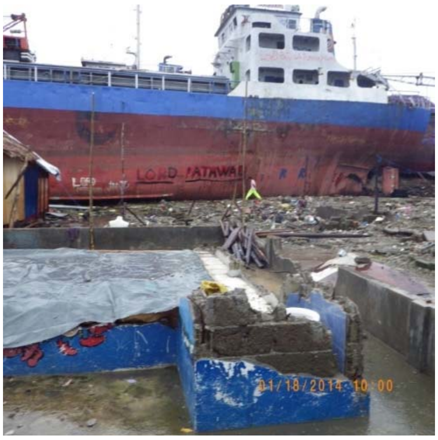 

Fig.5-14. Flattening of houses by a drifting ship in coastal Tacloban.

5.5 Wind damage

Damage due to extreme wind was present throughout the survey area. The major mechanism of wind damage was the ripping off of roofing materials from roof frames. Once the roof was destroyed, rain poured into the structure, ruining the architectural elements, equipment, furniture, and other items inside. **Fig.5-15** and **Fig.5-16** show examples of roofs ripped off public structures. In addition to destroyed roofs, wind-borne projectiles shattered windows and soft walls.

The most common roofing material in the region is Corrugated Galvanized Iron (GI) sheets, which are popular because of their low cost and ease of installation as shown as **Fig.5-16**. They are tied to the roofing frame/rafters (usually wooden, though sometimes metal) by nails. A common mechanism of failure of these ties is the nails ripping through the GI sheet. Sometimes the sheets and the nails are dissimilar metals, which can accelerate corrosion of both nail and sheet, further weakening the tie-down. In most cases, the roofing frames themselves remained tied down to the building structure quite well; contrast this to the US, in which the most common roof failure mode during hurricanes and tornadoes is the entire roofing frame lifting up off the building structure. The most direct method of preventing nails from ripping through GI sheet roofs is by using thicker GI sheets. However, this increases costs, and some hospitals complained that thicker GI sheets were not available (not in stock locally) for use in repair or reconstruction of their roofs after Haiyan, so thin GI sheets were used instead.

Fig.5-17 shows a building that was totally damaged by wind and storm surge, and **Fig.5-18** is a health facility partially damaged by only wind. Both health facilities were not functioning as of mid-January, 2014.

Coconut trees dominate the vegetation in eastern Leyte Island. These are the source of the coconut oil industry in the area. Many trees fell and snapped off their trunks during the storm. A devastated canopy of coconut trees was observed as shown in **Fig.5-19**.

Fig.5-15. Roof damage at a public area in Tacloban.

Fig.5-16. Corrugated Galvanized Iron (GI) sheet roof for residential house commonly found in Tacloban Area.

Fig.5-17. Roof damage at a hospital in Palo (south of Tacloban).

Fig.5-18. Tacloban Doctor's Medical Center affected by only strong wind.

Fig.5-19. The canopy of coconut trees was destroyed by strong wind.

5.6 Eastern Samar damage

The eastern coast of Samar faces directly into the Pacific Ocean, thus it was exposed to the nearly 20 m height (offshore) waves generated during Haiyan. Most of the eastern coast drops rapidly to deep water, with coral reefs along the shoreline. However, there is a small, shallow bay (Matarinao Bay) near the town of General MacArthur. As **Fig.5-20** shows, high water levels (6 to 10 m) were measured along the coastline. Inside Matarinao Bay, lower flood levels (about 3 m) were inferred via interviews.

Near the Guiuan PAGASA station, **Fig.5-21** shows a surge (mostly from wave setup) of 3 to 4 m, and wave heights of about 3 m on the landward side of the reef. Approximating runup as surge plus wave height (i.e. against a vertical wall), the 6.6 m recorded water level is reasonable. **Fig.5-22** shows a foundation destroyed by the flood. Scour of sand under the foundation is responsible for some of the damage, as well as wave forces. Concrete blocks from foundations were drifted up to 30 m landward by the waves. In addition to the damage on the coast, the flood propagated far inland. **Fig.5-23** shows a school building half kilometer inland flooded by the surge. However, due to lack of ground-level topography data in this location, inundation here cannot be simulated. Since a palm forest over 1/2 km wide separated this school from the coast, waves could no longer have been sizeable by the time they reached this location, so it is likely that the flood here was due to surge induced by wave setup.

Further north, in a coastal Barangay of Salcedo, total water level was measured to have been at least 11.5 m above mean sea level. **Fig.5-24** shows a toilet vault along a debris line located on land at 9 m above mean sea level, and a building with its top story washed away. The base of the top story is located at 11.5 m above mean sea level. From these photos, it is evident that scour was also a major cause of destruction. The toilet vault had been buried in the sand before the storm, so sand around the vault must have been scoured to have allowed the vault to float. Sever scour (greater than 1 m) is also seen around the foundation of the house in **Fig.5-24**. Scour caused the house's approach stairway to collapse, though the house itself remained standing because its foundation footings remained partially supported by sand. The reason total water level was higher in Salcedo than in Guiuan was probably because the reef in Salcedo was much narrower than it was at the Guiuan site, allowing larger waves to runup onshore, whereas at the Guiuan site waves broke over the reef, causing a large setup but lower wave heights onshore.

Fig.5-25 shows surge elevation and wave heights along the northern segment of Eastern Samar surveyed. At Quinapondan and General MacArthur, due to wave breaking over the broad reef at the entrance to Matarinao Bay, wave breaking inside the shallow bay itself, and shielding by islands inside the bay, wave heights were small. However, surge inside the bay, due to both wind-induced and wave-induced setup, was about 3 m above Mean Sea Level. This agrees with the water level measurements of **Fig.5-20** at the locations inside Matarinao Bay. **Fig.5-26** shows damage seen in the fishing village of Quinapondan surveyed. Some traditional low-lying wooden homes on stilts were destroyed by the surge, but damage was not widespread, probably due to the lack of large waves. A similar situation existed in the town of General MacArthur.

Further to the north, in the town of Hernani, damage was severe. **Fig.5-25** shows about 3 m of surge and 3 m wave heights, thus about 6 m runup height would be expected on the landward side of the reef; however, runup up to 9 m was reported by eyewitness accounts (**Fig.5-20**), indicating that local topography might have played a role in enhancing damage to this town (ground-level topography and actual nearshore bathymetry data for this area were not available). This town has been repeatedly damaged by typhoons, and had even been relocated from its previous location further southwest after the town in that location had been destroyed by a typhoon. Hernani has two seawalls, an old one slightly offshore which had already been demolished by previous storms, and a new one at the shoreward edge of the town. Nonetheless, damage to Hernani was severe. **Fig.5-27** shows an example of scour measured in the town. **Fig.5-28** shows the remaining frame columns of a wooden house washed away by a bore-like surge (filmed by Nickson Gensis, a member of Plan Philippines International). **Fig.5-29** shows the damage seen along the coast of the town, reinforced concrete structures demolished by waves riding atop surge. Bricker and Roeber (2015) show the bore-like surge in Hernani was due to “bore-like” surf beat, where incident wave groups are transformed by the reef into infragravity (long-period) waves. Each of these infragravity waves steepens over the reef, and thus strikes the town as a bore. Resonance of the reef with the periodicity of the wave groups amplifies the surf beat, resulting in the large, destructive, long-period wave observed.

In Llorente, north of Hernani, maximum water level was reported by witnesses to be up to 6 m above Mean Sea Level (**Fig.5-20**). However, the town experienced little damage. One reason for this is the elevation of the town, the coastal part of which is about 5 m above Mean Sea Level; this is in contrast to Hernani, where most of the devastated area was at most 3.5 m above Mean Sea Level. Also different from Hernani is that Llorente is in a bay and has no coral reef offshore. The lack of a coral reef prevented the formation of the bore-like surf beat that destroyed Hernani. Llorente was exposed to very large ocean waves, but these waves could not penetrate inland as far or as high as the bore-like surf beat in Hernani did.

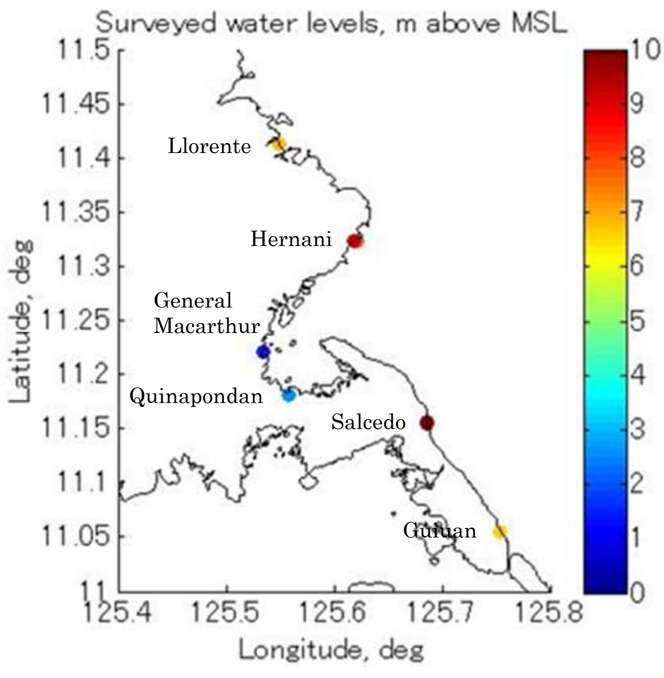

Fig.5-20. Measured maximum water levels in Eastern Samar (both surge and wave effects included).

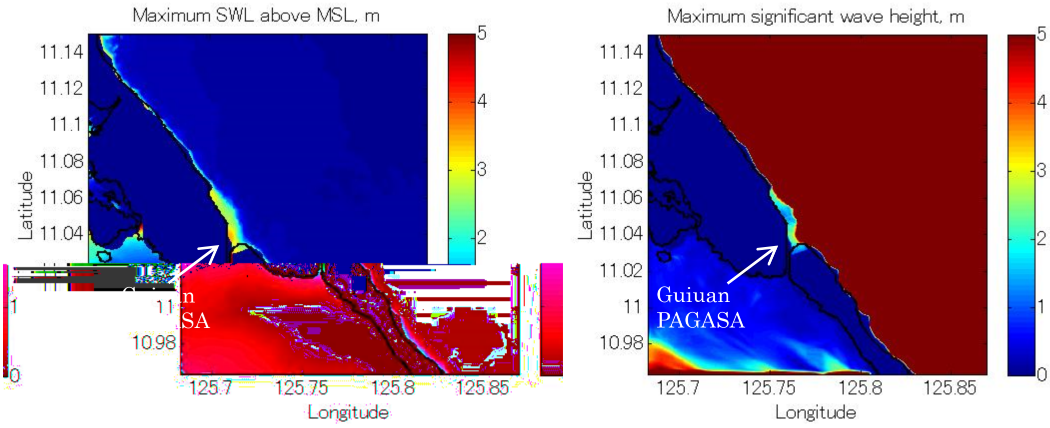

Fig.5-21. Surge water level and significant wave height near Guiuan.

Fig.5-22. Damage near Guiuan PAGASA station. Damaged foundation located 4 m above Mean Sea Level.

Fig.5-23. School building located about 1/2 km inland from Guiuan PAGASA. Flooded 2 m above floor level.

Fig.5-24. Damage in a coastal Barangay of Salcedo. Toilet vault (left) deposited on land at 9 m above Mean Sea Level. (right) top story at 11.6 m above Mean Sea Level washed away.

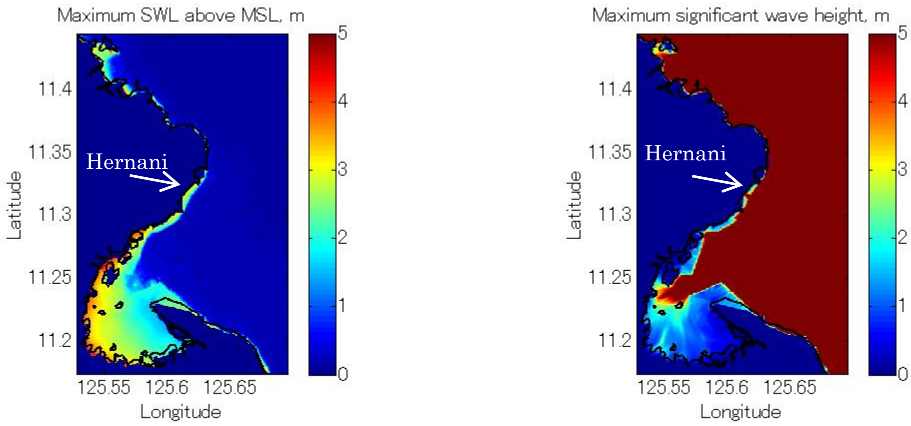

Fig.5-25. Surge water level and significant wave height near Hernani.

Fig.5-26. Damage in Quinapondan fishing village.

Fig.5-27. Scour up to 1 m deep around foundation in Hernani.

Fig.5-28. Piles of house washed away by bore-like surge in Hernani.

Fig.5-29. Debris from reinforced concrete house along coast in Hernani.

5.7 Seawall damage

Seawall damage was observed in areas with significant wave activity, both in Leyte and Eastern Samar. **Fig.5-30** shows one of the breaches on the eastern shoreline of Tacloban Airport. The seawall was pushed from its base a few meters inland. **Fig.5-31** shows similar damage at the MacArthur Memorial on the east coast of Palo, just south of Tacloban Airport. Damage was similar, with the revetment parapet pushed landward. The Palo seawall was a rubble-fill concrete structure with a concrete parapet. **Fig.5-3** and **Fig.5-6** show the maximum storm surge height and significant wave height at each of these sites. Surface waves were 3-4 meters high, on top of a 3-4 meter sustained surge. Since each seawall crest was about 3 m above water level, the mean water level (surge) reached at least the top of the parapets. This allowed the waves striking the seawalls to impact the full frontal area of the seawalls, and exert a large horizontal force. In addition, buoyancy caused by submergence of the seawalls reduced their weight, making them easier to slide. Finally, as seen clearly in **Fig.5-31**, overtopping caused severe scour landward of the seawalls, allowing them to be more easily displaced landward.

Fig.5-32 shows the Hernani seawall in Eastern Samar. This seawall is a coral-fill embankment topped by a concrete parapet and covered with grouted concrete armor on the landward and seaward faces. The Hernani seawall was breached in multiple locations. Coral-fill debris and pieces of the parapet and facing armor were scattered both landward and seaward of the wall's original location. **Fig.5-33** shows a steady surge of over 3 m near Hernani, indicating that water had risen to at least the crest of the seawall. **Fig.5-33** also shows wave heights on the landward side of Hernani's coral reef to also have been over 3 m. In addition to large individual waves, the bore-like surf beat, described in **Chapter 4.4** and **Chapter 4.5**, caused much of the damage in Hernani. **Fig. 5-34** shows a time series of these infragravity bores striking the seawall. The impact force of these bores as well as large individual waves was likely responsible for the seawall damage observed.

Fig.5-35 shows the seawall in Llorente, north of Hernani. This seawall consists of a concrete bulkhead wall held in place by gravity to retain fill used to elevate the town's coastline. The top section of the bulkhead wall is a recurved parapet. This seawall experienced no visible damage, indicating that the presence of fill behind the bulkhead wall prevented the wall from sliding under the wave forces to which it had been exposed. In addition to the strength imparted against sliding by fill, it's likely this seawall contained rebar sufficient to prevent the parapet section of the wall from breaking off the bulkhead section; this is in contrast to **Fig.5-31** and **Fig.5-32**, where the parapet section of each wall sheared off the revetment or bulkhead section. Another factor that likely prevented failure of the Llorente seawall is the concrete deck covering the fill on its landward side; this likely acted as armor to prevent scour of the fill behind the wall during wave overtopping of the parapet (wave overtopping of up to 2 m was reported by witnesses); this is in contrast to **Fig.5-31**, in which scour of the landside fill allowed waves to push the parapet section off the bulkhead section of the seawall.

Fig.5-30. Seawall breach on eastern coastline of Tacloban Airport. Crest height 3 m above Mean Sea Level.

Fig.5-31. Seawall damage at the MacArthur Memorial south of Tacloban Airport. Crest height 3 m above Mean Sea Level.

Fig.5-32. Damage to the Hernani seawall. Crest height 3 m above Mean Sea Level.

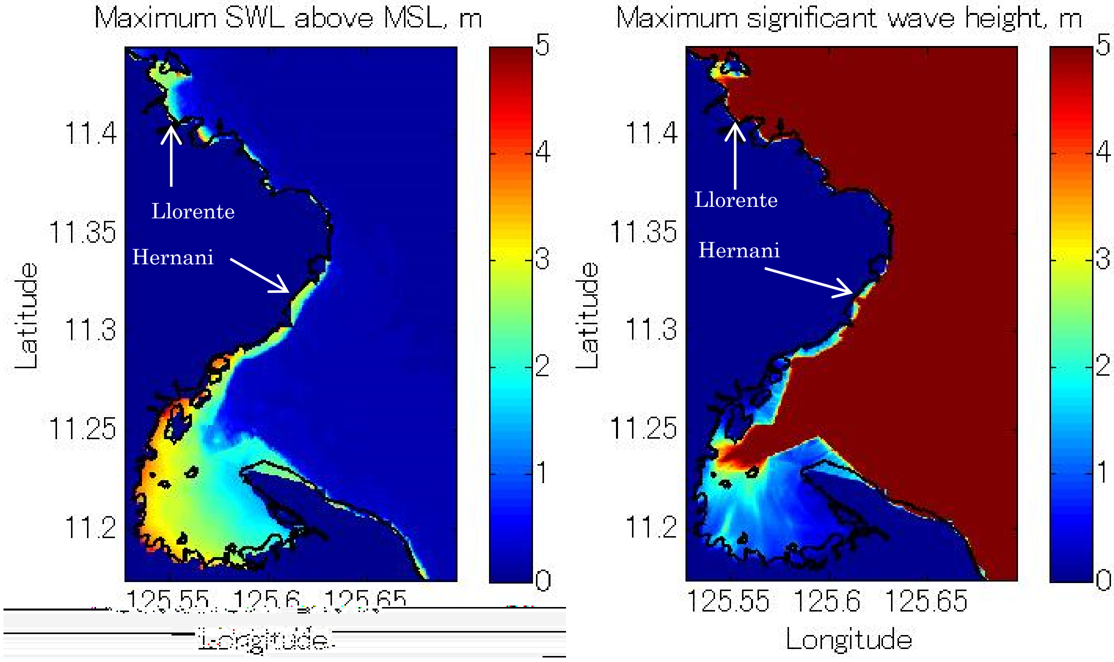

Fig.5-33. Maximum storm surge (left) and significant wave height (right) near Hernani.

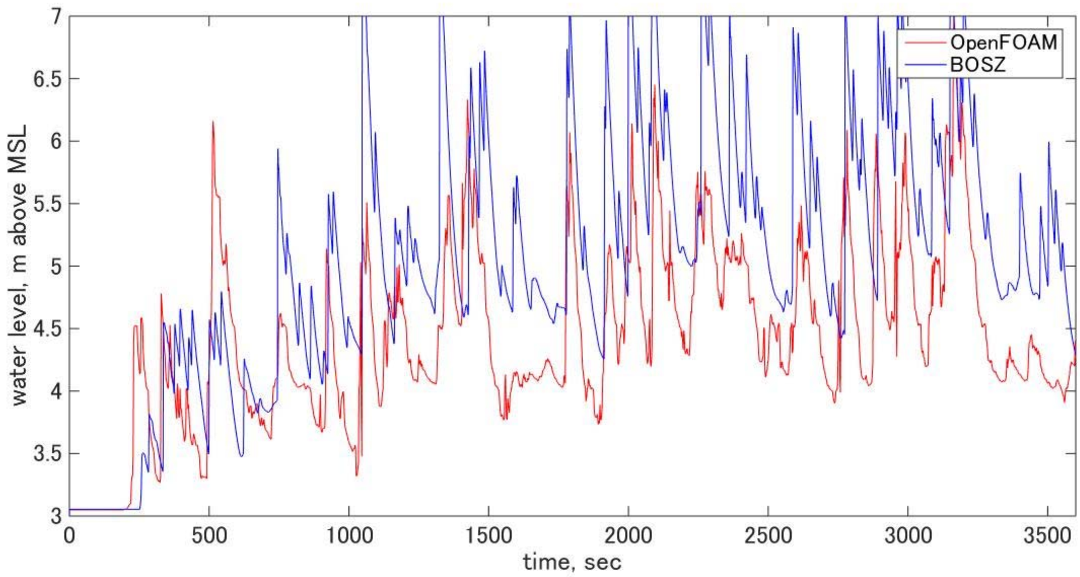

Fig. 5-34. Water level (above MSL) landward of the seawall in Hernani, as simulated by phase-resolving wave and storm surge models.

Fig.5-35. Seawall in Llorente.

5.8 Conclusions and Recommendations

An on-site field survey in Leyte and Eastern Samar was conducted by the Hazard and Damage Evaluation Team, IRIDeS from January 16 through 24, 2014 in order to investigate damage due to storm surge, large waves, and strong wind induced by super typhoon Haiyan.

Inundation heights due to storm surge and high waves were measured by the team in Leyte and Samar and an inundation map of Tacloban city was developed mainly through local interviews. Storm surge heights up to 6 m were measured near the shoreline in Tacloban. Moreover, survivors reported waves up to 4 m high atop the surge. It was found from the survey that the surge travelled far to the north in the Samar-Leyte strait. Local river flooding and landslides due to heavy rainfall were also observed at several points in Tacloban and Palo. Also, runup due to large waves (up to 12 m) was measured in Eastern Samar.

Several types of damage induced by Haiyan were described in this chapter. Along the coastline of downtown Tacloban the presence of waves atop the wind-driven storm surge caused heavy damage. While concrete buildings are concentrated in downtown Tacloban, poorly built unsafe wooden houses are along the coastline because of poverty, causing vulnerability of Tacloban city against coastal water-related hazards. Another mechanism of damage to coastal buildings was debris impact. Also, seawall damage was observed in areas with significant wave activity, both in Leyte and Eastern Samar.

Damage due to wind was present throughout the survey area. The major mechanism of wind damage was ripping of the roofing materials off the roofing frame of each structure. Once a structure's roof was destroyed, rain poured into the structure, ruining the architectural elements, equipment, furniture, and other items inside.

The eastern coast of Samar faces directly into the open Pacific Ocean, and so was exposed to the nearly 20 m high waves (offshore) generated during the Haiyan event. Scour of sand by large waves of the foundations of houses is responsible for some of the damage, but wave force is also responsible for much of the damage. It should be emphasized that the bore-like surge that struck Hernani and washed away some houses. This bore was due to a large wave group having been transformed into "bore-like" surf beat by the presence of the coral reef offshore (Bricker and Roeber, 2015).

From the survey the team concluded that storm surge, large waves, and high speed wind induced by Haiyan caused enormous damage to people, buildings and coastal structures in Leyte and Samar, and the vulnerability of the coastal area and fragility of houses made the damage more serious. Data analysis and numerical simulations of Haiyan are ongoing, but analysis and the survey results thus far have produced the following recommendations:

- Several observation weather stations should be installed for the monitoring of the wind speed, air pressure, tide level, rainfall, etc. The monitoring system should be protected against strong wind and storm surge, so that it should be effective even in the event of a super typhoon like Haiyan.
- Inland topography and local bathymetry along the coast should be measured in more detail for the numerical simulation of the storm surge and large waves in order to compute the inundation situation more precisely and clarify the mechanism of localized phenomena such as the bore-like surge that struck Hernani.
- Storm surge hazard maps should be updated and developed in coastal areas in the Philippines under the worst scenario considering the impacts of climate change, land use/cover change, etc.
- Seawalls should be reconstructed and multiple countermeasures such as combinations of seawalls, tide-water control forests, no building zones, etc. should be developed. These systems should be evaluated from the view point of efficiency, low cost and easy maintenance.
- New building structures and roofing system should be developed to withstand strong wind speeds during super typhoons. A small design change such as implementing a curved roof, using thicker GI sheets instead thin GI sheets, and screws instead of nails for connections may make a big difference and might cost less and save lives. The effects of these design changes should be quantitatively evaluated.
- Selection and construction of suitable evacuation centers and places
- Education to emphasize the urgency of evacuation
- Development of an early warning system for storm surge inundation

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6. IRIDeS fact-finding mission, Warning and Evacuation Assessment Team

6.1 Purpose

Warning and Evacuation Assessment Team aims at examining and recording evacuation behavior and information notification in the affected area by Haiyan. Empirical studies contribute to develop policies that will mitigate damages by coming typhoons in the future.

Although the team employed both of qualitative and quantitative methods for collecting information, it is focused on delivering some preliminary results by the qualitative approach in this article.

Warning and Evacuation Assessment Team

1. Ass. Prof. Yasuhito Jibiki (Team Leader, International Regional Cooperation Office)
2. Assoc. Prof. Miwa Kuri (International Regional Cooperation Office)
3. Ass. Prof. Shuichi Kure (Disaster Potential Study)
4. Dr. Maritess Quimpo (Department of Public Works and Highways, Philippines)

6.2 Method: Social survey

A questionnaire survey at Tacloban, Palo and Tanauan cities in Leyte Island was implemented from 14th March 2014 to 22nd March 2014. These three cities in the Philippines had different types of damages by storm surge, wind, and torrential rains.

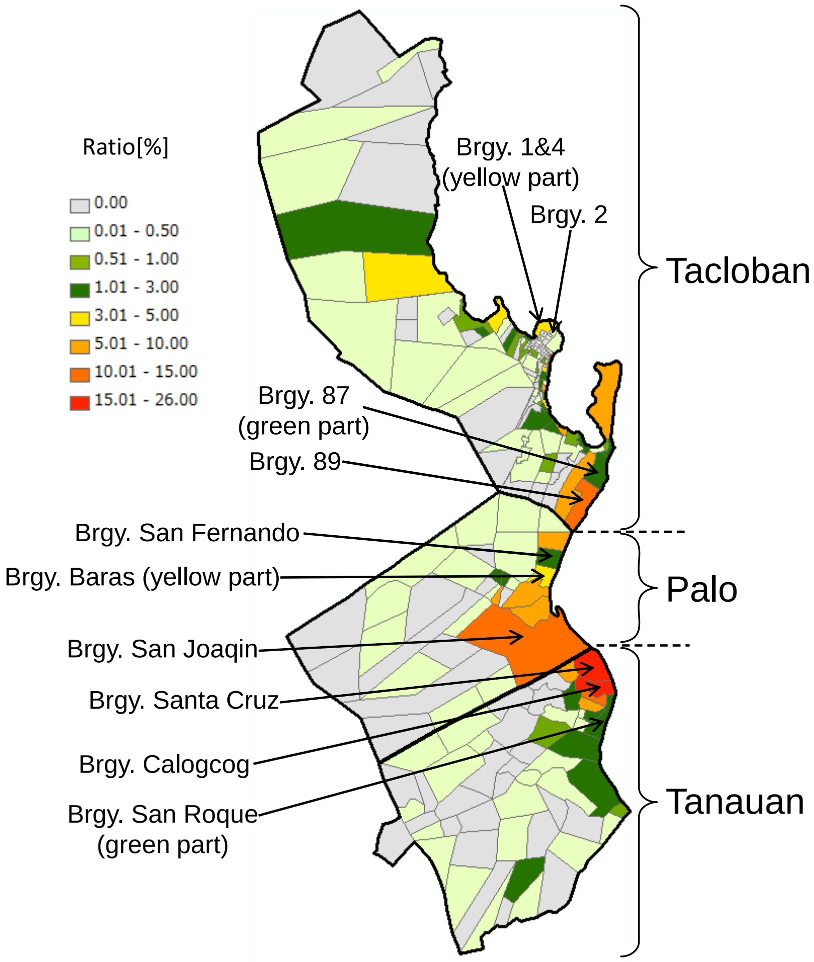
Fig.6-1 shows the death and missing ratio of each barangay in three cities based on hearing data from city governments and barangay offices. The designed total sample size is 600 and individual sample size of three cities is 200. High ratio sites are picked up in three cities as target sites. The complex situation and the heavy damages prevent the survey from employing the random sampling method based on the residential lists.

200 samples divide into 8 cells based on the population condition of generation and gender. The generation brackets are composed of 4 groups: 20-29, 30-39, 40-49, and over 50. According to National Statistics Office of the Filipino government, the ratio of male and female are almost same. Thus, the each number of the sample is divided equally in terms of gender. Contrary, the number of the young generation is larger than that of the elder (see **Table 6-1**). Therefore, designed number of 200 samples is allocated into 8 cells on actual population condition (see **Table 6-2**).

In addition with the settings above, geographical closeness are also considered. In each sites, it is biased if many samples are selected from specific barangays. However, the number of the samples in the survey is limited. Thus, samples are gathered from some barangays where locate along with coastal line of San Pedro and San Pablo Bay, and each barangays exist nearby in each other. For the control of geographical factors and hazard characteristics, the survey did not intend to distribute samples in Samar or other islands.

Each respondent were interviewed by enumerators. Finally 642 samples are gained. The final number of samples is bigger than the original designed number. Although in gender condition the number of female is slightly larger than that of male, a chi-square test demonstrates that the difference does not have statistical significance. In generation condition, the number of gained samples in each site is varied, but no statistical significance is observed amongst the difference. The final sample size is enough to be similar with the original designed sample size in the population condition of attribute, generation and gender.

For complementary information, 645 residents joined the survey, but 3 samples were excluded because their age was under 20 years old. **Table 6-3** shows the total number of the samples is 641. However, as shown in a note of **Table 6-3**, a respondent did not answer its gender and the respondent is included in the analysis in this report.



Source: Hearing data from offices of city government and barangay by the authors

Fig.6-1. Distribution of the death and missing ratio of each Barangay in survey area.

Table 6-1. Distribution of age population.

Age	20-29	30 - 39	40 - 49	Over 50
Ratio	30.5%	24.6%	19.6%	25.2%

Note: Age under 19 years old are excluded in the calculation.

Source: This table is made by the authors based on National Statistics Office.

http://www.nscb.gov.ph/beyondthenumbers/2012/11162012_jrga_popn.asp#tab2

Table 6-2. Design of allocated sample size in each cites (sample size: 200).

Age	20-29	30 - 39	40 - 49	Over 50	Sum
Male	30	25	20	25	100
Female	30	25	20	25	100
Sum	60	50	40	50	200

Source: This table is made by the authors.

Table 6-3. The number of the obtained samples by each survey sites.

Tacloban

	20s	30s	40s	Over 50s	Sum
Male	30 (14.4%)	24 (11.5%)	25 (12.0%)	22 (10.5%)	101 (48.3%)
Female	31 (14.8%)	29 (13.9%)	22 (10.5%)	26 (12.4%)	108 (51.7%)
Sum	61 (29.2%)	53 (25.4%)	47 (22.5%)	48 (23.0%)	209 (100.0%)

Palo

	20s	30s	40s	Over 50s	Sum
Male	31 (14.5%)	26 (12.1%)	21 (9.8%)	27 (12.6%)	105 (49.1%)
Female	31 (14.5%)	31 (14.5%)	21 (9.8%)	26 (12.1%)	109 (50.9%)
Sum	62 (29.0%)	57 (26.6%)	42 (19.6%)	53 (24.8%)	214 (100.0%)

Tanauan

	20s	30s	40s	Over 50s	Sum
Male	30 (13.8%)	28 (12.8%)	20 (9.2%)	27 (12.4%)	105 (48.2%)
Female	31 (14.2%)	31 (14.2%)	22 (10.1%)	29 (13.3%)	113 (51.8%)
Sum	61 (28.0%)	59 (27.1%)	42 (19.3%)	56 (25.7%)	218 (100.0%)

Total (Tacloban + Palo + Tanauan)

	20s	30s	40s	Over 50s	Sum
Male	91 (14.2%)	78 (12.2%)	66 (10.3%)	76 (11.9%)	311 (48.5%)
Female	93 (14.5%)	91 (14.2%)	65 (10.1%)	81 (12.6%)	330 (51.5%)
Sum	184 (28.7%)	169 (26.4%)	131 (20.4%)	157 (24.5%)	641 (100.0%)

Note: One respondent did not answer his/her gender. The respondent lived in Tacloban and 68 years old. The respondent is included in the analysis.

Source: This table is made by the authors.

6.3 Situation prior to Yolanda

6.3.1 Estimation of damages by Haiyan and real damages caused by Haiyan

It has not clearly been stated whether local people estimated that Haiyan gave such a devastating impacts. The authors prepared a question that aims at clarifying whether the respondents estimated damages of Haiyan would be severe. The question is "Before the typhoon Yolanda, how did you expect the possible damage to your family/house due to a typhoon?" The results state that the sum of the answers "Very high" and "High" is 27.0%, although the sum of "Very low" and "Low" is 55.6%. It indicates that many respondents underestimated the damages of Haiyan before its devastation. Comparing with each survey site, statistical significance was observed (χ^2 (8, N=637) = 21.696, p<.01). The respondents in Tanauan tended to underestimate the damages (see the left side of **Fig.6-2**). No statistical significance was detected in gender (χ^2 (6, N=636) = 5.987, p<n.s.). The male and female respondents underestimated to the same degree. In the generation brackets, there was statistical significance (χ^2 (12, N=637) = 62.476, p<.01) and the bracket of 30s tended to have underestimation.

Contrary to the estimation, real damages of the respondents house were that the answer "Swept away" was 55.2%, and "Highly damaged" was 30.9% (see the right side of **Fig.6-2**). The results clearly demonstrates that the respondents had severe damages against their initial estimation. Calculating relation with estimation of damages and real damages, no significance is shown (χ^2 (16, N=634) = 15.971, p<n.s.) and it is obvious that the initial estimation was failed.

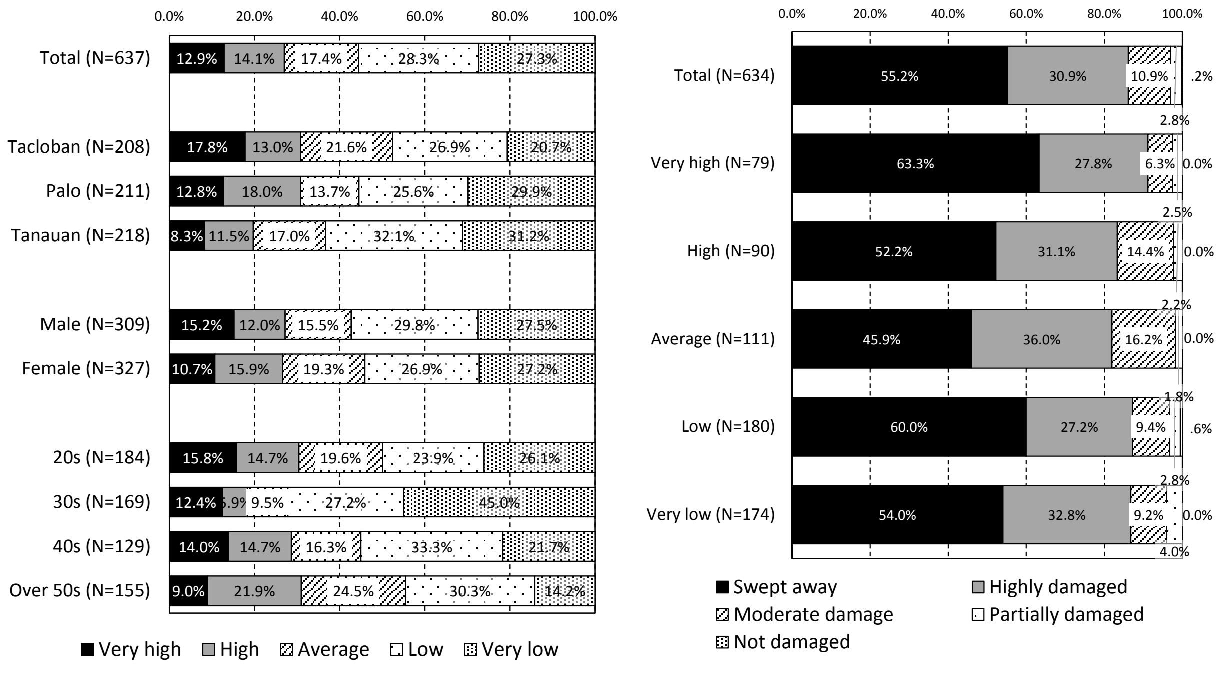


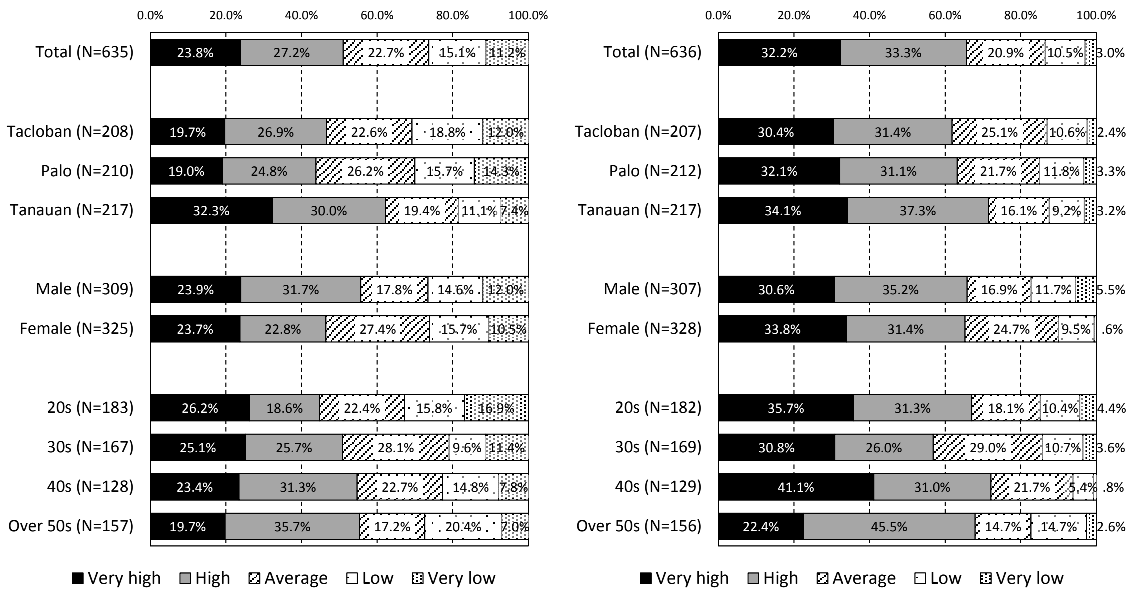
Fig.6-2. Estimation of damages by Haiyan and real damages caused by Haiyan.

6.3.2 Trust for barangay captains and PAGASA

Exploring early warnings in the case of Haiyan, the authors set questions clarifying how much degree barangay captains and PAGASA as sources of disaster related information were trusted by the respondents prior to Haiyan. The questions are "How much did you rely on Barangay captain (PAGASA) in order to get disaster related information such as typhoon warning?"

In barangay captains, the sum of the answers "Very high" and "High" is 51.0% and those of "Very low" and "Low" is 26.3% (see the left side of **Fig.6-3**). Thus, it can be stated that trust for barangay captains was relatively higher. Comparing with each survey site, the respondents in Tanauan had tendency to rely higher on barangay captains (χ^2 (8, N=635) = 22.235, p<.01). In gender, the male respondents tend to give reliance on barangay captains rather than the female (χ^2 (4, N=634) = 11.542, p<.05). The sum of the answers "Very low" and "Low" are the almost same with the male and female, but the sum of the answer "Very high" and "High" in the male respondents is larger than those of the female. Analyzing difference of the generation brackets, the elder tends to rely on barangay captains (χ^2 (12, N=635) = 31.500, p<.01). The sum of the answers "Very high" and "High" becomes gradually bigger in older generations, and the ratio of "Very low" decreases.

In PAGASA, The sum of the answers "Very high" and "High" is 65.6%, although The sum of "Very low" and "Low" is 13.5% (see the right side of **Fig.6-3**). Comparing with the ratio of trust in barangay captains, PAGASA obtained higher reliance from the respondents. There is no statistical significance between the survey sites, in the case of PAGASA (χ^2 (8, N=636) = 7.229, p<n.s.). In gender, the female respondents tended to rely on PAGASA higher (χ^2 (4, N=635) = 19.394, p<.01). The sum of "Very low" and "Low" in the female answer is smaller than those of the male. In the generation brackets, the bracket of 40s gave bigger reliance on PAGASA (χ^2 (12, N=636) = 36.897, p<.01). In the age of 40s, the sum of the answers "Very low" and "Low" is smaller than others.



Note: The right figure is the result of barangay captains and the left one is those of PAGASA.

Fig.6-3. Trust for barangay captains and PAGASA

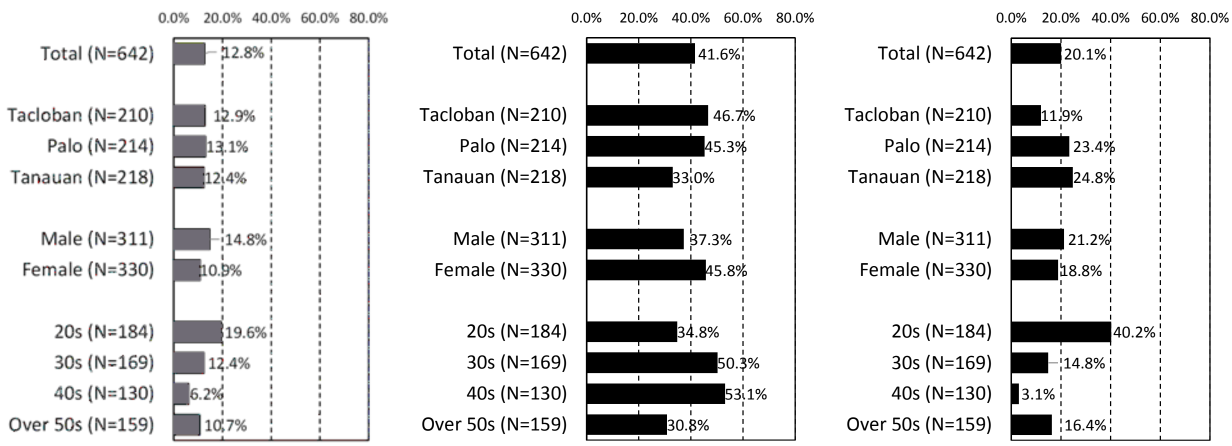
6.3.3 Recognition of technical terms: Storm surge, the maximum instantaneous wind speed or peak gust, atmospheric pressure

Early warning messages include technical terms. Once these terms are recognized by people, early warnings might be influential on human behaviors, although the terms are not the only factor to facilitate necessary actions. In this section, the authors aim at describing how much degree the respondents recognized technical terms in relation with typhoons. Three terms, storm surge, the maximum instantaneous wind speed or peak gust, atmospheric pressure, are investigated.

The recognition rate of storm surge is 12.8% in average and it is the lowest among three terms (see the left in **Fig.6-4**). In the generation bracket of 20s, it has the largest recognition comparing with others (χ^2 (3, N=642) = 13.368, p<.01). No statistical significance was observed both in the survey sites (χ^2 (2, N=642) = .049, p<n.s.) and gender (χ^2 (1, N=641) = 2.163, p<n.s.).

The maximum instantaneous wind speed or peak gust has the highest recognition among three terms (see the middle in **Fig.6-4**). The term has the 41.6% in average recognition. In the survey sites, the respondents in Tanauan tended to not recognize the term (χ^2 (2, N=642) = 10.038, p<.01). In gender, the female respondents recognized the term higher than the males (χ^2 (1, N=641) = 4.713, p<.05). The generation brackets of 30s and 40s have relatively larger recognition percentage (χ^2 (3, N=642) = 23.439, p<.01).

Atmospheric pressure was not recognized highly and its rate was about 20% (see the right in **Fig.6-4**). Comparing with each survey site, Tacloban had the lowest recognition (χ^2 (2, N=642) = 13.167, p<.01). In the generation bracket of 20s had significantly the largest recognition, contrary to those of 40s (χ^2 (3, N=642) = 74.198, p<.01). Gender did not show difference of the recognition (χ^2 (1, N=641) = .594, p<n.s.).



Note: The result of storm surge locates in the left, the maximum instantaneous wind speed or peak gust in the middle and atmospheric pressure in the right.

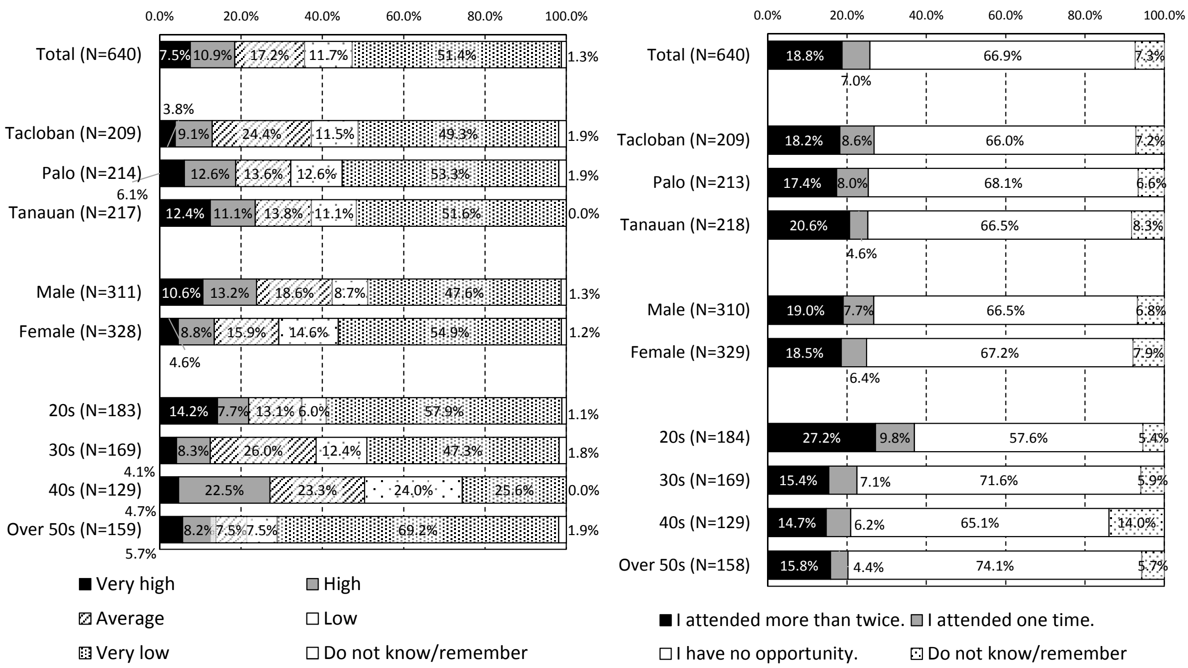
Fig.6-4. Recognition of technical terms: Storm Surge, The maximum instantaneous wind speed or peak gust, Atmospheric pressure

6.3.4 Learning and evacuation training before Haiyan

Studying the residents' behavior in the case of Haiyan, the authors considered that it is important to investigate whether the respondents had been already prepared for typhoons, from the view point of educational and practical efforts. If they had rich experience on learning and evacuation training, these experience is expected to have positive effects on their actions. However, the survey illustrates that both of learning and training opportunities were not sufficiently organized before Haiyan.

The 63.1% of the respondents answered that opportunities to learn the natural disasters (typhoon, earth quake, tsunami, fire) before the typhoon Yolanda were "Low" or "Very low" (see the left in **Fig.6-5**). The sum of "Very high" and "High" were 18.4%. In the survey sites, Tanauan had the largest opportunities among three sites (χ^2 (10, N=640) = 26.687, p<.01). In gender, the female respondents had lower opportunities (χ^2 (5, N=639) = 17.697, p<.01). It is very low in the generation bracket of over 50s (χ^2 (15, N=640) = 111.488, p<.01).

No attendance ratio of the evacuation training (typhoon, earthquake, tsunami, fire) before Haiyan was more than 60% (see the right side of **Fig.6-5**). No statistical significance was found in the survey sites (χ^2 (6, N=640) = 4.037, p<n.s.) and in gender (χ^2 (3, N=639) = .728, p<n.s.). Calculating a tabulation in the generation bracket, the age of 20s tended to have more frequent opportunities for the evacuation training (χ^2 (9, N=640) = 27.290, p<.01). However, 57.6% of the generation bracket of 20s had no opportunities for evacuation trainings before Haiyan, and the opportunities were quite limited.



Note: The right figure is the result of learning opportunities and the left one is those of evacuation trainings.

Fig.6-5. Learning and evacuation training opportunities before Haiyan

6.4 Results on evacuation and discussions

6.4.1 Evacuation behavior

The survey data demonstrates that around 70% of the respondents evacuated to some places except their house (see **Fig.6-6.**). About 30% of the respondents did not evacuate to anywhere outside of their houses. In other words, they remained at their houses.

In the detail analysis, three types of cross tabulation were calculated. Regarding the cross calculation on the survey sites, a statistical difference is observed (χ^2 (2, N=589) = 8.265, p<.10). The respondents in Tacloban tends to not evacuate to anywhere outside of their houses, comparing with those in Palo and Tanauan. In terms of gender, a statistical difference is also detected (χ^2 (2, N=588) = 8.219, p<.05). The result indicates the male does not tend to evacuate to anywhere outside of their houses, in comparison of female. In the analysis between evacuation behavior and the age brackets, a statistical difference is observed (χ^2 (2, N=589) = 15.447, p<.01). According to **Fig.6-6**, the ratio in 30s and "Not evacuated" is higher than those of others. And, the percentage in over 50s and "Not evacuated" is also bigger than those of 20s and 40s.

These results implies that people in Tacloban has a different view on evacuation in the case of Haiyan, comparing with Palo and Tanauan. Thus, in further analysis, it seems important to examine the geographical uniqueness. Also, the statistical difference in gender and the age brackets, it can be interpreted that typical tendency might be observed in the case of Haiyan. Many cases in natural disasters, male hesitates in being absent from its house, and the elder has a comparatively greater difficulties in moving from its house to another places.

6.4.2 Reasons for evacuation to outside of houses

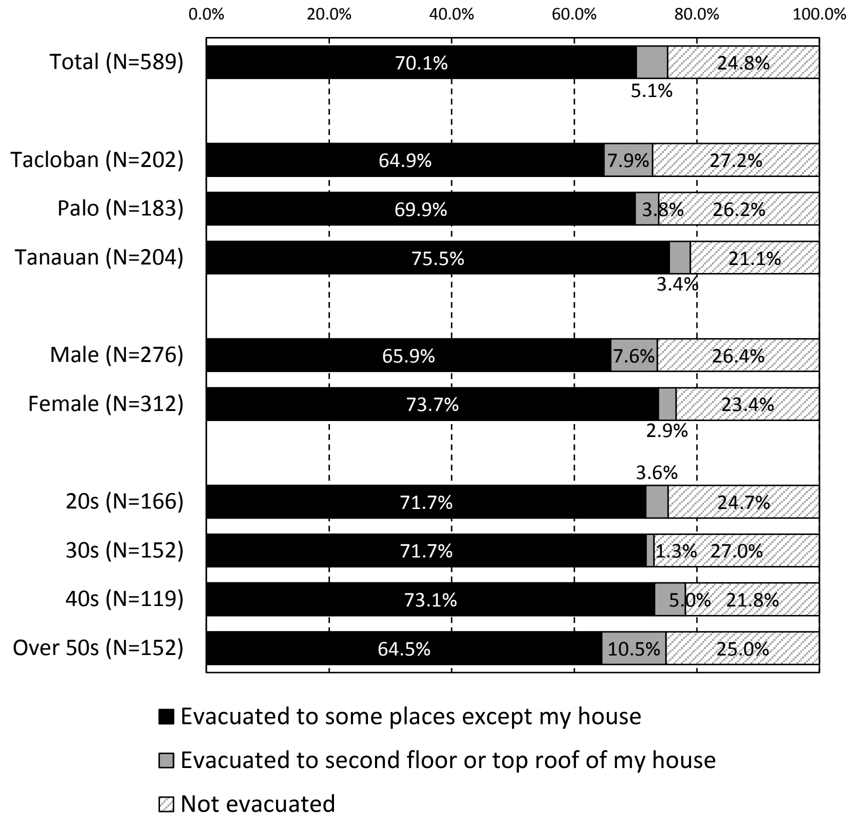
In the survey, the respondents, who answered that they evacuated to outside of houses, showed reasons for their behavior. The largest response is the recognition for the approach of super typhoon (37.7%). Next to that, the notion for the strong wind was high (30.0%). The role of barangay leaders (barangay captains) is the third largest (26.3%). It can be argued that the role of barangay leaders seems to be less significant rather than spontaneous evacuation by residents.

Results of cross calculations between the reason and the survey sites might imply that decisions by people in Tanauan were quicker than those of Tacloban and Palo. Statistical differences are observed in three answers (see items highlighted by red boxes in **Fig.6-7**). It can be interpreted that people in Tanauan did not wait for other persons' decisions, because the ratio in Tanauan is the lowest in "Whole Barangay member decided to do that." Also, the least percentages in the answer 7 and 8 might indicate that people in Tanauan did not face with or tried to avoid crisis of their lives. On the contrary, people in Tacloban evacuated because their houses were getting flooded due to sea water, and it means they have already been inundated and surrounded by water. Regarding "I felt I might be dead if I stay there," response in Palo is remarkably higher than other two sites.

6.4.3 Reasons for not evacuated to outside of houses (remained at houses)

In contrast to reasons for evacuation to outside of houses, the survey had a question for those who remained at their houses. The most common answer is “the wave should not be that large” (64.8%). The second largest percentage is “my house was strong enough” (31.8%). These results indicate that many people were not able to imagine how Haiyan was severe. Furthermore, it is questionable for adequateness for contents of information including warnings and news programs which was disseminated prior to Haiyan’s landfall.

Cross tabulation analysis demonstrates four reasons have statistical significance with the difference of the survey sites (see items highlighted by red boxes in **Fig.6-8**). It can be considered that people in Tacloban and in Tanauan had a different point. Based on Tacloban response, people had sufficient knowledge about behavior in the emergency (in answer 1 of **Fig.6-8**, Tacloban has 0.0%), but they were unable to estimate Haiyan’s influence (see answer 2 in **Fig.6-8**). On the other hand, people in Tanauan were aware that their land was not high enough against Haiyan (see answer 2 in **Fig.6-8**), but they had no idea how to behave in face of disasters (see answer 1 in **Fig.6-8**). These difference seems to mention the importance to disseminate information and evacuation instructions taking into account of local contexts.

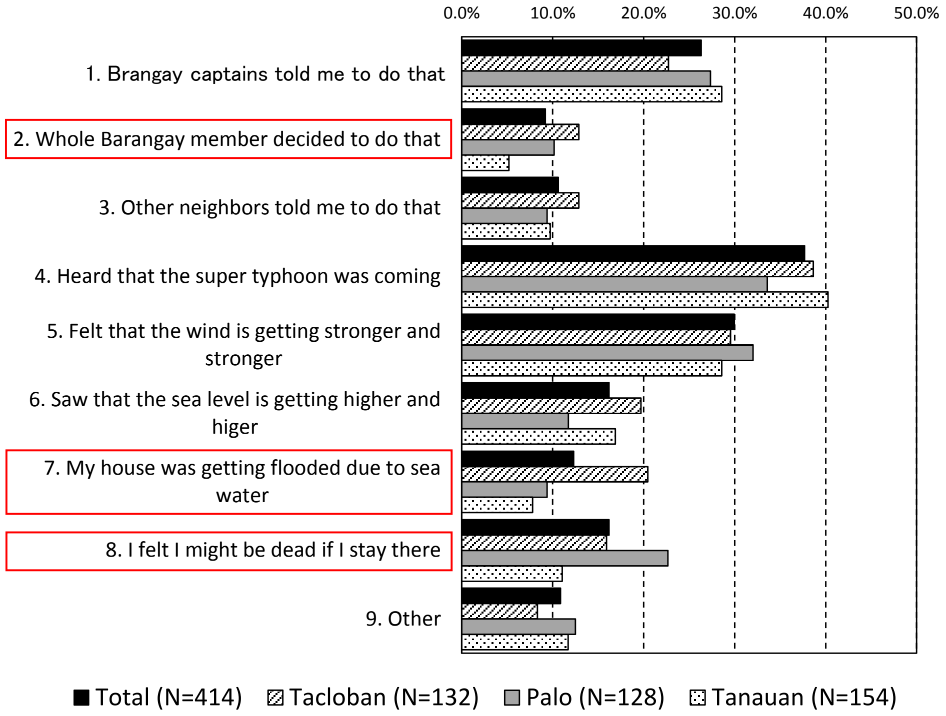


Note 1: Since one respondents did not answer its gender and was not able to include the calculation, the sum of the number of male and female is different from those of sites and age brackets.

Note 2: No answers and wrong answers are excluded in the analysis.

Source: This figure is made by the authors.

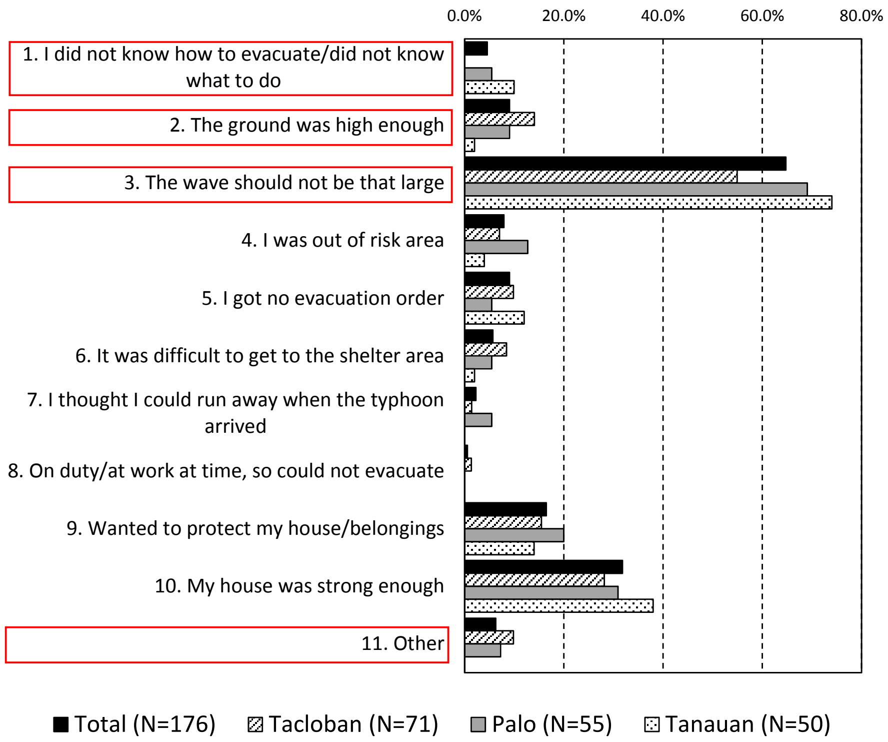
Fig. 6-6. Table calculations of evacuation behaviors.



Note: Answers highlighted by red boxes have statistical difference among the survey sites.

Source: This figure is made by the authors.

Fig.6-7. Reasons for evacuation to outside of houses (Multiple answer).



Note: Answers highlighted by red boxes have statistical difference among the survey sites.

Source: This figure is made by the authors.

Fig. 6-8. Reasons for not evacuated to outside of houses (remained at houses) (Multiple answer).

6.5 Summary

This survey indicates that it is not reasonable to understand that local residents were fully prepared for the super typhoon Haiyan. It is very obvious that the respondents of the survey underestimated the impacts of Haiyan. Technical terms of typhoons were not shared among the respondents. Learning and evacuation training opportunities were quite limited prior to Haiyan. In terms of information source, barangay captains and PAGASA were trusted relatively highly. Especially, PAGASA enjoyed higher trustiness from the respondents. However, considering the poor knowledge of technical terms in the respondents, it could hardly work that relevant information caused the local people's evacuation behavior adequately, even though PAGASA's information reached the local residents.

This survey shows that the ratio of evacuation to the outside of houses is relatively high. However, evacuation in detail differs with sites, gender and age. Reasons and clues for evacuation to outside of houses and reasons for remaining at houses are also depend on the difference of sites. Although the survey sites locate in the same island and share the same coastal line, local characteristics are observed in the preliminary analysis. The finding is considered to be utilized in further inquiries.

It is required to clearly state that the research has two limitation. Just as a great problem which was occurred in Great East Japan Earthquake, a social survey by the team is able to contribute for revealing only survivors' behaviors. In other words, the analysis is lack of viewpoints from those who could not be survivors. Critical questions for identifying factors which differentiate survivors or not are complemented by qualitative interviews by survivors partially. Regarding the method in the survey, it cannot be said that the sampling covered the all affected area. Not only in Leyte Island, but also in Samar, Cebu and other islands, the large number of population was damaged by Haiyan. The results of the survey are required to be compared with other efforts.

In addition with the quantitative survey, the team conducted interviews in Samar Island (Samar Island is next to Leyte Island). Interviews were conducted in western parts of Samar. The team visited Basay and Marabut. Costal Barangays in Basay were severely affected by the storm surge. Contrary, damages in Marabut were due to the strong wind rather than the surge. The city of Calbayog was selected for complementary analysis. The city had relatively smaller damages by the typhoon, and supported affected local governments in Leyte Island. The interviewees are varied from the city mayor to Barangay captains and affected residents. These interviewees responded to questions about early warning, disaster information dissemination and public awareness for the coming typhoons. Findings from the qualitative surveys are required to be compared with results by the social survey.

6.6 Situation after Yolanda

In addition to the previous questionnaire survey for local people in the Tacloban, Palo and Tanauan cities, another questionnaire survey was conducted for each barangay captain in the barangay in order to understand the barangay captains' disaster-related information transfer system, their considerations for the evacuation facility selection and the current situation to prepare for the next typhoons. Also, evacuation situations, against Typhoon Hagupit and Tropical Storm Jangmi that landed around the Visayas region in December 2014, are discussed in this section.

6.6.1 Target barangays

The questionnaire survey for barangay captains in the Tacloban, Palo and Tanauan cities in Leyte Island was conducted from 20th November to 23rd November 2014. As many as 31 barangays, shown in **Fig. 6-9**, are selected for this survey. The barangays are located in the coastal area highly affected by the storm surges induced by Haiyan. It should be noted that the number of samples, 31, might be insufficient to identify the statistical differences, so that the results presented below should be considered as those of initial assessment and reference information. It should be also noted that some barangay captains did not join this survey due to their own duties during the survey period. In that case, barangay council members answered the barangay situations instead of the captains.

Fig.6-9. Target barangays (Blue zones) in Tacloban, Palo and Tanauan for the survey.

6.6.2 Information transfer system and considerations for the selection of evacuation places

From the questionnaire survey results, it was found that many barangay captains transferred the evacuation order by themselves by walking to their barangay and talking to the people individually (**Fig. 6-10** [upper left]). Regarding evacuation places, many barangay captains answered that they would tell the barangay people to evacuate to schools in the barangay, rather than high elevation areas or tall and strong buildings in the barangay (**Fig. 6-10** [upper right]). On the other hand, many barangay captains considered that the evacuation places should withstand strong winds and have no possibility to be flooded by a sea water or river flooding (**Fig.6-10** [lower left]). From those, it would be possible to consider that basically, the barangay captains might want the barangay people to evacuate to such safer places. However, they selected the schools because that was the most appropriate place they could choose under the circumstances. This fact may imply that there is no appropriate evacuation facility such as strong buildings and high elevation areas in the barangays.

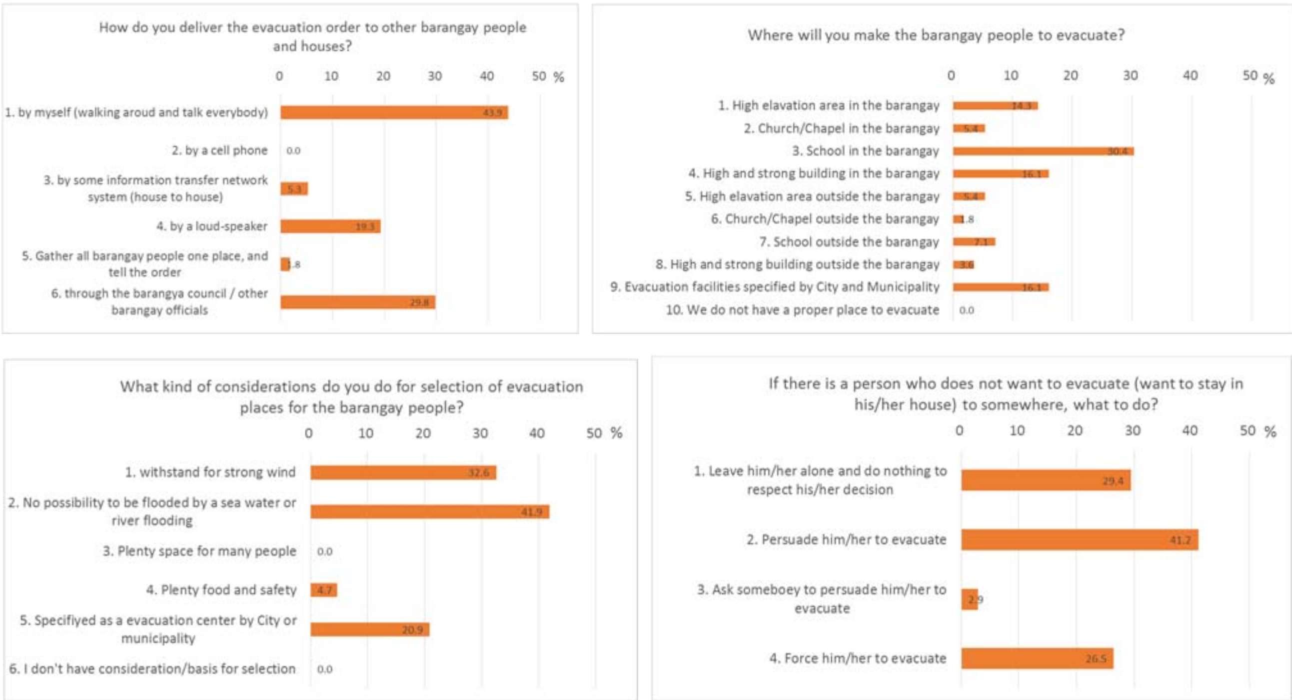


Fig.6-10 Barangay captains' actions and considerations for evacuation (Multiple Answer).

The important point is about 30% of barangay captains answered that they would leave him/her there by respecting his/her decision and do nothing when there is a person who does not want to evacuate to somewhere (**Fig. 6-10** [lower right]). In order to save lives of local people, it is highly recommended for barangay captains to persuade or force them to evacuate to somewhere against super typhoons like Haiyan. In order for that, it is essential that the barangay captains have knowledge and leadership to judge the magnitude and route of typhoons and transfer the information properly and understandably to the local people. However, even a year after Haiyan event, almost 50% of barangay captains do not understand the meaning of Storm Surge (**Fig. 6-11**). The word "storm surge" is not widely understood compared to other natural disaster words generally used such as Tsunami, Earthquake, and Typhoon. This kind of situation should be improved through disaster education and trainings provided by the Philippines government, international organizations, etc. IRIDeS conducted a disaster education program (See **Chapter 13**), and this kind of program should be provided more often to people in local barangays.

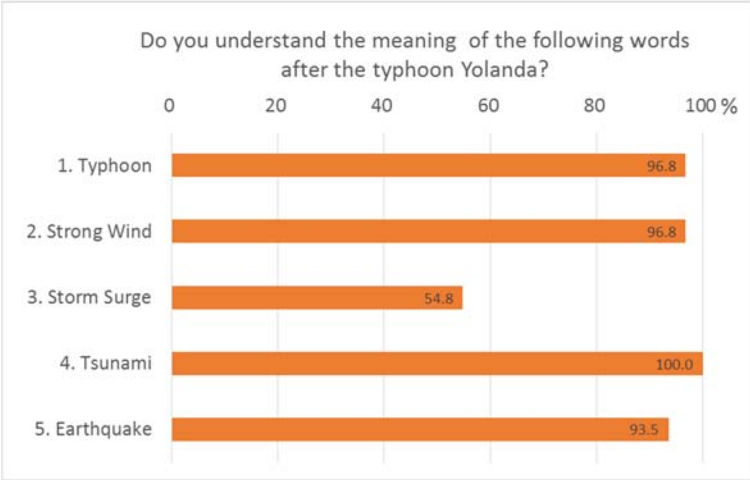


Fig.6-11 Questions if the natural disaster terminologies (Multiple Answer) are understood.

For the above questions, we set multiple answer options, so that the relationship between barangay captains' answers and the fatalities of the Haiyan event at each barangay could be found. **Table 6-4** shows the representative questions and answers in which the difference between the areas with high fatalities and the areas with low fatalities might be identified. From this table, it might be inferred that barangay captains' knowledge and leadership affect the evacuation behavior and fatality of the local people during the Haiyan event. It should be noted, however, that this is an initial assessment and due to the small number of samples, it is difficult to identify any statistical differences to lead to this conclusion. Thus, these results should be analyzed more carefully and further surveys are definitely required.

Table 6-4. Representative questions and answers which show the differences between high and low fatality areas.

		Q	How do you deliver the evacuation order from you to other barangay people and houses?	Where will you make the barangay people to evacuate?		What kind of considerations do you do for selection of evacuation places for the barangay people?		If there is a person who does not want to evacuate to somewhere, what to do?	Do you understand the meaning of Storm Surge after the typhoon Yolanda??
Fatality Ratio [%]	Barangay Captains's experiences (The number of taking charge of evacuation situation except typhoon Haiyan)	A	By myself	School in the barangay	High and strong building in the barangay	withstand for strong wind	no possibility to be flooded by a sea water or river flooding	Leave him/her alone and do nothing to respect his/her decision	
2.7	1	Included	○						○
1.7	1	Included				○		○	
3.5	2	Included	○		○	○	○		○
1.1	mora than 10	Included	○		○	○	○		○
5	mora than 10	Included	○		○	○	○	○	○
2.3	2	Included	○	○	○	○	○		○
9.9	1	Included	○		○		○	○	
12.2	1	Included		○					
13.3	1	Included	○	○					○
8.4	1	Included	○	○					
8.3	more than 10	Included	○			○	○		
12.2	3	Included	○	○			○	○	○
9.01	1	Included	○	○					
16.7	1	Included		○				○	
16.3	1	Included				○	○		○

6.6.3 Evacuation response to Typhoon Ruby

A year later from the Haiyan event, another powerful tropical cyclone, named as Typhoon Ruby called Hagupit in the Philippines, struck the Visayas region at 11:00 pm on December 6, 2014 with maximum sustained winds of 175 kph near the center and gustiness of up to 210 kph (PAGASA, 2014a). The Severe Weather Bulletin #8 with the Public Storm Warning Signal no.3 on the Visayas region (Northern Samar, Eastern Samar, and Samar) was issued at 11:00 pm on December 5, 2014. The warning included the message "those living along the coast are warned on the occurrence of big waves associated with Storm Surge which may reach up 4 meters." The track of Typhoon Ruby is shown in **Fig.6-12** (PAGASA, Severe Weather Bulletin #8, 2014b). According to NDRRMC (2014a), 18 deaths were reported in Regions VI-A, IV-B, VII, and VIII but only one death was reported in Leyte (Capoocan barangay).

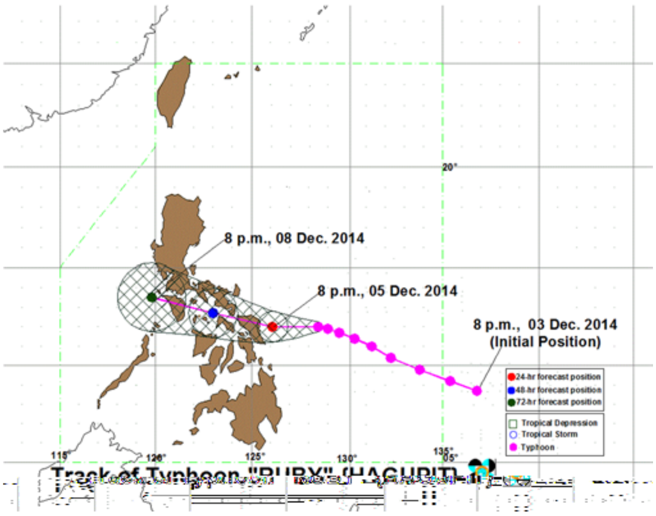


Fig.6-12. Track of Typhoon Ruby presented in the Severe Weather Bulletin #8 issued by PAGASA (PAGASA, 2014b)

The initial forecast for Ruby was that it would take a similar route and magnitude of Haiyan, so that many people in Tacloban felt fears and in panic. Therefore, Tacloban City and people were well prepared for Ruby and more than 50,000 people in the city evacuated before and during the event. Also, Ruby took a more northward route compared to Haiyan, so there was no causality in Tacloban City.

After the Ruby event, we conducted a questionnaire survey for barangay captains in Tacloban, Palo and Tanauan in order to understand the evacuation situations and problems during the Ruby event. The target barangays and captains are the same as those discussed in the previous section.

It can be seen from **Fig.6-13** (upper left) that many people evacuated during the Ruby event, and before its landing many barangay people thought Ruby would have almost the same magnitude as Haiyan (**Fig.6-13** [upper right]). Also, **Fig.6-13** (lower) shows barangay captains' attitudes toward people who did not want to evacuate to somewhere. The answers are slightly different from the ones obtained from the questionnaires (**Fig.6-10** [lower right]) conducted before the Ruby event. Some barangay captains changed their responses from "Leave him/her alone and do nothing" and "Force him/her to evacuate" to "Persuade him/her to evacuate". This may imply that the

Ruby related information made barangay captains more serious but not as much as forcing the people to evacuate. What they could do was to persuade them to evacuate under the actual situation.

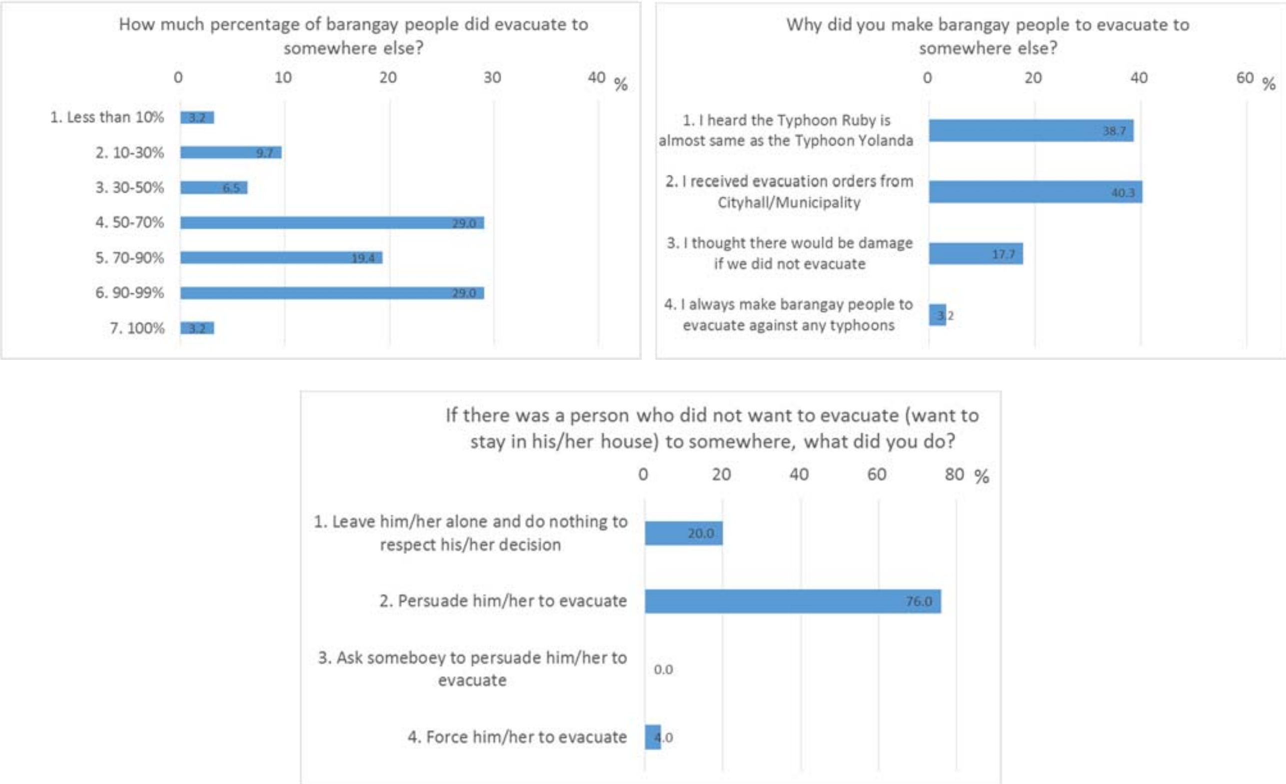


Fig.6-13. Evacuation situation against Typhoon Ruby (Multiple Answer)**.**

Several problems occurred during and after evacuation (**Fig. 6-14** [upper]). There were many cases of power outage in the evacuation facilities due to the damage of the electric facilities induced by strong wind of Ruby. It should be noted that some people claimed that the evacuation was meaningless because there was no big damage or causality. Thus, it would be needed for the local government and barangay captains to carefully explain the situation and importance of the evacuation even there was no damage. Otherwise some people might not evacuate in the future typhoon events. It should be emphasized that only 30% of barangay captains realized that the Ruby's track, taking a more northward route compared to the Haiyan's track, was related to the reason that no severe storm surge occurred in the San Pedro bay in this event (**Fig.6-14** [lower]). Not only typhoon's strength and wind speed but also typhoon's routes are important factors to generate storm surges and large waves. According to Mori et al. (2014), Haiyan took the worst path and speed to generate the severe storm surge in the San Pedro bay. These scientific views and mechanism of the storm surge should be explained simply and understandably to the barangay captains and local people as further information so as to help them make evacuation decisions properly in the future.

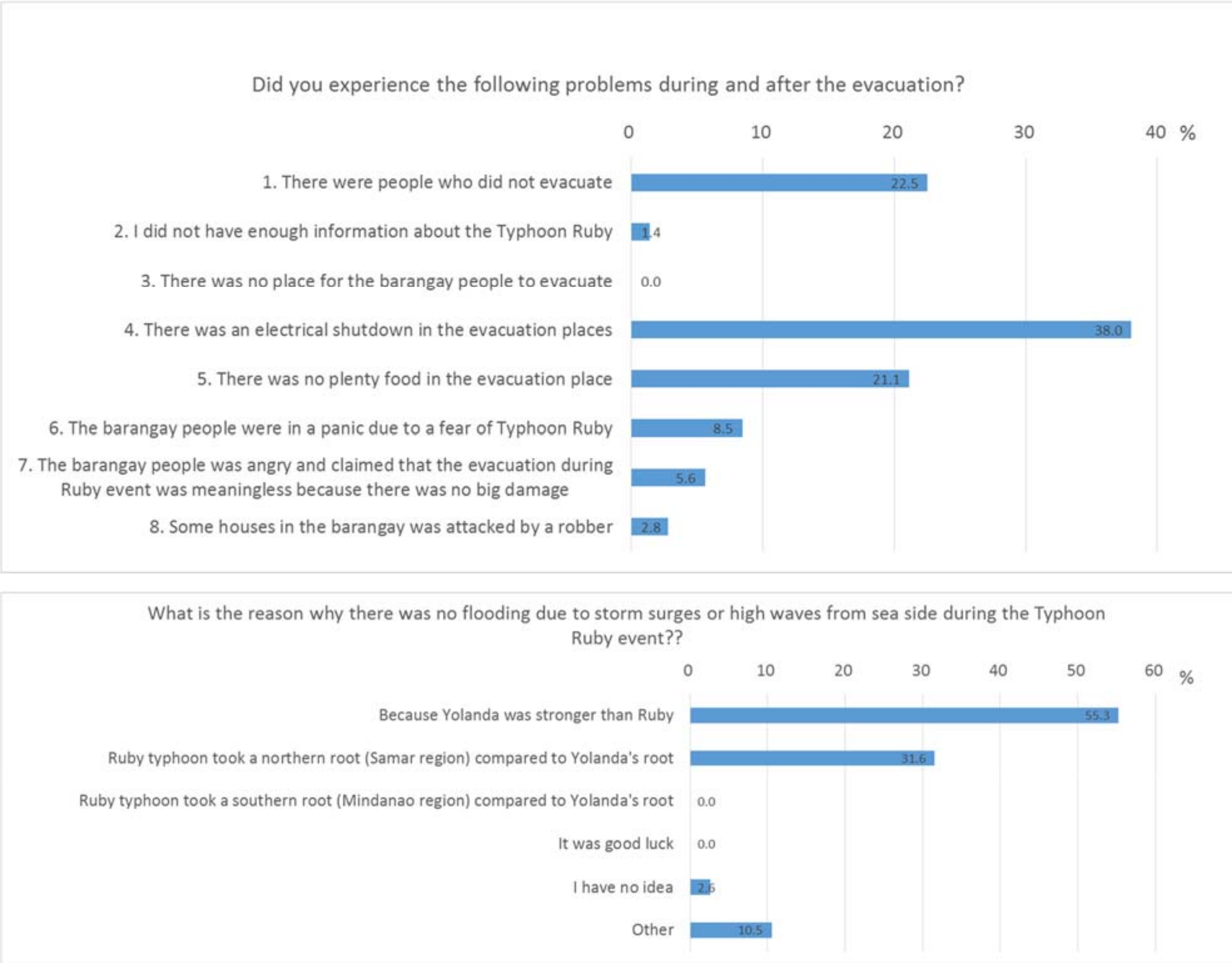


Fig.6-14 Problems during and after evacuation (upper) and the reasons why there was no severe storm surges in the Ruby event (lower).

6.6.4 Damage from Tropical Storm Jangmi

After the landfall of the typhoon Ruby, a tropical storm, named as Jangmi called Seniang in the Philippines, struck the Mindanao region at 6:00 am on December 29, 2014 with maximum sustained winds of 65 kph near the center and gustiness of up to 80 kph (PAGASA, 2014c). The Weather Bulletin #6 with the Public Storm Warning Signal no.1 on Leyte was issued at 11:00 am on December 19, 2014. The warning included the message “Residents in low lying and mountainous areas are alerted against possible flashfloods and landslides.” The track of Tropical Storm Jangmi is shown in **Fig.6-15** (PAGASA, Weather Bulletin #6, 2014c). According to NDRRMC (2014b), a total of 66 deaths were reported in Regions VI, VII, VIII, X, XI, and CARAGA, mainly due to flooding/flashflood and landslide. Twelve deaths were reported in Leyte and 20 deaths were reported in Samar. Five individuals were dead in the Cabuynan barangay of Tanauan City in Leyte because of landslide (**Fig.6-16**) induced by a heavy rainfall during the event. It should be emphasized that even lower wind speeds compared to Ruby with the signal no.3, Jangmi with the signal no.1 brought a heavy rainfall and resulted in many casualties.

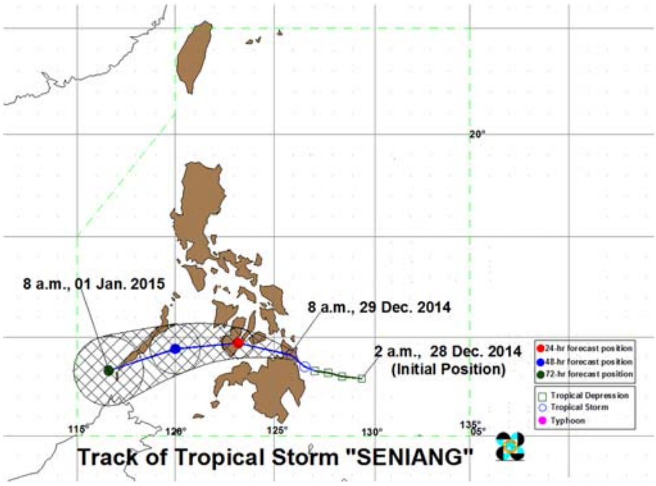


Fig.6-15. Track of Tropical Storm Jangmi presented in the Weather Bulletin #6 issued by PAGASA (PAGASA, 2014c)

Fig.6-16. Landslides occurred in the Cabuynan barangay of the Tanauan city in Leyte (Pictures taken by Dr. S. Kure on January 29, 2015).

The two events, Typhoon Ruby and Tropical Storm Jangmi, raise several important issues, and we must learn from those events that the successful evacuation can save many lives even in cases of strong typhoons. Also, not only wind speeds but also heavy rainfalls should be considered for evacuation. PAGASA's warning signal (#1 - 4) is based on the wind speed, and many barangay captains judge whether to evacuate or not based on the warning signal number (**Fig.6-17**).

A year after Haiyan, the precious lives of 84 people were lost in these two events, which has given us many lessons for future disaster mitigations and preparations.

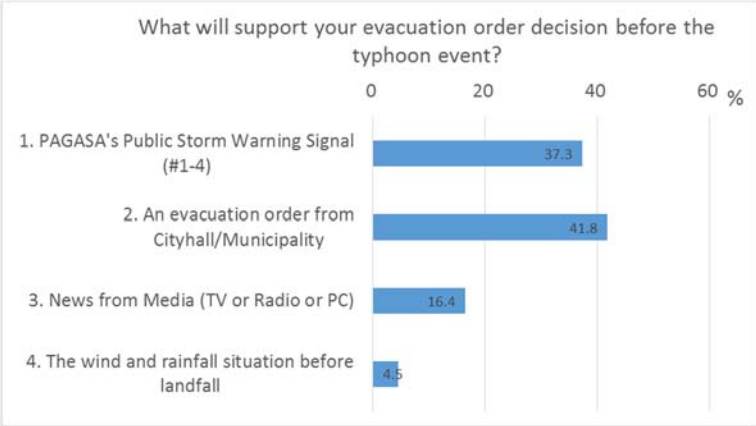


Fig.6-17. Supporting information for barangay captains' evacuation judgment (Multiple Answer).

6.6.5 Recommendations

The results discussed in this section are from our initial assessment, and data analysis is still ongoing. Also, it should be noted that the number of samples of this survey might be insufficient to identify the statistical differences and thus further surveys are required for conclusions. However, the initial assessment of the survey result leads to the following recommendations:

- The leadership and knowledge of barangay captains play an important role to make the barangay people to evacuate properly. The disaster educations and trainings should be provided at the barangay level. It was found out through our survey that the barangay captains and people are willing to take those trainings and they are waiting to be given those opportunities.
- Based on the disaster-related educations, trainings, evacuation drills, etc., a Community Based Disaster Risk Reduction (CBDRR) should be developed in the city and barangay levels. The CBDRR may be one of the suitable options for future disaster mitigations of the Philippines because Philippine's disaster information transfer system (**Fig.2-10** of **Chapter 2**) is based on the house to house transfer system at the local barangay level.
- Even a year after Typhoon Haiyan, many people do not understand the meaning and mechanism of the storm surge. The scientific view of the storm surge should be explained simply and understandably in order for people to make a decision to evacuate and to receive the PAGASA's warnings properly.
- Tropical Storm Jangmi reminded us that a small tropical storm may bring a heavy rainfall and causalities because of flooding and landslides induced by the heavy rainfall. Not only PAGASA's warning level (# 1 - 4), but also the messages included in the weather bulletins issued by PAGASA should be carefully checked.

One basic and important recommendation is to check the hazard map provided by JICA (JICA, 2014). JICA developed the detailed storm surge hazard map based on a numerical simulation after Haiyan, and conducted a location and capacity assessment of evacuation centers based on the hazard map. This kind of project should be announced widely and the hazard map developed by JICA is strongly encouraged to introduce and explain to local people so that they can understand the situation and find an appropriate evacuation facility. Also, it should be emphasized that so many damaged evacuation facilities due to Haiyan still remain damaged and have not been reconstructed. Those evacuation facilities should be rebuilt as soon as possible before the landfall of the next super typhoon in the near future.

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7. IRIDeS fact-finding mission, Disaster Medical Research Team

7.1 Missions

In order to establish the international standards for effective medical and public health response, Division of Disaster Medical Research has missions to investigate the acute and chronic phase of the response and recovery together with preparedness. In this Typhoon Haiyan disaster, we investigated the immediate medical and public health response, domestic and international medical aids, outbreak of infectious diseases, psychosocial problems and mental health of the affected people. Since it is not easy to grasp the whole figure of a disaster by short term visit at the phase of chaos after huge calamity, we revisited the affected area one-year later and investigated the damage of disaster and how the local healthcare providers are "building back better".

We collaborated with the medical and public health practitioners and researchers in Philippines, Department of Health (DOH), World Health Organization (WHO) and others to promote collaborative research and publicizing of the results. Basic concept and strategy of psychosocial interventions at post-disaster settings has been shared between Japanese and Phillipino mental health workers, and cultural and social differences in mental health between two countries and perspectives in international collaboration on disaster mental health has been depicted.

Disaster Medical Research Team

1. Prof. Shinichi Egawa (Team Leader, International Cooperation for Disaster Medicines)
2. Prof. Toshio Hattori (Disaster-related Infectious Disease)
3. Prof. Hiroaki Tomita (Disaster Psychiatry)
4. Assist. Prof. Haorile Chagan-Yasutan (Disaster-related Infectious Disease)
5. Assist. Prof. Hiroyuki Sasaki (International Cooperation for Disaster Medicine)

7.2 Investigations

Disaster Medical Research Teams were dispatched in the 1st, 2nd, 4th and 6th investigations. One year later, we re-visited the Tacloban and Palo area to investigate the long-term recovery and reconstruction process of the affected area.

1. Common themes
   a. Investigations on health damage by Typhoon Haiyan from various perspectives at relatively short term (three months) and long term (one year and three months).
   b. Interview at Japanese Embassy about their response and health problems of Japanese residents.
   c. Establishment of educational system in collaboration with the medical and health related universities about Disaster Medicine
   d. Establishment of collaboration with University of Philippines Manila (UP Manila) and Angeles University through MOAs
   e. Establishment of collaborative relationship with DOH, WHO and WPRO

2. Division of International Cooperation for Disaster Medicine (Prof. Egawa and Assist. Prof. Sasaki)
   a. Investigation of structural, non-structural and functional damage of hospitals, Rural Healthcare Unit, Barangay Health System and other related facilities by direct visit and interview.
   b. Post disaster change of the medical and public health needs of the affected people and areas.
   c. Elucidation of the obstacles to recovery and reconstruction of the damaged health related facilities at three months and one-year later.
   d. Observation of health and sanitary condition of the affected people together with some interviews
   e. Investigation of damage and reconstruction plan of medical educational institutions such as UPM-SHS, RTR foundation and Bethany Hospital.
   f. Discussion and recommendation in the DOH about the "Safe Hospital" concept. Structural, non-structural and functional strengthening of the hospitals including hospital BCP, network promotion and systemic disaster medical response preparedness.
   g. Investigation of domestic and international medical aids in collaboration with DOH and WHO.
   h. Interview with JICA about their concept and role in the reconstruction of health related facilities.

3. Division of Disaster Related Infectious Disease (Prof. Hattori and Assist. Prof. Chagan-Yasutan)
   a. The sanitary condition of affected area and the occurrence of Dengue, Leptospirosis, Tetanus, Measles, Tuberculosis, HIV, Melioidosis and others.
   b. Establishment of early detection system and pathological analysis of the infectious diseases in collaboration with San Lazaro Hospital.
   c. A questionnaire survey health personnel in the Philippines to investigate a) awareness of the international frameworks related to disaster medicine and humanitarian response and b) risk perception of natural disasters and disaster-related infectious diseases.

4. Division of Disaster Psychiatry (Prof. Tomita)
   a. Investigation of mental health care of Japanese residents.
   b. Establishment of collaborative mental health research with researchers in Philippines.
   c. Investigation of the current situation and future perspectives of psychological primary care in the medical system in the Philippines.
   d. Education of public health students about mental health in disaster.

7.3 Methods

1. Geographical mapping of the possible hospitals and health related facilities in the affected area in collaboration with remote sensing team (Dr. Carine Yi). Based on the prepared map, individual visit of the facilities and interviews with the medical directors of the hospitals together with architect from University of Philippines (Mr. Karl Taberdo).

2. Visiting the tent and temporary housing areas to observe the sanitary and health condition of the affected people with some interviews.
3. Visiting the international agents for humanitarian assistance including Red Cross, MSF and others.
4. Based on the MOA and collaborative history with San Lazaro Hospital (Dr. Elizabeth Telan), extended collaboration with DOH (Drs. Marilyn Go, Winston Go, Carmencita Banatin and Alex Dimapilis), WHO (Drs. Arturo Pesigan, Lester Geroy, Alice Ruth Foxwell and Jonathan Abrahams) and WPRO (Dr. Nevio Zagaria) to get the information about health cluster approach and humanitarian assistance.
5. Visiting Japanese Embassy (Drs. Junichi Nitta, Yasuyuki Matsumoto and Akira Yokoyama) and JICA (Ms. Atsuko ltsuki) to interview their health related response and reconstruction plan.
6. Attending the annual congress of Philippines Psychological Association and DOH to get connected with the mental health stakeholders (Drs. Lourdes L. Ignacio and Benjamin V. Marte).
7. Re-visiting the hospitals one year later and interview systematically according to the prepared format as below about the real damage to the in-patients, lifelines and hospital functions. Interviews about their preparedness to the future disasters.

Hospital Investigation Sheet

I. Basic information of your hospital
   a. Name of the hospital
      ____
   b. Public or private
      ____
   c. Mailing address
      ____
   d. Phone number
      ____
   e. Number of beds
      ____
   f. Number of inpatients at the Typhoon Haiyan
      ____
   g. Number of daily out patients before Typhoon Haiyan
      ____

II. Person to contact
   a. Name
      ____
   b. Official Position
      ____
   c. E-mail address
      ____

III. What was the actual human damage of your hospital in Typhoon Haiyan?
   a. Inpatients
      1. Number of lost
      ____
      2. Number of injured
      ____
      3. Number of get wet (estimation)
      ____

   b. Did you send the inpatients who can walk to their own home before the Typhoon?
      1. Yes____, then why?
         a. To decrease the workload of the staff to prepare for the Typhoon
         b. Other, please specify ______________________________
      2. No_____, then why?
         a. It was too dangerous to send them home.
         b. Other, please specify ______________________________

c. Medical Staff
   1. Number of lost ____________________
   2. Number of injured ____________________
   3. Number of get wet (estimation) ____________________
   4. Number of staff who lost their own family ____________________

IV. What was the structural and non-structural damage of your hospital?

a. Structural (building) damage (check multiple that apply)
   1. Yes_____
      a. Roof damage
      b. Wall damage
      c. Whole building damage
   2. Cause of damage
      a. Damage by the wind
      b. Damage by the storm-surge
      c. Both
   3. No_____
   4. Time to recover to the basic level
      a. Several days
      b. Several weeks
      c. Several months
      d. Not yet

b. Non-structural damage (check multiple that apply)
   1. Yes_____
      a. Window damage
      b. Door damage
      c. Ceiling damage
      d. Bed damage
      e. Laboratory equipment damage
      f. Radiological equipment damage
      g. Computer damage
      h. Medical record damage
      i. Air conditioner damage
      j. Elevator damage (If there is no elevator, check here_______)
      k. Ramp damage
      l. Other (please specify)_________________
   2. Cause of damage
      a. Damage by the wind
      b. Damage by the storm-surge
      c. Both
      d. Other (please specify)_________________
   3. No_____
   4. Time to recover to the basic level
      a. Several days
      b. Several weeks
      c. Several months
      d. Not yet

c. Functional damage
   1. Patient care
      a. Fully available throughout the disaster
      b. Closed for less than a week
      c. Closed for more than a week
      d. Closed for more than a month
      e. Inpatients
         i. Limited
         ii. Regular
         iii. Surge
      f. Out-patients
         i. Limited
         ii. Regular
         iii. Surge
      g. What was the wanted human resource? (check multiple that may apply)
         i. Medical doctor

A) Surgeon
B) Internist
C) Emergency care specialist
D) Pediatrician
E) Psychiatrist
F) Other specialty (please specify____________)

ii. Nurse
iii. Midwife
iv. Pharmacist
v. Laboratory technician
vi. Radiology technician
vii. Dietician
viii. Cook
ix. Officer
x. Logistician
xi. Social worker
xii. Other (please specify______________)

h. Who gave you medical relief after disaster (check multiple that may apply)
i. Local team (please specify)
____
____
____
ii. Domestic team (please specify)
____
____
____
iii. Foreign team (please specify)
____
____
____

i. What was the type of relief? (check multiple that may apply)
i. Out-patient clinic
ii. Inpatient care
iii. Substitution of the affected medical doctors
iv. Substitution of the affected staff
v. Coordination
vi. Drug transportation
vii. Laboratory assist
viii. Radiological assist
ix. Dietary assist
x. Other (please specify)

j. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

2. Electricity
a. Availability after the disaster
i. Full
ii. Partial
iii. Completely lost
b. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

3. Tap water
a. Availability after the disaster
i. Full
ii. Partial
iii. Completely lost
b. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

4. Bottled water
    a. Availability after the disaster
        i. Full
        ii. Partial
        iii. Completely lost
    b. Time to recover to the basic level
        i. Several days
        ii. Several weeks
        iii. Several months
        iv. Not yet

5. Gas for cooking
    a. Type of gas
        i. Propane
        ii. City gas
    b. Availability after the disaster
        i. Full
        ii. Partial
        iii. Completely lost
    c. Time to recover to the basic level
        i. Several days
        ii. Several weeks
        iii. Several months
        iv. Not yet

6. Communication tool
    a. Availability after the disaster
        i. Full
        ii. Partial
        iii. Completely lost
    b. Which was useful? (check multiple that may apply)
        i. Phone line
        ii. Cell phone
        iii. Satellite phone
        iv. FAX
        v. E-mail
        vi. SNS (social network system)
    c. Time to recover to the basic level
        i. Several days
        ii. Several weeks
        iii. Several months
        iv. Not yet

7. Laboratory
    a. Availability after the disaster
        i. Full
        ii. Partial
        iii. Completely lost the function
    b. What was the most wanted function in disaster?
        i. Blood count
        ii. Biochemistry
        iii. Transfusion
        iv. Pathology
        v. Microbiology
        vi. Technician
        vii. Other_______________
    c. Time to recover to the basic level
        i. Several days
        ii. Several weeks
        iii. Several months
        iv. Not yet

8. Radiological equipment (check multiple that apply)
    a. Availability after the disaster
        i. Full
        ii. Partial
        iii. Completely lost the function
    b. What was the most wanted function in the disaster?
        i. Simple X-ray

ii. CT scan
iii. MRI
iv. Ultrasonography
v. Technician
vi. Other_______________

c. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

9. Medical record (check multiple that apply)
a. Availability after the disaster
i. Full
ii. Partial
iii. Completely lost the function
b. What was the most wanted function in the disaster?
i. Electric record
ii. Paper record
iii. Medical record personnel
iv. Other_______________
c. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

10. Pharmacy inside the hospital (check multiple that apply)
a. Availability after the disaster
i. Full
ii. Partial
iii. Completely lost the function
b. What was the most wanted function in the disaster?
i. Oral drugs
ii. Injections
iii. Crystal fluids
iv. Pharmacist
v. Other_______________
c. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

11. Inpatient's diet (check multiple that apply)
a. Availability after the disaster
i. Full
ii. Partial
iii. Completely lost the function
b. What was the most wanted function in the disaster?
i. Gas for cooking
ii. Cooking devices
iii. Food stock
iv. Dietician
v. Other_______________
c. Time to recover to the basic level
i. Several days
ii. Several weeks
iii. Several months
iv. Not yet

V. Preparedness of the hospital (check multiple that may apply)
a. Before Typhoon Haiyan (Yolanda)
1. Structural
a. Regular building cord
b. Strengthened building (please specify the strengthened part)
____
2. Non structural

a. Strengthening of the window
b. Relocation of the medical record
c. Relocation of the laboratory equipment
d. Relocation of the radiological equipment
e. Other (please specify)

3. Functional
   a. Early warning and evacuation training
   b. Designation of evacuation center
   c. Training as a response base
   d. Assignment of disaster manager
   e. Regular training with DOH-HEMS
   f. Training of SPEED system
   g. Pre-disaster help relief network formation
   h. Contraction with suppliers
   i. Establishment of Business continuity plan

b. After Typhoon Haiyan (Yolanda) what has been done in one year?
   1. Structural
      a. Regular building cord
      b. Strengthened building (please specify the strengthened part)
      ____
   2. Non structural
      a. Strengthening of the window
      b. Relocation of the medical record
      c. Relocation of the laboratory equipment
      d. Relocation of the radiological equipment
      e. Other (please specify)
   3. Functional
      a. Early warning and evacuation training
      b. Designation of evacuation center
      c. Training as a response base
      d. Assignment of disaster manager
      e. Regular training with DOH-HEMS
      f. Training of SPEED system
      g. Pre-disaster help relief network formation
      h. Contraction with suppliers
      i. Establishment of Business continuity plan

c. What is to be done for the next hazard?
   1. Structural
      a. Regular building cord
      b. Strengthened building (please specify the strengthened part)
      ____
   2. Non structural
      a. Strengthening of the window
      b. Relocation of the medical record
      c. Relocation of the laboratory equipment
      d. Relocation of the radiological equipment
      e. Other (please specify)
   3. Functional
      a. Early warning and evacuation training
      b. Designation of evacuation center
      c. Training as a response base
      d. Assignment of disaster manager
      e. Regular training with DOH-HEMS
      f. Training of SPEED system
      g. Pre-disaster help relief network formation
      h. Contraction with suppliers
      i. Establishment of Business continuity plan
      j. Relocation of the hospital
      k. Other (please specify____________________)

7.4 Results

7.4.1 Hospital Damages

We visited the pre-searched hospitals and health related facilities as shown in **Table 7-1** except one private image-diagnostic facility (#2). The mapping of hospitals and health related facilities through satellite images was quite useful for the comprehensive investigations. It is strongly recommended for the local governments and all clusters share such multi-information-layered maps at the time of disaster. Strong wind, heavy rain and storm surge devastated many hospitals and health related facilities not only in the coastal areas but also in the inlands (**Fig.7-1 left panels**). The damage to the roofs and windows and following heavy rain paralyzed the function of the hospitals including X-rays, CT, MRI and laboratory instruments. There remained only one CT in Tacloban and Palo area (**Fig.7-1**, #5 left). The only psychological ward in that area was also devastated (**Fig.7-1**, #13 left). Most of the hospital rooms were too damaged to accept patients. Many hospitals accommodated small number of in-patients and kept the out-patient department partially functional (ex. **Fig.7-1**, #10 left). The hospitals should deal with the surge of medical and public health needs of the affected people even though the employees themselves were affected by Typhoon Haiyan. The main cause of deaths was drowning by the storm surge as vigorous as Tsunami. The medical and public health needs after Typhoon Haiyan was, however, relatively small number of injuries, but mostly the non-communicable disease and the preventative effort for the outbreaks of infectious disease. The out-patient department of each hospital were congested with people who need medication. There were almost daily deliveries in the maternity hospitals during the disaster. Nurses and midwiferies took care of the deliveries. The students also helped as much as possible to treat the patients.

Most of the hospitals saved the lives of in-patients as much as possible and among the facilities we visited only one patient in ICU lost his life due to the power outage of the ventilator as summarized in **Table 7-2**. The workers in the hospitals were also saved. There is the possibility that patients who can go home in preparation to the Typhoon might have lost their lives. Most of the hospitals utilized the limited resources to keep running the out-patient departments to accept the surge of medical needs. Two hospitals had to completely shut down due to the complete outage of the resources (**Fig.7-1**, #7 and #6 left) at the time of our first visit. One of these was taken over by Doctors Without Borders (MSF) to use the ward as the outpatient clinic and was planned to reopen the hospital in May, 2014 (**Fig.7-1**, #6 left). One year late, it was revealed that this reopen was suspended due to financial and internal problems (**Fig.7-1**, #6 right). On the contrary, one closed the oldest maternity hospital in Tacloban managed to reopen with strong demand and support by Tacloban Women's Association (**Fig.7-1**, #7 right).

The buildings of the hospitals were built according to the latest building code to endure 200 km/h wind, but the real strength of the Typhoon exceeded the expectations (**Fig.7-1**, #5 left). Most of the hospitals had emergency power generator and water stock for daily use (not potable). Fortunately, there was no lack of fuel supply for cars and emergency generators. Potable water for the patients and staffs was provided by the city authority and international aids. Propane gas was used for cooking the meals in the hospital. Small number of the hospital had a contraction with the food vendors. Thus the outage of the lifelines of the hospital was limited, though the rehabilitation of the building was still on-going two months and even one-year after disaster.

The preparedness of medical and health related facilities had been strengthened by the governance of DOH/HEMS (Health Emergency Management Staff) before the Typhoon. Every hospital should have disaster manager to be licensed and "Safe Hospital Campaign" was promoted by DOH in collaboration with WHO from 2008 to 2010. EVRMC owned by DOH (**Fig.7-1**, #1 left), the biggest tertiary center in the region, was inundated by the similar storm surge in 1898, but was not relocated. This time, the government decided to relocate the hospital to the safer place. JICA was planning to assist the reconstruction of EVRMC out-patient department, and was also intending to effectively assist the reconstruction of Rural Health Unit (RHU) that is important for the primary health care.

The information sharing at the onset of disaster still had problems, even the Typhoon developed very rapidly. Some hospital (**Fig.7-1**, #4 left) protected its glass wall by temporally shielding structures and had less damage to the wards. This hospital also relocated the medical records to the third floor and protected the record from storm surge inundation (**Fig.7-1**, #4 left). The remained CT scan in the region was located deep inside of the hospital to avoid the rain fall from the damaged roof (**Fig.7-1**, #5 left). This hospital also located the laboratory instruments at the deep inside and protected from the rain damage, though its ICU was totally devastated by the strong wind and rain though the broken glass window (**Fig.7-1**, #5 left).

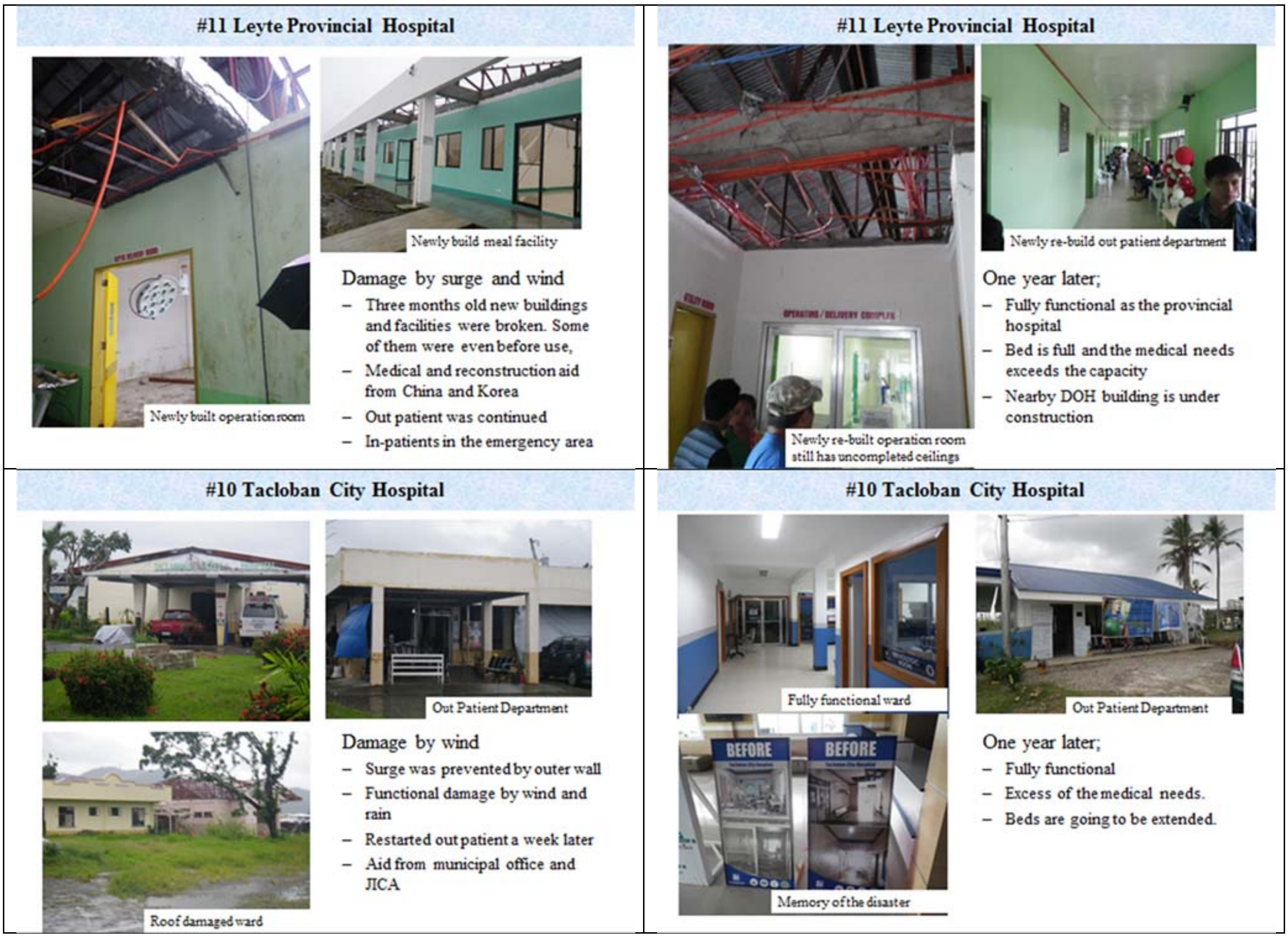
One year later, we revisited the hospitals and investigated the details of the damage by Haiyan. Similar strength Super-Typhoon Hagupit (Local name: Ruby) attacked the same area on Dec. 6, 2014. The memory of Typhoon Haiyan evoked the people and health professionals to prepare to Hagupit. Many hospitals protected their glass windows by strengthened boards (**Fig. 7-1**, #8 right) and carried all the equipment to the upper floor. Fortunately Hagupit landfall was more North-bound compared to Haiyan, resulted in far-less storm surge and human damage. Strong wind and heavy rainfall, however, destroyed roofs, windows of some hospitals again (**Fig. 7-1**, #8 #9 right).

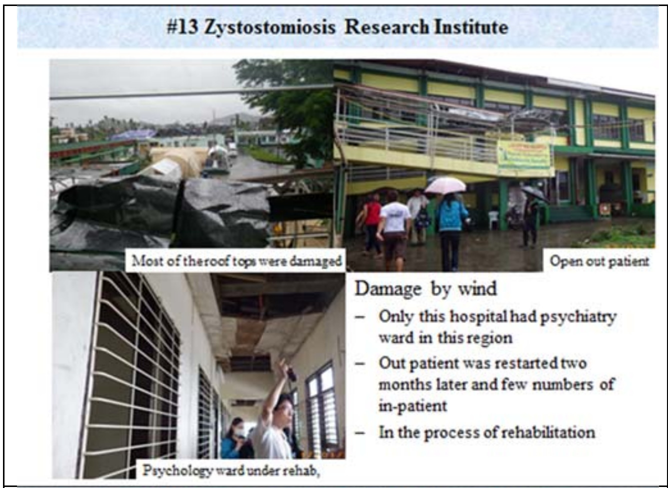
Consecutive investigations in 2014 and 2015 made it possible to measure the recovery and reconstruction process of the hospitals and the difference between the relatively acute phase (three months after disaster) and long-term phase (one year and three months after disaster). Typhoon Hagupit attack became the real situation to test the preparedness of the hospitals. In 2014, the affected area still had debris and the people's life was totally compromised. The hospitals were also severely damaged and in the process to recover to the basic level. One year later, most of the hospitals became fully functional even though some of the damage was not completely fixed. Public hospitals recovered relatively quickly by the governmental support, while the private hospital faced severe financial problem. DOH decided to relocate EVRMC in accordance with the partial relocation of the Tacloban downtown to the Northern part of Leyte Island. Other hospital remains in its current location but faces the basic surge of the medical and public health needs of the area. Most of the hospital-beds are full and they are considering expansion the number of beds. The area seems to be facing to serious shortage of the physicians especially for the mental and psychiatric care. The role of public health nurse and midwives are also very important resource since the population is growing and the public health education is needed. The life of the people are getting better than the immediate situation, but number of people are living in the temporary houses and even in tents without appropriate sanitary and nutritional condition.

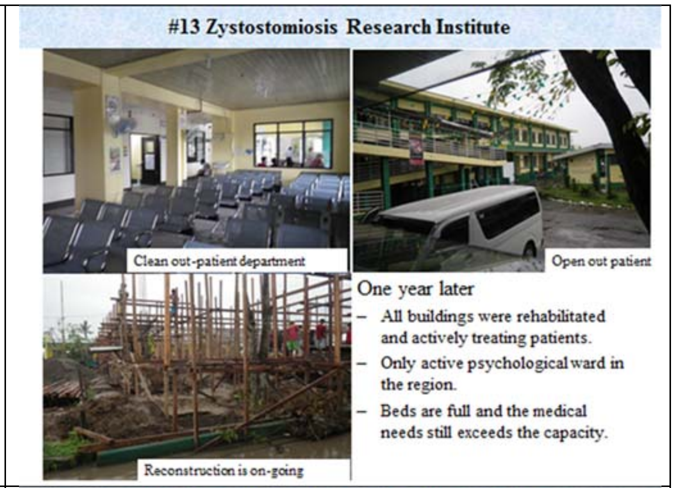
In Angeles City, Pampanga, Luzon Island the people were resettled by the governmental coordination after Mt. Pinatubo eruption. At that time, people were provided a fixed size of land and a house as a personal property in Angeles City. Twenty three years later, the resettled area formed an active community with fundamental educational and health facilities (**Fig. 7-2**). The policy and player of the national government changes, but the recover and reconstruction after disaster should be prioritized and implemented as a legal enactment for equity and human rights.

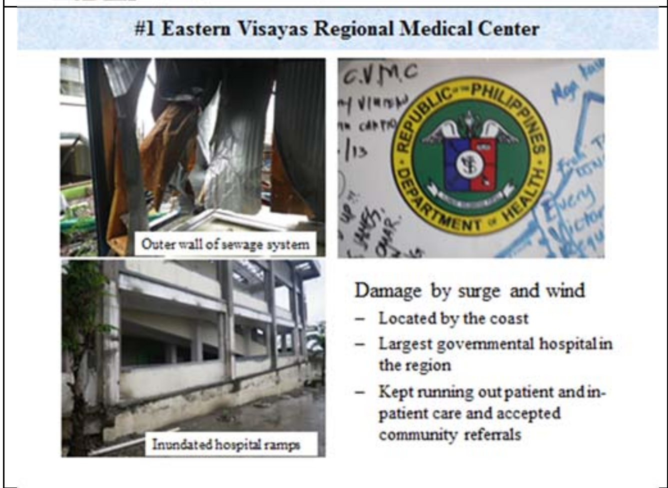
Table 7-1. Hospitals and health related facilities in the affected area

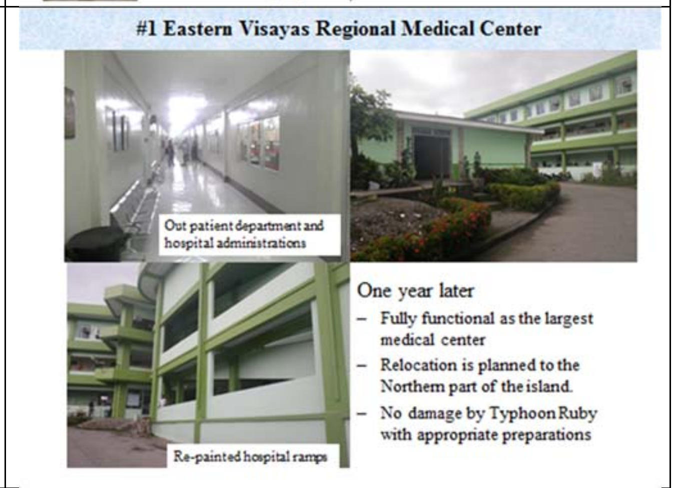
ID	Name	Address
1	Eastern Visayas Regional Medical Center (EVRMC)	Tacloban
2	Ultrascan Diagnostic Center & Healthcare Services	Tacloban
3	Philippine National Red Cross	Tacloban
4	Divine World Hospital	Tacloban
5	Tacloban Doctors Medical Center	Tacloban
6	Bethany Hospital	Tacloban
7	Tacloban Maternity Hospital	Tacloban
8	Mother of Mercy Hospital	Tacloban
9	Remedios Trinidad Romualdez Medical Foundation (RTR)	Tacloban
10	Tacloban City Hospital	Tacloban
11	Leyte Provincial Hospital	Tacloban
12	U. of the Philippines Manila School of Health Sciences (UPM-SHS)	Palo
13	Zystostomiosis Research Institute	Palo

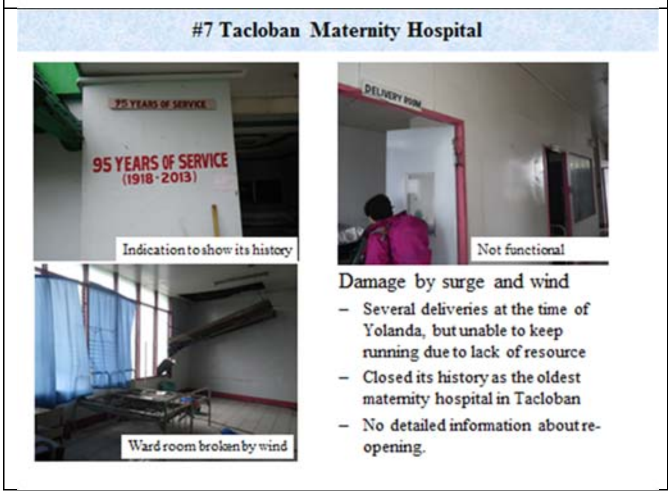


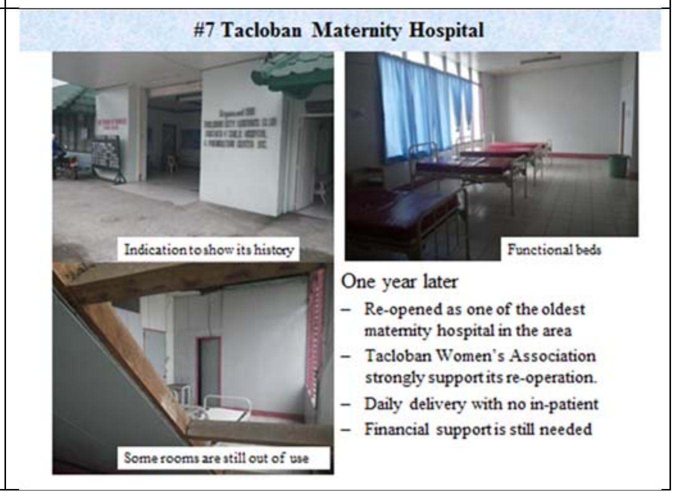

#13 Zystostomiosis Research Institute
Most of the roof tops were damaged
Open out patient
Psychology ward under rehab,
Damage by wind
– Only this hospital had psychiatry ward in this region
– Out patient was restarted two months later and few numbers of in-patient
– In the process of rehabilitation


#13 Zystostomiosis Research Institute
Clean out-patient department
Open out patient
Reconstruction is on-going
One year later
– All buildings were rehabilitated and actively treating patients.
– Only active psychological ward in the region.
– Beds are full and the medical needs still exceeds the capacity.


#1 Eastern Visayas Regional Medical Center
Outer wall of sewage system
REPUBLIC of the PHILIPPINES
DEPARTMENT of HEALTH
Inundated hospital ramps
Damage by surge and wind
– Located by the coast
– Largest governmental hospital in the region
– Kept running out patient and in-patient care and accepted community referrals


#1 Eastern Visayas Regional Medical Center
Out patient department and hospital administrations
Re-painted hospital ramps
One year later
– Fully functional as the largest medical center
– Relocation is planned to the Northern part of the island.
– No damage by Typhoon Ruby with appropriate preparations


#7 Tacloban Maternity Hospital
95 YEARS OF SERVICE
95 YEARS OF SERVICE
(1918-2013)
Indication to show its history
DELIVERY ROOM
Not functional
Ward room broken by wind
Damage by surge and wind
– Several deliveries at the time of Yolanda, but unable to keep running due to lack of resource
– Closed its history as the oldest maternity hospital in Tacloban
– No detailed information about re-opening.


#7 Tacloban Maternity Hospital
Indication to show its history
Functional beds
Some rooms are still out of use
One year later
– Re-opened as one of the oldest maternity hospital in the area
– Tacloban Women's Association strongly support its re-operation.
– Daily delivery with no in-patient
– Financial support is still needed

#4 Divine Word Hospital


Less damage by board protection


Protected and functional ICU


Medical record on the 3rd floor

Damage by surge and wind

- Protected the glass window in front of ICU by hard board two days before Yolanda
- Roof tops were blown off, X-ray, MRI, labs were damaged
- Kept running out patient and in-patient
- New facilities reduced the risk

#4 Divine Word Hospital


Some of the buildings are under reconstruction


Congested out patient department

One year later;

- Fully functional
- Medical needs exceeds the capacity
- Hospital preparedness are strengthened.
- At Typhoon Ruby, all equipment were carried to the upper floor.

#5 Tacloban Doctors Medical Center


5th floor with roofs blown out


Glass windows in the front


CT was saved at the center of building

Damage by wind

- Kept running out patient and in-patients
- Only functional CT in the region
- Aid from parental group
- Emergency power generator was functional

#5 Tacloban Doctors Medical Center


Only the roof was reconstructed in the 5th floor


Some of the Glass windows in the front was broken again by Ruby


Fully functional Intensive Care Unit

One year later;

- Fully functional but one floor remains still totally devastated.
- Financial support is needed

#9 Remedios Trinidad Romualdez Medical Foundation

Operations at Tacloban and vicinity

Owns its medical and nursing school

Damage by wind

- Kept running out patient and in-patients
- Lost CT by power outage
- Got aid from congressman RTR and served as a center for medical and relief operations under control of disaster manager (medical director)
- Schools restarted two month later

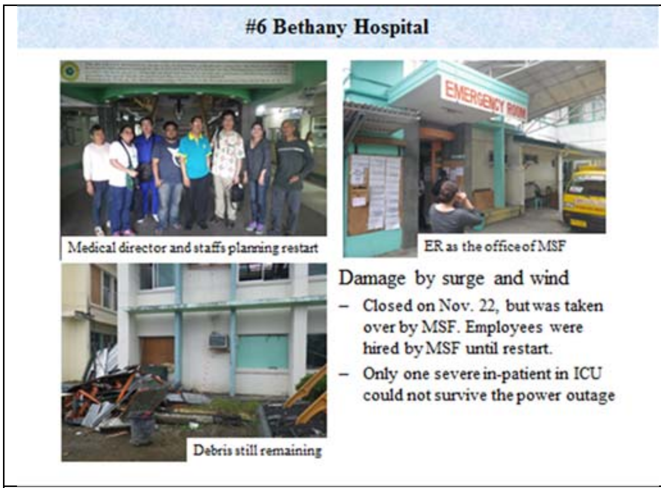
#9 Remedios Trinidad Romualdez Medical Foundation (with Schools)

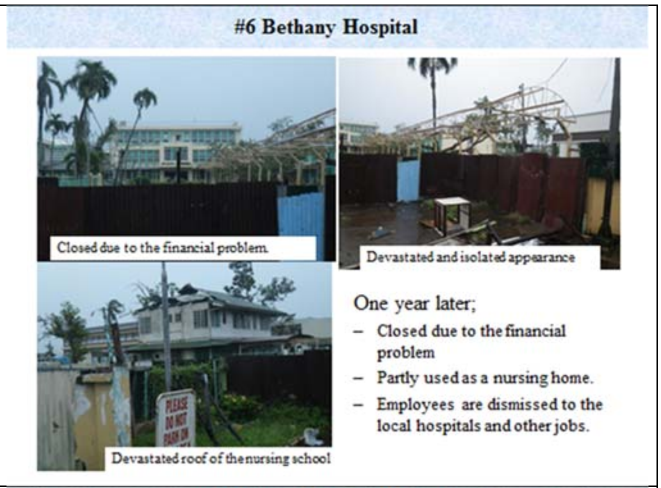

Front glass wall was broken by Ruby


Reconstructed nursing school

One year later;

- Fully functional
- Expanding the beds
- Little damage by Typhoon Ruby





#8 Mother of Mercy Hospital was not visited in Jan 2014.

Fig.7-1. Hospital damages in Tacloban and Palo area (Left side: as of Jan 2014, Right side: as of Jan 2015)

Table 7-2-1. Summary of the hospitals and health related facilities damaged by Typhoon Haiyan

ID	Name	Beds	Human loss	Human injury	Type of damage	Jan 2014	Jan 2015
1	Eastern Visayas Regional Medical Center	360	0	3 medical staff 0 patient	Surge & Wind	Active	Fully functional
2	Ultrascan Diagnostic Center & Healthcare Services	0				Not visited	Not visited
3	Philippine National Red Cross (operation center)	0			Surge & Wind	Active	Not visited
4	Divine Word Hospital	160	0	1 guard 0 patient	Surge & Wind	Active	Fully functional, rehabilitation on-going
5	Tacloban Doctors Medical Center	35	0	0 medical staff 0 patient	Wind	Active (CT)	Functional, but partial building damage remains
6	Bethany Hospital (with Schools)	150	1 patient in ICU	1 medical staff	Surge & Wind	Restoring (MSF until May)	Closed
7	Tacloban Maternity Hospital	12	0	0 medical staff 0 patient	Surge & Wind	Closed	Functional, some rooms are out of use

8	Mother of Mercy Hospital	50	0	0 medical staff 0 patient	Wind	Not visited	Fully functional
9	RTR Medical Foundation (with Schools)	50	0	0 medical staff 0 patient	Wind	Active	Fully functional
10	Tacloban City Hospital	50	0	0 medical staff 0 patient	Wind	Active	Fully functional
11	Leyte Provincial Hospital	50	1 patient old and TB	0 medical staff 0 patient	Surge & Wind	Active	Fully functional
12	UPM-SHS (School with delivery clinic)	0	0	3 students 0 patient	Wind	Active	Students are temporary studying in UP Tacloban. Planned to relocate

Fig. 7-2 Resettled areas in Angeles City 23 years after Mt. Pinatubo eruption

Upper left: Rural health unit providing primary health care, delivery and public health service including vaccinations and sanitation. **Upper right:** Elementary school, **Lower left:** Typical house built and given by the national government to the residents of resettlement area. Resident owned this house and can expand it as a home or sell it as a personal property. **Lower right:** Wide road and stores for living.

7.4.2 Health-related needs of the affected people and the medical aids.

As a matter of fact, 6,300 people were killed by the typhoon and storm surge and more than one million houses were damaged (NDRRMC, 2014). When we visited three months later, some of the affected people were already living in the restricted zone of within the 40 m from the coastal line and getting the food and water supply, partly working or finding any type of livelihoods.

Many international medical teams came in to provide medical relief and found that the number of injured patients was small, but that the medical needs including diarrhea, pneumonia, bronchial asthma and their prevention were remarkable. Middle to long-term lack of food and lifelines deteriorated the health condition of the affected people and increased the risks of malnutrition and epidemic outbreaks (**Fig.7-3**). Water and food was supplied by the local government and humanitarian agencies, but the information where and when it will be supplied was insufficient. There are thousands of evacuation tents along with the coastal line but the tent did not have floor other than a simple sheet, and two to three families were living in one tent (**Fig.7-3**). The sanitary condition of the affected people was also very insufficient, cooking foods by burning the wrecks and debris, washing close without proper sewage, running with sandals in the muddy water, toilet on the sea. People were educated not to drink the water from the well, but there are increased symptoms of the abdomen especially in the malnutritional areas.

The elementary school was opened but no lunch is provided. Thus, the children should bring their own lunch or had to go back home to eat lunch. This could cause malnutrition of the children and increase the vulnerability especially for poor people.

The international agencies provided the town clinic and visiting medical cares. JICA provided three terms of JDR as medical relief. These were coordinated by the health cluster meetings led by DOH and WHO. One private hospital (RTR, **Fig.7-1**, #9) provided medical care and relief goods to the Tacloban and Palo vicinities as a hub of private relief from the congressman in Manila. The coordination of private and public relief are necessary.

Cooking by burning the debris

House built on wrecked container

Fig.7-3. The life of the affected people

Philippines had incorporated the Surveillance in Post Extreme Emergencies and Disasters (SPEED) system since 2010 (http://healthmarketinnovations.org/program/surveillance-post-extreme-emergencies-and-disasters-speed). This SPEED system collected the number of infectious and common disease occurrence and was effective to assist the preventative medical response such as mass vaccination campaign against measles and tetanus, preventative drug administrations and the improvement of sanitary conditions.

San Lazaro Hospital dispatched the special team to provide educations to early detection and treatment of tetanus (Dr. Alex Dimapilis). The medical teams through this education successfully saved all patients with tetanus. Most of the affected people were living in the coastal area and kids were playing with bare feet where the rusted nails from wrecks and debris could cause infection of tetanus. Prevention and the early detection is the only way to save the patients with tetanus.

7.4.3 The role of central and local governments and humanitarian agencies

The domestic and international medical and humanitarian aids were coordinated by the Health Cluster. There was little confusion within more than 150 foreign teams from more than 100 countries and 1,200 delegates from international aids through DOH/WHO coordination with back-up from WPRO. Even so, the aids tend to concentrate on the Tacloban area which was most damaged and therefore the most frequently appear in media. It might have created the unreached area where the relief and aids were truly needed. Thus, the multilayered mapping of the affected area based on the demographical data is vital to provide effective relief.

The International and Philippine Red Cross had also cluster approach to provide the relief goods and help effectively (**Fig.7-4**, left). Philippine Red Cross does not have any its own hospital, but is trained to act as emergency and disaster relief. The relief goods and the blood for transfusion was stocked and provided at the operation center (**Fig.7-4**, left). They provided the town clinic using 7-8 ambulance cars with two medical doctors and two nurses. This mobile clinic stayed in one place for five hours and cared 80-90 patients/day. They made briefings every day to reorganize the plans for effective relief. If the mobile clinic does not have a doctor, even the trained surgical nurse felt the frustration of treating the patients without supervising doctor.

The communication was made through satellite phones and the relief goods were provided from the health and welfare sector in the airport. Public health nurses performed the assessment of the evacuation shelters and reported to DOH using SPEED system every day. The sanitary condition of the people were monitored and helped in collaboration with water, sanitation and hygiene (WASH) sector. Preventative administration of doxycycline was provided for the people who walked in the muddy water to prevent Leptospirosis. Mass vaccination for the pneumonia, polio, measles and tetanus were performed by DOH and international humanitarian agencies using “cold chain”. Cold chain is the networking of the refrigerators to stock heat-fragile vaccines. The national government declared national calamity and freeze the price of medicines immediately after the disaster. Educational gathering of the community people were frequently hosted by the humanitarian agents about the nutrition, hygiene and possible diseases in the current situation. Breast feeding was recommended to mothers to avoid contamination of milk for the babies.

We visited the base camp of the International Association of Red Cross and Red Crescent (**Fig. 7-4 right**). The concept of base camp was first developed by the Danish Red Cross to provide the comfortable work place for the delegates. About 20 big tents with individual small tent inside were built as the residential areas. There were showers and toilets. They had the water purification system and clean kitchen to provide safe water and foods. They first bring all the materials with them but gradually utilized the local resources as much as possible to prevent the suppression to the local industries. They had Sunday off so that the delegates could appropriately take rests and provided the mental and physical supports.

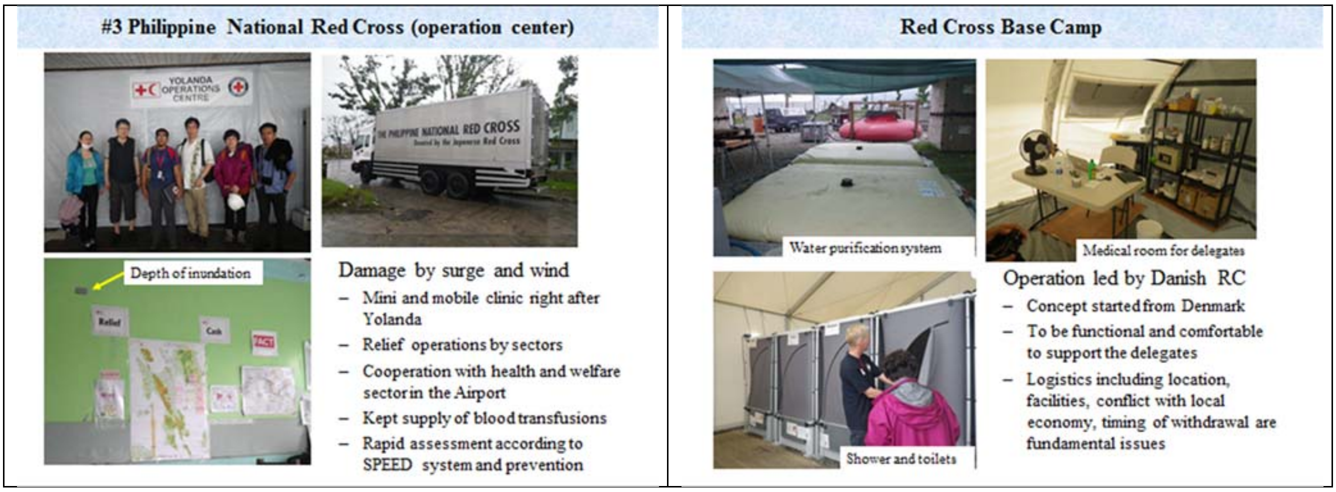


Fig.7-4. Humanitarian agencies in Tacloban

Left: Philippine Red Cross operation center in Tacloban. This building was inundated by storm surge. **Right:** Base camp of International Association of Red Cross and Red Crescent.

In Manila, we shared the experience and the lessons from Great East Japan Earthquake in the technical discussion on making our hospitals/health facilities safer in emergencies “My Hospital: Last Building Standing in Disasters” in the presence of Secretary Dr. Enrique Ona and Undersecretary Dr. Teodoro J. Herbosa in DOH (**Table 7-3**). The systematic medical response in Japan was presented including Disaster Base Hospital, DMAT, wide area transportation, disaster emergency medical information system and medical-public health coordinators.

Table 7-3. My Hospital: Last Building Standing in Disasters: A technical discussion on making our hospitals/health facilities safer in emergencies at DOH

Opening remarks	Hon Secretary Dr. Enrique Ona
Introduction and opening	Dr Roland Cortes, Assistant Secretary of Health Dr Julie Hall, WHO Representative in the Philippines
Technical presentations	Overview: Dr Arturo Pesigan, WHO Philippines: Safe Hospitals Programme: Assessment of Hospitals Dr Marilyn Go, Preparedness Div. Chief, HEMS Disaster Base Hospitals and Business Continuity Management: Lessons from the Great East Japan Earthquake: Prof Shinichi Egawa, Tohoku University, IRIDeS
Panel of reactors	Representative, Bureau of Design, DPWH Atty Violeta Seva, Earthquakes and Megacities, Inc (EMI) Professor Ruel Ramirez, UP Diliman
Technical inputs from participants and recommendations	Guided discussion on recommendations for Post Haiyan Recovery and safe hospitals Moderator: Dr Sandra Tempongko Deputy Director, SEAMEO-TROPMED Network

The Philippine Government worries about the delayed restarting of the schools due to the evacuated people and is planning to use hospitals and RHU as evacuation shelters. Further discussion will be necessary to reconstruct the health care plans. DOH is emphasizing the safe hospital concept with business continuity plans. The structural, non-structural and functional strengthening will be required.

The health insurance system in Philippines makes the difference between public hospitals where patient with low income can access to the medical service for cheaper expense and private hospitals where people who can afford the cost. This made the difference in the financial and temporal difference in the recovery and reconstruction process. One year later, most of the public hospitals were fully functional, while some private hospitals remained partially destructed and even closed. In Japan, where the health care system is totally different, the private hospital cares the patient at the same price with public hospitals due to the national health insurance system and most of the tertiary centers are expected to serve as a disaster base hospital regardless of public or private administration. At Typhoon Hagupit, the national government was also on alert and prepared to the disaster. Thaks to the early warning and evacuation, the number of human damage was small, but the people living in the temporary houses and tents found their living place again in the ruins. Reducing the vulnerability before disaster and increasing the capacity of health in every measure is important to decrease the risk. Ironically, smaller typhoon after Hagupit killed more than 10 people in the area because of land slides. Reconsideration of the role of hospitals as a "building last standing in disaster" and safety net of the society could lead to the prioritization of health as a disaster risk reduction.

Embassy of Japan in the Philippines contacted all of the Japanese residents in the affected area to make sure the safety and physical and mental health conditions, and found out that there seems to be no serious health problems, which urge immediate care.

7.4.4 Infectious disease

Mass vaccination campaign and the extermination of mosquitos prevented the remarkable outbreak of infectious diseases. But, there was a tendency of measles outbreaks and the situations such as deteriorated sanitary condition, malnutrition and crowded populations especially in the coastal and relocated areas where people cook by burning the wrecks suggested the probability of respiratory and digestive disease outbreaks at any time. The difficulties of medical access for the affected people will lead to the spontaneous termination of drug treatment of HIV or Tuberculosis resulting in the increased frequency of drug-resistance. The demographic analyses of the patients are urgently needed. The future flooding and mosquito activities will also increase the chance of Dengue and Leptospirosis. In collaboration with Dr. Elizabeth Telan from San Lazaro Hospital, we studied various bio-markers using ELISA and Luminex and found that Gal-9 could serve as an important novel biomarker of acute DENV infection and disease severity and potential target to control DENV pathogenesis (1). In addition, we initiated new investigation of Melioidosis and Chikungunya in Philippines.

We also performed a questionnaire survey that showed the awareness of international frameworks for disaster preparedness and response were not so high. Risk perception of natural disaster could be locally rather than globally influenced by the profile of natural disaster (2).

Professor Hattori promoted the establishment of collaborative relationship between UP Manila and Angeles University. The long collaborative history with San Lazaro hospital made fruitful results not only with infectious disease but also the whole activities of Disaster Medical Research Team.

7.4.4.1 Melioidosis

Melioidosis is a severe tropical disease caused by *Burkholderia pseudomallei*, a Gram-negative, aerobic bacterium that is present mostly in soils and water in tropical regions. It is endemic in Southeast Asia and northern Australia. It is believed that melioidosis is underreported in the Philippines and it is also a one of disaster-related infectious diseases (especially after Tsunami). The incubation period preceding melioidosis may be 2-3 days or many years. Fever, productive cough, weight loss, chest pain, and hemoptysis are frequently present in more severe and disseminated disease. It was frequently misdiagnosed as other pathogens such as *Burkholderia cepacia*, *Pseudomonas spp*., and *Mycobacterium tuberculosis*. There were only 4 *B. pseudomallei* strains from the Philippines collected since 1969 that have been genotyped by the CDC. These genotypes are sequence types (ST) 57, 62, 98, and 99; three of which were collected from monkeys, while only one strain was isolated from human. With limited genetics data of *B. pseudomallei* in the Philippines, we are interested in obtaining more information about this disease in the Philippines. *B. pseudomallei* strains collected in this study are subjected to genotypic characterization and molecular epidemiological investigation.

This study is attempted to identify the presence of melioidosis using culture or genetic diagnosis and characterize their features by biomarkers among patients with pneumonia, sputum-negative tuberculosis and leptospirosis, and help local doctors to recognize the disease in Philippines especially in Manila and Tacloban. The study title of [Investigation of melioidosis in the Philippines] is submitting to ethical committee of San Lazaro Hospital (SLH) and will be conduct the research both in San Lazaro Hospital and Eastern Visayas Regional Medical Center (EVRMC) upon acceptance of research proposal. In EVRMC, Aileen T. Riel-Espina the new Chief of Hospital and

Dr. Jane Borrinaga the head of Internal Medicine showed interest to collaborate on this project. Dr. Espina said that Melioidosis research is a good way to start involving the clinicians in EVRMC to do research. Upon reading the contents of the proposal Dr. Espina wanted to clarify what will be the role of EVRMC in Melioidosis research, will they be a co-investigator, or just a site for sample procurement. Dr. Espina wanted to know the staffing procedure if Tohoku University will hire their own Research Assistant or EVRMC will provide a research assistant and a doctor to work on this research. For the sample population, she suggested that the Institute of Pediatrics should be included since the proposed target age group is from 16-21. Informed consent written in their native language shall also be done. She also informed that their Ethics Review Board is not yet accredited thus they will follow the procedure and the requirements of SLH. Dr. Espina and Dr. Borrinaga gave us a hospital tour after the meeting particularly the laboratory of the hospital. Ms. Susan Leano from SLH was able to talk to the medical technologist in-charge of the Microbiology laboratory and discussed the protocols for Melioidosis detection and isolation.

Microbiology Lab at SLH

With director Go and Dr. Telan in SLH

Microbiology Lab at EVRMC

7.4.4.2 Chikungunya

After typhoon Yolanda, there were potential new cases of chikungunya outbreak according to local doctors from EVRMC in Tacloban. However, it was difficult to confirm since it was the first exposure of this diseases in Tacloban and no any diagnostic tool was available at that time. Therefore, we have been starting a new project at Research and Biotechnology Division (RBD) of St. Luke's Medical Center, Manila, Philippines to understand the epidemiology and pathogenesis of this mosquito-borne disease. RBD was established under the leadership of Vice President for research, Filipinas F. Natividad, Ph.D. (Ma'am Pi). RBD is the one of the few research center that can diagnosis and treat chikungunya virus infection in Philippines. The center could bring together both basic scientists and clinicians to promise challenge of pioneering biomedical research on a wide variety of medical research. RBD is fully equipped for advanced biomedical research such as facilities for DNA isolation and analysis, protein isolation, purification and quantitation, gene sequencing, cell culture and cryopreservation, advanced microscopy, darkroom facilities and animal studies (3). RBD is the only institution in the Philippines that has the capability to detect chikungunya virus (CHIKV) using Reverse Transcription Polymerase Chain Reaction targeting E1, NSP1 and NS1 regions, other research facilities use serological methods such as ELISA and ICT in detecting CHIKV. RBD was able to isolate and perform a whole gene sequencing on CHIKV of which the whole sequence analysis is now published in Genome announcement. Several researches are also in the works for publication together with the partnership of the clinicians in St. Luke's Hospital and Medical Center.

Our team visited RBD at Dec. 2014 to start collaboration on chikungunya research. We introduced Disaster-related Infectious Diseases Laboratory, IRIDeS, Tohoku University and the institution's goals and objectives. Ma'am Pi and Ms. Maria Luisa G. Daroy (Ma'am Chuchi) also gave a brief background as to what type of research RBD has been working on. Tohoku University and RBD is interconnected due to the existing collaboration of the two Institutes. Ma'am Pi raised several points regarding the future CHIKV collaboration, such as defining and completing the requirements for Ethical Clearance, writing an Informed consent, the timetable for the research study, the target sample size and patient criteria of the research as well as the activities of the research study to be done in Japan and Philippines. The timetable to finish all the documents for ethical clearance of CHIKV research was set for 3 months. Since this will be a new collaboration, Ma'am Pi requested if some of the laboratory activities will be done in RBD such as Cytokine Panel analysis, since the laboratory has already a MagPix (Luminex) set-up as well as sending some research staff in the Philippines to Japan and vice versa for the exchange of technology and education. They will be including these requests in their justification for the creation of this new collaboration. According to Ma'am Chuchi, one of the clinicians in St. Luke's hospital, Dr. Evan Glenn Vista, a rheumatologist is interested on CHIKV research and he welcomes Tohoku University as a partner in this study, furthermore he is willing to share his patient samples and medical data. Before the end of the meeting the Materials and Transfer Agreement (MTA) contract were signed by Ma'am Pi, Ma'am Chuchi and Professor Hattori. The research proposal title [Detection of Inflammatory Markers: MMP-9, Interleukin-6, Osteopontin and Galectin-9 among initial Chikungunya Patients and Post Chikungunya Patients with Arthritis] is now submitting to Ethical Committee of RBD at St. Luke's Medical Center.

Signing of MTA for CHIKV research

Lab Tour at RBD

With Drs. Chuchi, and Evan

7.4.4.3 Tuberculosis

Mycobacterium tuberculosis (MTB) is the causative agent of tuberculosis (TB), the sixth leading cause of death and illness in the Philippines. Despite global trends towards decreasing incidence, prevalence, and mortality associated with MTB infection, approximately 230,000 cases were found in the Philippines alone in 2012. Developing a rapid, simple, and accurate test for TB diagnosis is a main focus of many investigators. In the present study, we evaluated the reliability of LAMP for detecting MTB infection and used spoligotyping to identify the most prevalent MTB genotype in Metro Manila. We also analyzed a broad spectrum of biomarkers, which reflect both cellular and humoral immune response to MTB infection. The study population consisted of 37 HIV negative TB patients randomly selected from the out-patient department of San Lazaro Hospital before the initiation of their anti-TB treatment. The controls were healthy volunteers lacking signs of TB. The study was approved by the ethics committee of SLH and the Tohoku University Hospital, and written informed consent was obtained from each participant. Basic anthropometric and clinical characteristics of study participants are shown in Table 1. We confirmed MTB infection in all TB patients' samples by LAMP method. All DNA samples were subjected to spoligotyping and we found that all patients were infected with a Manila type MTB. This finding of a uniform genotype of MTB was rather surprising. The arrival of Chinese, Japanese, and Spanish groups may have influenced the acquisition of various MTB genotypes in the region; however, little information is available regarding prevalent MTB genotypes circulating in the Philippines. Using a multiplex immunoassay, we assessed the concentrations of 29 soluble plasma biomarkers in TB and health control (HC) individuals. Biomarker levels and their comparisons between groups are shown in Table 2. The role of matricellular proteins supporting TB infection is not well studied. We found high plasma levels of two matricellular proteins, osteopontin (OPN), and, for the first time, gal-9 in treatment-naive TB patients. Matricellular proteins are secreted into the extracellular matrix environment but do not play a primary structural role in this location and regulate an unusually diverse array of cellular functions, including cell adhesion, shape, migration, differentiation, proliferation, and inflammatory responses. It has been proposed that matricellular proteins enter inflamed tissue and become immobilized at that site to generate signals for phagocytosis and chemotaxis of inflammatory cells.

Table 2: Comparison of cellular and humoral immunity biomarkers between HC and TB individuals.

Biomarker (pg/mL)	HC	TB	P
	Median (range)		
General activation			
IL-1α	0 (0–51.7)	6.8 (0–40.7)	**
IL-1RA	39.7 (0–374.9)	34.7 (0–230.9)	ns
TNF-α	4.2 (0–15.2)	9.6 (0–60.5)	****
IFN-α	40.6 (0–128.5)	23.6 (3.9–157.9)	ns
IL-6	0 (0–23.4)	6.6 (0–41.4)	****
Th1 related			
IFN-γ	9.3 (0–35.2)	12.7 (0–60.8)	ns
IL-12p40	31.4 (0–140.6)	14 (0–249)	ns
IL-12p70	13.5 (0–73.9)	6.7 (0–58.2)	ns
Bone marrow derived			
IL-7	11 (0–34.9)	9.6 (0–25.4)	ns
GM-CSF	7.6 (0.8–23.0)	5.1 (0–49.2)	ns
G-CSF	144.1 (19.3–458.0)	129.4 (0–310.4)	ns
Stromal, angiogenic			
VEGF	128 (0–344.1)	178.4 (0–1287.3)	ns
EGF	109.8 (42.3–488.2)	109.8 (0–459.5)	ns
Chemokine			
IL-8	2.3 (0–10)	8 (0–61.1)	****
IP-10	242.6 (97.8–453.3)	1290 (0–9235)	****
MCP-1	87.1 (48.7–154.5)	128.5 (41.6–280.5)	****
MIP-1β	31.9 (0–51.9)	33.3 (0–58.8)	ns
Eotaxin	38.5 (18.1–112.6)	48 (20.7–133.8)	*
Matricellular protein			
OPN (ng/mL)	69 (40–118.9)	159 (28.9–256)	****
Gal-9	195.8 (108–507.6)	377 (0–2181)	****
Antibody			
Anti-TBGL IgG (U/mL)	2.3 (0.5–37.3)	9.3 (0–64.2)	**
Anti-TBGL IgA (U/mL)	1 (0.2–76)	2.6 (0–57.6)	*

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.0001$, ns: not significant.
TB group versus HC group by Mann-Whitney U-test.

OPN is highly expressed in tuberculous granuloma and supports granuloma formation via its functions as a chemoattractant cytokine. OPN and gal-9 may be produced by activated circulating immune cells, but a more plausible explanation is that they are released into the circulation from tissue sites. Our unpublished data showed elevated pleural fluid/plasma ratios of gal-9 and OPN in a TB patient, and Inomata et al. showed that OPN levels increase proportionally with the extent of lung lesions. We evaluate differences between patients with and without granuloma formation, factoring in the extent of lesions and other clinical parameters; however, we did not observe any statistical correlations, probably because radiological findings with most patients were not suggestive of granulomas.

Neutrophils, one of the most predictive markers of active TB infection, were found to have the largest influence on WBC elevation in TB patients. Neutrophils are generally thought to have strong activity against infectious agents. Higher neutrophil counts were observed in TB patients and were associated with poorer prognosis. Neutrophils are attracted by various cytokines and chemokines, including IL-8, and quickly accumulate at sites of mycobacterial infection. We also observed IL-8 elevation in TB patients, which may be due to hyperproduction by stimulated macrophages, by epithelial cells in lungs, or even by neutrophils themselves, although no correlation with neutrophils was observed. Previous study showed that low lymphocyte count is suggestive of extension of the disease by new tubercle formation, but switch to lymphocytosis shows tendency to healing. Therefore, careful evaluation of hematological changes may have diagnostic value. We performed correlation analyses of the three most predictive TB markers with other measured parameters. IP-10 expression levels positively correlated with loss of appetite, IL-1β, IL-6, IL-8, OPN, and gal-9 expression and negatively correlated with anti-TBGL IgG antibody titer. In contrast with low circulating levels of IFN-γ, the high levels of IP-10 in the blood produced by antigen stimulated cells make this chemokine a promising candidate biomarker for MTB infection, even in HIV-infected individuals. We found that patients with high plasma IP-10 reported loss of appetite, but such a tendency was not observed with other biomarkers. Juffermans et al. had similar observations, where IP-10 but not IL-8, MIP-1b, or MCP-1 was associated with loss of appetite and fever. We found that the OPN and gal-9 correlated with IL-8 and IP-10 and we hypothesize that OPN and gal-9 activate the expression of chemokines and cytokines like IP-10, TNF-α, IL-6, and IL-8 in macrophages, helping to recruit immune cells to the site of MTB infection. TB patients' neutrophilia was associated with increased WBC counts, IFN-γ, and decreased hemoglobin levels, hematocrits, plasma IgG titers, and lymphocytopenia.

Finally, we studied the relationship of gal-9 to biomarkers and other laboratory parameters. High gal-9 levels correlated with higher TNF-α, IL-6, IL-5, IL-3, EGF, IL-8, and IP-10 expression and lower levels of GM-CSF. Biomarkers that differentiated HC and TB were analyzed by ROC analysis and cut-off values were determined based on the best proportion between sensitivity, specificity, and likelihood ratio (Table 3). The highest discriminatory property had IP-10 and OPN, followed by neutrophils, platelets, TNF- α, MCP-1, WBC counts, gal-9, and IL-8. Next, we performed analysis, which is a multivariate discrimination method to characterize the most discriminatory variables among groups. OPN was identified as having the highest discriminatory capacity, followed by IP-10, neutrophils, IL-6, IL-8, TNF- α, MCP-1, platelets, gal-9, and WBC (4).

Using a combination of these markers, all healthy individuals and 96.3% of TB patients were correctly classified. In conclusion, LAMP is a simple and low-cost method for the direct detection of MTB in patients' sputa. Moreover, the LAMP method together with spoligotyping method serves as sensitive, accurate tools for TB diagnosis and for monitoring prevalent lineages of TB in certain regions. Increased IP-10, OPN, and neutrophils levels best reflect the acute stage of TB infection, and measuring their fluctuations may provide a reasonable basis for determining TB severity and prognosis.

7.4.4.4 Leptospirosis

Leptospirosis is an emerging infectious disease caused by a pathogenic spirochete of the genus *Leptospira*. Leptospirosis has become a global public health problem, especially in developing countries including Philippines and it often cause outbreaks after flood. Severe leptospirosis is associated with a high rate of mortality due to renal damage, cardiopulmonary failure, widespread hemorrhage, liver failure, and meningitis, if antibiotic treatment is not initiated within five days after the onset of symptoms, the period during which antibiotics are most effective. However, clinical diagnosis is difficult because patients present various non-specific symptoms that are also associated with other endemic and epidemic diseases such as dengue, rickettsiosis, malaria, and enteric fevers. Therefore, clinical diagnosis alone is inadequate and early laboratory confirmation is essential for disease control and patient management.

Anti-leptospira antibody can be identified by serological testing. The gold standard assay for leptospirosis is the microscopic agglutination test (MAT), in which live antigens representing different serogroups of leptospiras are reacted with serum samples and then examined by dark-field microscopy for agglutination. MAT is more specific than other serological tests, but it is time consuming, requires specialized facilities for culture and maintenance of live antigen panels, and requires technical expertise. Alternatives to MAT are the enzyme-linked immunosorbent assay (ELISA) and immunochromatography (ICT), which require less time to perform and provide high sensitivity and specificity. Therefore, it is important to evaluate the diagnostic efficacy of ELISA and ICT in comparison to MAT. PCR methods provide efficient early diagnosis of leptospirosis, as it can detect leptospiral DNA in serum and urine before and after the appearance of anti-leptospira antibody. Several studies have described real-time PCR as a rapid and sensitive tool for leptospiral DNA detection. Loop-mediated isothermal amplification (LAMP) is an alternative method for rapid DNA amplification. Unlike PCR, LAMP amplifies target DNA under isothermal conditions, usually between 60°C and 65°C, with high specificity, efficiency, and speed, and the results can be evaluated by the naked eye. LAMP requires low-cost, simple equipment, and is thus a useful diagnostic method in resource-limited countries. In study with San Lazaro Hospital, we investigated the diagnostic efficacy of combined anti-Leptospira antibody and leptospiral DNA detection. MAT, ELISA, and ICT detected leptospira antibody in 68%, 76%, and 60% of 113 leptospirosis cases. The sensitivity and specificity of ELISA were 87.01% and 72.22%, whereas these values for ICT were 79.22% and 80.56%, respectively. LAMP detected four positive patients, three of which were confirmed by real-time PCR. Urine pellet samples enabled detection of leptospiral DNA for a longer period after the onset of symptoms. Of the patients for whom diagnosis was not confirmed by antibody detection, 10% were identified as leptospirosis positive by DNA detection; thus, 83% of 135 patients with suspected leptospirosis were confirmed as positive by using combined antibody and DNA detection techniques (5). In addition, the inflammatory markers in leptospirosis patients are under analyzing to understand the complicated pathogenesis of severity in this disease.

7.4.4.5 Dengue

Dengue virus (DENV) is transmitted by the mosquito vector, and causes a wide range of symptoms that lead to dengue fever (DF) or life-threatening dengue hemorrhagic fever (DHF). Philippines is one of dengue endemic area. The host and viral relationships that contribute to DF and DHF are complex and poorly understood, but appear to be linked to inflammation and impaired coagulation. Full-length osteopontin (FL-OPN), a glycoprotein, and its activated thrombin-cleaved product, trOPN, integrate multiple immunological signals through the induction of pro-inflammatory cytokines. To understand the role of OPN in DENV-infection, we collaborated on dengue infection samples from San Lazaro Hospital and assessed circulating levels of FL-OPN, trOPN, and several coagulation markers (D-dimer, thrombin-antithrombin complex [TAT], thrombomodulin [TM], and ferritin in blood obtained from 65 DENV infected patients in the critical and recovery phases of DF and DHF during a dengue virus epidemic in the Philippines. Levels of FL-OPN, trOPN, D-dimer, TAT, and TM were significantly elevated in the critical phase in both the DF and DHF groups, as compared with healthy controls. During the recovery phase, FL-OPN levels declined while trOPN levels increased dramatically in both the DF and DHF groups. FL-OPN levels were directly correlated with D-dimer and ferritin levels, while the generation of trOPN was associated with TAT levels, platelet counts, and viral RNA load. Therefore, the study demonstrated the marked elevation of plasma levels of FL-OPN and thrombin-cleaved OPN product, trOPN, in DENV-infection for the first time (6). Further studies on the biological functions of these matricellular proteins in DENV-infection would clarify its pathogenesis.

7.4.4.6 Other issues related to infectious disease

Current situation of Tacloban city:

The effect of typhoon Haiyan in the community is still noticeable. There are a lot of Settlement areas in Tacloban that serves as refuge for the residents who lost their houses during the disaster. Most of the residents living in this so-called “bank houses” lived in the Novel Zone (40 meters from the sea wall- the place that was heavily hit by typhoon Haiyan). One settlement area has about 500 families. According to one of the residents, initially the government told them that they will only live in the area for 3 months, but until now they were not able to move to a more stable house since the housing projects have not started yet. The resident didn’t elaborate further on the reason or the cause of the delay of the project. There are two types of bank houses, categorized according to the number of family members. There are (1) for families with five members and below and (2) for families with six family members and above. Bank houses for five family members and below have an area of 8x16 feet and the bank houses for 6 family members and above measures 16x32 feet. Six families share a communal restroom facility, each of the family take turns in taking care of this facility. Each family set-up their on bathroom in front of their house. The local government only allow each house to have one lighting equipment and 1 ceiling fan, they were not allowed to have a television set even the portable one. According to them this is to help the government save with the electricity, and since probably not all of the electricity plants have been restored to its full potential. One of the main problems of the residents in the area is that they don’t have enough water supply, which is provided by MILWASA, a government owned water facility. The residents have to save and store water for them to be able to do their normal household chores and hygienic routines. He further told us the each settlement areas is different from each other and facing different challenges every day. NGO's are still working hand in hand with the locals and the local and national government. We saw a lot of schools and houses that were built by NGO's from Taiwan (Tsuchi) and Korea. The NGO's mostly care the residents that live away from the Novel zone since most of the government programs are centered in the "Novel zone". The government also instructed the residents that they can only ask assistance from either NGO or government; this is to ensure that all the residents will get the assistance they need to get back to their normal routine.

Temporary house at Tacloban | Living space of temporary house | Talking with resident

Eastern Visayas Regional Medical Center (EVRMC):

In EVRMC we were able to meet with Dr. Aileen T. Riel-Espina the new Chief of Hospital and Dr. Jane Borrinaga the head of Internal Medicine. Dr. Espina recently came back from Japan for a two-month training on hospital management. Dr. Espina gave us a summary of what have been the effect of Typhoon Haiyan epidemiologically speaking. She said there were a lot of suspected CHIKV cases though they were not able to confirm it due to lack of CHIKV detection kits, there were no increase in Leptospirosis cases since during and after the typhoon they were vigilant in distributing a lot of medicine packs for leptospirosis prophylaxis. They noticed in the evacuation sites that there was a budding increase of measles cases and right away the hospital alarmed DOH and WHO regarding this matter. Upon doing epidemiological investigation they came to a conclusion that these cases must be imported since they were keen on doing mass immunization for Measles after the typhoon. They noticed that patients primarily infected with measles came from Manila. These families seek refuge in Manila during the disaster crisis and then came back to Tacloban once the effect of the typhoon has already calm down. These patients were believed to be absent during the time local health officials had their anti-measles vaccination program. One of the most interesting stories that Dr. Espina shared to us was that they had two typhoon related cases that occurred during the patient's preparation for typhoon Haiyan. One patient suffered from laceration and the other one suffered from punctured wound. Because of typhoon Haiyan, the local government officials and the hospital officials created a disaster response team. The new team was first put into action during typhoon Ruby, which happened days before our Tacloban visit. For the first time even before typhoon Ruby was expected to landfall in Tacloban, the residents of Tacloban asked the government officials to evacuate them right away. Dr. Espina was very interested on how Japan operates during disaster and she wanted to pattern some of the Japanese response procedures in case of disaster for EVRMC. Dr. Espina is also working on making a Typhoon Haiyan museum in Tacloban and putting up a research facility in the area.



Dr. Espina introduced renewed EVRMC　Discussion with Drs. in EVRMC　With Drs. Espina and Borrinaga

Schistosomiasis Research and Training Center:

Dr. Charlemagne N. Escape, the Chief of hospital, told us that the hospital has already fully recovered from the effect of Typhoon Haiyan. Though he felt bad that there are still a lot of residents in the area that were not accounted for during Typhoon Haiyan devastation. After the typhoon he said that there was no increase in Schistosomiasis and Psychiatric patients. The hospital usually has 5-6 cases of Schistosomiasis monthly. Originally the 38 bed capacity hospital was built to cater Schistosomiasis cases only but as time passed by there was a steady decline of Schistosomiasis cases thereby the hospital decided to add more services such a Psychiatric and Obstetrics and Gynecology to prevent the hospital from closing. Because of the increasing number of delivery cases that hospital has to build a building for Operating Room and Delivery Rooms, the building will be done in five months' time. The research wing of the hospital is currently doing collaboration with Brown University, New York. The title of the study is determining the birth outcomes of Schistosomiasis infected expecting mothers taking placebo and medications (metronidazole, praziquantel) for Schistosomiasis. The birth outcomes that they are observing are: low birth weight, cognitive development and hematological effects of the diseases and the medication on infants. In this study they have a total of 370 patients and one of them had a case of vertical transmission. The research facility has also an ongoing research involving carabaos (water buffalos) as their main subject. These carabaos serve as a reservoir of Schistosomiasis organisms. They enrolled a total of 36 carabaos, 35 of them were Schistosomiasis positive. These infected carabaos were asymptomatic but carabao perfusion and hepatic biopsy revealed that these carabaos were heavily infected with Schistosomiasis ova. The research center hopes to put an end if not decrease the cases of Schistosomiasis in Tacloban and nearby province. The medical technologist said then that an on-going war of existence is occurring between man, animals, environment and organisms causing harmful and deadly infectious diseases. The question is who is winning and who is losing?



With Dr.Escape　Discussion with the researchers about Schistosomiasis

7.4.5 Mental health

The number of psychiatrists in Philippines is quite small as of several hundreds in the country the majority of whom work in urban area around Manila, whereas the Philippine archipelago comprises over 7,000 islands, of which about 2,000 are inhabited. These situation causes remarkable shortage of psychiatrists and mental health care givers especially in rural areas, including the areas severely affected by Typhoon Haiyan. To improve the situation, the Philippine Psychiatry Association had provided a Training of Trainers for a psychosocial Intervention Program in Disasters, in 2007 and 2008, to develop leaders in the provision of psychosocial program in their respective regions in the country.

As for psychosocial support for the victims of Haiyan, a local mental health care giver who has taken the training course, along with the disaster mental health support teams lead by the National Center for Mental Health (NCMH) are the core of the mental health response and care for children in disaster, which are supplemented with private stakeholders. However, generally speaking, the middle- and long-term mental health supports are very insufficient.

It is important to centralize the mental health as a framework to improve the primary care and reconstruction in collaboration with DOH, National Mental Health Center, Philippine Psychological Association, World Association for Psychological Rehabilitation, University of Philippines, and other relevant organizations (**Fig.7-5**).

Fig.7-5. Establishment of collaborative relationship with Philippine Psychiatric Association by Prof. Tomita.

7.5 Future Perspectives

a. Investigations of the pathogens of infectious disease in Tacloban and its vicinity in collaboration with EVRMC and San Lazaro Hospital
b. Investigation of hospital, RHU and BHS reconstruction in the affected area in collaboration with DOH, JICA,

WHO and others.

c. Analysis of medical needs in the affected area including mental health in collaboration with UPM and others.
d. The statistical analysis of international medical aids.
e. Promotion of education and research on Disaster Medicine in the collaborative health related universities.

7.6 Establishment of Partnerships

1. Application of JST-RAPID emergency research project through Letter of Intent from UP Manila
2. MOA with San Lazaro Hospital was already concluded.
3. MOA with UPM was concluded on Jun. 2014 (**Fig. 7-6** left)
4. MOA with Angeles University Foundation was concluded on Oct. 2014. (**Fig. 7-6** right)

Fig.7-6. MOA with UP Manila (left) and Angeles University Foundation (right)

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8. Simple Construction Practices for Health Facilities Safe from Typhoons and Storm Surges – Post Haiyan Recommendations

Abstract

To mitigate the effects of typhoons, flooding and storm surges on health facilities is an essential pursuit that every design professional and health professional should follow. For a country usually visited by strong winds and rains, it is their duty to think of ways to strengthen the hospitals, both physically and operationally, so that while a disaster is happening, the hospital is the last building standing. This paper aims to describe the most practical and simple construction practices that all health facilities should apply.

8.1 Introduction

On November 8, 2013, a category 5 (Saffir-Simpson scale) typhoon locally named Yolanda (International: Haiyan) made landfall in the Philippines, affecting many provinces. Straight out of the Pacific Ocean, the eye of the storm struck the island of Leyte which is located in Eastern Visayas. Despite warnings as early as six days before the typhoon pounded the island, no one was truly prepared for the side effect that ultimately took more than 6,000 lives in the country, the storm surge.

While it is well known that a natural event such as this is unavoidable, its deadly effect on human life is surely preventable. Sadly, the Philippines is plagued with underdevelopment and poverty that can be blamed for the tremendous loss of lives. The most vulnerable to disasters are those who are not sheltered in well-made structures.

A well-made structure is defined as any building that is technically designed to guard its users against harmful outdoor elements. Such structures, in general, supposedly have features like a tied foundation, an elevated floor, reinforced concrete columns and beams, slab roofs or tightly fastened sloped roofs.

A health facility, especially a hospital, must be designed and built as a well-made structure safe from natural and man-made disasters. A hospital that is physically damaged cannot function properly. It is a well-known fact that the breakdown of any health facility during emergencies and disasters is a disaster in itself.

Sometime January 17-23 2014, the International Research of Disaster Sciences (IRIDES) in Tohoku, Sendai, Japan, sent an investigative team of technical experts, through a project entitled “IRIDES Fact-Finding Mission”, in collaboration with various government agencies and research organizations in the Philippines.

Part of this study team was the IRIDES Disaster Medical Science Team, assisted by representatives from the Philippines Department of Health (DOH), World Health Organization Western Pacific Region (WHO-WPRO), University of the Philippines Manila and Angeles University. To help the medical investigation, the M Arch Hospital Design Program of the College of Architecture, University of the Philippines, through Professor Cristopher S.P. Espina and Research Associate Karl Taberdo, assisted in the survey of damages of selected essential health facilities in areas which bore the brunt of the disaster.

This report, therefore, aims to describe and investigate the physical damages and the subsequent breakdown of functional services of six (6) disabled health facilities, post Haiyan, and recommend methods of mitigating the bad effects of typhoons and storm surges in the future.

8.2 Post Haiyan Experiences and Damages to Health Facilities in Leyte

A total of six (6) health facilities are studied in this report as follows:

1) The Eastern Visayas Regional Medical Center (EVRMC)

The EVRMC is the prime government hospital in Region VIII, where the Island of Leyte is a part of. The whole complex is located in Tacloban City, on the east side of the Island, beside the sea, close to the coastline, where the storm surge partly occurred. The sea waters inundated the site about 3 meters or more deep, reaching the rain gutters of the one-story structures in the complex. The hospital complex is composed of several buildings 1 to 3 stories high spread out along the coast.

According to the Medical Director, Dra. Riel-Espina, the sea water surge rushed in from a breach in the perimeter concrete hollow block fence facing the sea and flooded the ground floor of the hospital site, with such force, displacing furniture and equipment and damaging essential hospital equipment such as the x-ray units and the CT-scan. The main generator was not spared, rendering it inutile during the rest of its post Haiyan life. Electricity was partially restored in two weeks when the first of the smaller generators came. It is good that potable water was not a problem, since there were two main sources of water: the main source came from the Leyte Metropolitan Water District (LMWD) and a secondary source from a deep-well. The main damages to the hospital plant can be summarized as follows;

a) Damage to the main generator, located in the power house on the portion of the hospital site close to the coastline;

b) Damage to the desalination and the wastewater treatment plant also located in the service area near the coastline;

c) Damage to the imaging equipment; x-ray units, CT-scan, etc. due to flooding;

d) Cut-off of the main electrical service. Candles were used to go on with hospital operations for two weeks until a substitute generator of 10 KVA capacity was provided by the DOH; Incidentally, it was pointed out by one of the hospital maintenance personnel that smaller generators used during emergencies in a department in a hospital is much more convenient to handle for the following reasons:

- It is small, light, easy to carry and manipulate.
- It can be controlled locally within the department.
- During emergencies, only the affected portions of the hospital will be cut-off from electrical service.

e) Damaged roof of the Surgical Department. The Surgical Department had to be transferred to another area in the hospital to resume the necessary services.

f) Blown-off roof, metal gutters and metal fascias in many parts of the various buildings;

g) Broken glass windows and glass doors due to exposure to the winds;

h) Windows and exterior units of air-conditioning systems were blown off by the wind or were washed away by waves and the action of water;

i) Ceiling systems were blown-off due to strong internal wind pressure on open areas and on breaches on broken windows and doors;

j) Broken and pulled-off vitrified floor tile finish, slippery when wet.






2) Philippine National Red Cross Building

The Philippine National Red Cross is a referral center to the nearby East Visayas Regional Medical Center. Through private pharmaceutical companies, it distributes medicines to rural health units and deploys a mobile clinic and an ambulance in far-off barangays and municipalities in the region. The mobile clinic is manned by a doctor and 2-3 nurses and offers a "speed system" for diagnosis of disease in the various barangays. They also handle mass vaccinations for measles and dengue.

The PNRC Building is housed in a one-story building with a metal roof exposed with no parapets. Also located near the coastline, it was fully inundated up to door head height. During the height of the incident, when the surge of sea waters rushed to the site, the staff climbed up and sought refuge on the roof of the one-story building. Help came on the fifth day after the incident. The Danish Red Cross camped on site

The damages include the following:

a) Damages to the laboratory equipment and the blood bank;

b) Partially blown-off roof, ceiling, eaves, gutter and fascia.



3) Ultrascan Diagnostic Center

The Ultrascan Diagnostic Center is privately owned by Dr. Ignacio Valeriano. It offers basic laboratory and imaging services and is housed in two-story rentable area in a tall building. It was made un-operational due to the following damages:

a) The service entrance post toppled over cutting-off electric service to the Center;

b) The Center's roll-up metal door was blown off exposing the interior areas to wind and water;

c) The Center's medical equipment were damaged.

4) Divine Word Hospital

The Divine Word Hospital is a 3 and 4 story building with a metal roof covering the 3rd and 4th floors with metal cladded gutters. It has a glass curtain wall in the front façade and big glazed windows at the sides. The hospital is located beside a creek in the midst of an urban area.

The hospital was inundated about 0.90 meter high. When the water rushed from the driveway to the hospital's main lobby, the guard closed the front aluminum glazed doors and held it in place. However, because of the force of the water surging in, the glazing broke and unfortunately killed the guard.

Because there were announcements and warnings of the impending large typhoon that would hit the province, the front façade curtain wall was purposely boarded up because of the foreseen vulnerability of the glass façade. However, the big windows at the side elevations and the main entrance door were left un-boarded thereby subjecting the building to nature's pressure. A storm surge was totally not anticipated by the authorities.

Operations on the ground floor were totally disrupted. Existing patients and services had to be transferred to the upper floors and no new patients were admitted. The hospital had to share what was left of their stock of food to patients, their relatives and staff. According to Sister Sarah Gocela, the hospital's administrator, food should be stored on an upper floor so that they will be safe during emergencies. After a few days of temporary operations, the hospital had to let the patient's relatives and watchers leave the hospital because food was running out.

A summary of the damages include:

a) Damaged medical equipment including the MRI, CT Scan, X-ray units and others.

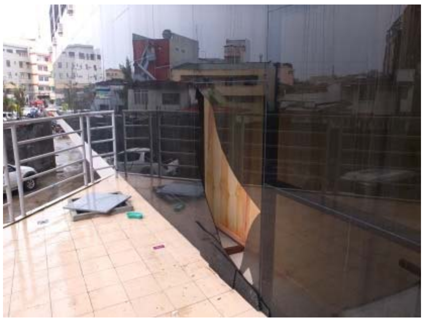
b) Third floor and fourth floor roofs were partially blown-off, especially the ones covering the open roof decks.

c) The laboratory department was fully inundated.

d) Blown-off window glazing destroying ceiling systems and partially damaging the interiors. It was noticed that end of corridor glazing was vulnerable to high winds.

e) Although the main generator was saved, the hospital could not use it because the conduits and wires on the ground floor were wet. Ten KVA generators became available after about a week courtesy of the City of Davao, through Mayor Rodrigo Duterte. These small generators were used to efficiently energize individual departments such as surgery and delivery.

f) Finally, the elevator was damaged making the ramp very useful during emergencies.

5) Tacloban Maternity Hospital

The Tacloban Maternity Hospital is a two-story building with a metal roof. It was fully inundated up to the second floor level. This Hospital totally close down after the destructive event and is generating funds for full rehabilitation.

The damages include:

a) Blown off roof, ceiling, jalousie windows, interior partitions, equipment, furniture and supplies.

b) Damaged laboratory equipment and X-ray unit.

c) Damaged Operating/Delivery Room Complex rendering it unusable.

d) All administrative records and files were lost.

6) Tacloban Doctors Medical Center

The Tacloban Doctors Medical Center is a modern building; four floors in front and five floors at the rear. Being the newest hospital built in the City of Tacloban, it has blue glass-cladding in the whole front facade, making it look like a state-of-the-art facility, similar to the latest buildings in Metro Manila.

The hospital building was severely hit by high winds in the front façade, breaking the glass cladding and allowing the water to penetrate the areas in front. Since the emergency department was in front, there was slight flooding about an ankle deep in the area.

The imaging equipment located deep inside the building remained intact, including the CT-scan, the MRI and the x-ray equipment. In fact immediately after the incident, the hospital's CT-scan was the only one functioning in the whole of Tacloban City. Likewise the OR/DR Complex remained functioning together with the Dietary Department which were located in the rear second floor of the building.

The damages in the Tacloban Doctor's Medical Center can be summarized as follows:

a) Blown off front glazing and blown-off roof in the front building and the covered roof deck at the rear;

b) Damaged ceiling from inward wind pressure and damaged second floor in front from rainwater penetration;

c) Some ward rooms and ICU unusable due to blown-off ceiling and windows;

d) Blown-off unit type air-con units in some ward rooms;

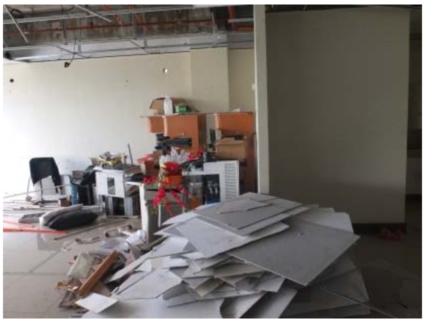
e) Damaged administrative office located at the front;

f) CSSR sterilizing equipment destroyed due to wind/rain penetration through broken window glazing;

g) Wind through end-corridor broken windows damaged ceiling systems and doors;

h) Elevator not functioning thereby making the ramp useful.



8.3 General Strategies for Mitigating the Effects of Typhoons and Flooding on Hospitals Safe From Disasters

In the book, "A Guide for the Planning and Design of Health Facilities Safe from Disasters" by Prof. Cristopher S. P. Espina and Arch Fiel Reventar, it is described that there are three levels of defence against natural hazards leading to disasters, tsunamis, typhoons and flooding included. The storm surge should have the same effect as these.

1) Level 1: Site proximity to hazard

The first level of defence is locating the building as far as possible from the hazard. Obviously, this entails many limitations but it cannot be denied that the best defense is through avoidance of danger.

2) Level 2: Site design solutions

The second level of defence is through site modification approaches. If and when the site is limited to a location with identified hazards, architects and engineers must look for answers to make the site suitable for building.

3) Level 3: Building design solutions

The final level of defence is by means of architectural and engineering solutions on the building itself. The building must serve as man's shield from hazards; therefore, everything in the building should protect its occupants from any strike.

A. Strategy for Tsunami Design (and Storm Surge)

1) Elevated Evacuation Refuge

For coastal communities, FEMA suggests the importance of creating a vertical evacuation refuge. This is a building or any elevated area in which the community can take refuge after tsunami warnings are given. Taking on this concept, health facilities located within the tsunami hazard zone should have an elevated evacuation refuge solely for their occupants. Logically, such facility should incorporate all design concepts to mitigate hazards that come with tsunami events such as floods, high winds and seismic activities.

B. Strategies for Flood Design

1) Flood Risk Prevention

Designers must refer to hazard maps and be aware of flood-prone areas to prevent the building of essential facilities such as health facilities in such sites.

2) Structural Site Filling

Structural site filling is a concept that can be used to protect the building from rising levels of water. This concept answers the depth and hydrostatic load factors of flood design. When the site is elevated above a certain established flood level, the building is spared from flood loads and may be able to continue operations.

With this concept, the Flood Emergency Management Agency/US Federal Insurance Administration (FEMA) defines the following sub-concepts for structural site filling that should guide designers:

- Base flood - is also known as the "100-year flood" or a flood having a one in one hundred chance of being equaled or exceeded in any given year.
- Base flood elevation (BFE) – is the computed elevation to which floodwater is expected to rise during the base flood. The BFE in moving floodwaters is adjusted and measured from the crest of the cascading waters.
- Design flood elevation (DFE) – is the computed elevation set by the community usually 300 mm or more above the BFE.

3) Flood Barriers

Flood barriers are in the form of levees or floodwalls which are solutions to impact loads such as debris and wave loads. A levee or floodwall is an embankment alongside a body of water which averts overflowing of water onto the site.

4) Anchorage

Like how an anchor holds the ship from sailing, the building must be properly anchored to the ground to prevent it from floating or lateral displacement when there is a flood and dislocation or collapse of its component parts.

5) Use of Flood-Proof Materials

Building materials used in construction systems below the DFE must be resistant to flood damage. According to FEMA, "flood-resistant material" is defined as any building material capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage. The term "prolonged contact" means at least 72 hours, and the term "significant damage" means any damage requiring more than low-cost cosmetic repair (such as painting).

The US Army Corps of Engineers (USACE) has classified flood-resistant materials from Class 1, unacceptable and not resistant to water damage to Class 5, acceptable and highly resistant to floodwater damage.

6) Flood-Proof Construction Details

Health facility design details should show how to minimize flood damage by elevating above the base flood level or by designing dry flood-proofing measures which will seal the building from flood water penetration.

7) Critical Systems

Buildings shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components.

C. Strategies for Wind Load (Effect of Typhoon)

1) Equilibrium due to weight

The concept of equilibrium due to weight pertains to the ability of the building to maintain balance between weight and wind forces. In this concept, a person blowing a pencil off the table is no different from wind blowing on a building. In other words, if the building weighs at least as much as the wind force, then equilibrium is obtained, hence, the building is safe from not getting blown off.

2) Accurate shaping

The concept of accurate shaping is the answer to the shape factor of wind load design. The following are examples of wind being affected by shape:

- Flat surface as opposed to curved surface - Buildings that have rounded wall surfaces are less resistant to wind loads. It is also important to note that a building's surface which is plain offers less resistance or wind drag than that that is textured.
- Tall and slender buildings – Buildings that are tall and thin have a tendency to overturn and produce horizontal deflection at the top.
- Buildings whose windward and leeward walls have openings – These buildings catch the wind and produce unwanted pressures inside the building.
- Building surrounding – Elements that surround the building, including the immediate topography, perimeter landscape and neighboring building heights also alter wind velocity. For example, trees, some of which, collapse during typhoons, may topple on the building, causing windows to break. Also, roofing materials, branches and other site debris may transform into dangerous projectiles when blown by wind. Even in cities, fairly mild wind speed can modify into turbulence when congested between tall buildings.

3) Vibration absorption

Following the concept of isolation for seismic design, the concept of vibration absorption is one that allows the building to receive vibration effects due to wind but reduces these effects with absorptive materials and mechanical devices.

4) Building Protection and Shielding

Since time immemorial, human activities sought the cover of natural terrain and trees to protect shelter against the forces of wind. Furthermore, indigenous architecture used ingenious techniques of cover and shielding for protection. Among the areas that have to be protected in a health facility are:

- The roofing edge by the use of a concrete parapet
- Door and window openings by the use operable shutters

5) Less is more

The concept of less is more goes along with the concept of minimalism for seismic design. In this concept, less embellishments is safer because, more often than not, embellishments in the building, being nonstructural items, are lightweight and can, therefore, be blown away easily by strong winds.

6) Uplift Chain

Establish a reliable uplift chain generally from the foundation to the roof of the health facility but with particular attention to the roof structure as follows:

- roof frame to building frame (roof truss to beam)
- purlins to top chord or rafter
- roof sheets to purlins

7) Redundancy

Redundancy is ensuring the integrity of the building's cladding (roof, walls, doors and windows) to prevent the penetration of wind through increase in sizes, support, shielding and anchorages by proper detailing and construction.

8.4 Post Haiyan Recommendations on Simple Design and Construction Practices for Hospitals Safe from Typhoons and Storm Surges

These recommendations are covered by the general strategies as described in section 1.2 above but are commonly overlooked when constructing hospital buildings. The purpose of these recommendations therefore is to translate in layman's terms simple design and construction practices which may mitigate the harmful effects of hospitals subjected to typhoons and storm surges.

A. On Design Practices

1) In general, on typhoon risk areas and areas subjected to flooding and close to shore, it is wise to raise the main floor level of the hospital such that the following are protected from water:

· Food – which is essential for the needs of patients and staff during and after an event.

· Medicines and medical supplies – coming especially from the pharmacy, central supply, CSSR.

· Imaging equipment – in the Radiology Department.

· Laboratory equipment and supplies – for testing infections during epidemics.

2) In the process of site planning, identify the risk areas and risk directions and provide barriers for cover:

· Strong concrete fence on the side of the risk direction

· Hurricane shutters for glass windows and doors

· Avoid any uncovered opening on the side of the risk direction

3) Ensure that the hospital can be fully enclosed with strong covers all throughout its peripheries during typhoons. No strong winds shall be able to penetrate inside the hospital plant and cause internal wind pressures. All vents, windows, doors and other openings shall be fully covered during typhoons. Double covering is recommended for door and window openings in risk areas and risk directions; the sashes itself and an additional cover such as window shutters and door shutters.

4) Provide a ramp to connect the following departments – Surgical Department and Wards, Emergency, ICU, Radiology and Dietary Departments to ensure the following wheeled connections:

· Emergency to Surgical

· Emergency to and from Radiology

· Surgical to and from Surgical Wards, ICU

· Wards to and from Radiology

· Dietary to and from Wards

5) Distribute hand-washing facilities evenly throughout the hospital, especially in possible surge areas for hygiene-promotion and infection control during epidemics.

6) Identify surge areas and locate provisions for hand-washing, toilet and bath facilities for possible surge of patients during and after a disaster.

7) Design exterior concrete signages for hospital identification instead of metal, plastic or other flimsy materials.

8) Use Big-V roofing sheets of adequate thickness rather than corrugated sheets of standard thicknesses for stronger resistance against strong winds.

B. On Construction Practices

1) Ascertain the BFE when establishing the building's vertical dimensions. The ground floor elevation shall be at least 300 mm above the BFE.

2) Ensure that doors and windows are well-anchored to the building structure, especially on the windward and leeward surfaces of the building.

3) Ensure that door and window openings are double-covered on risk areas and risk directions --- from wind and water surge.

4) Strengthen and fasten eave soffit to avoid a breach during wind uplift. Use adequate compressive vertical

frames as well as thick finishing material for the soffit.

5) Cover the roof edge with a boxed gutter of concrete or wood rather than an open gutter. Securely fasten metal fascias with steel framing.
6) Use bolts and/or metal anchors and plates to securely anchor the truss to the building frame.
7) Use metal or wood cleats to fasten purlins to the top chord or rafter.
8) Fasten roofing sheets to purlins by using U-bolts with rubber washers to augment tekscrews on roof areas.
9) Securely fasten window-type as well as outdoor units of split-type air-conditioning units to the buildings structural frame. For window-type ACUs, anchor A/C cover as well as the A/C unit to the concrete edges. Raise outdoor condensing units above BFE and fasten securely to concrete platform.
10) Avoid building exposed and flimsy metal roofs on the top floor. Protect the top floor roof with a strong roof, a strong ceiling and with exterior window walls completely enclosing the area.

C. On Hospital Operations

1) Institute operational systems that will decentralize the service functions to each department in terms of food supplies, medical supplies, equipment and utilities.
2) Equip possible surge areas with electric power, lavatories, access to water and access to toilet and shower facilities.
3) Supply each department with small capacity, easy to handle generator for emergencies.

8.5 Conclusion

Today, construction practices are encompassed by the use of modern materials and systems. Unfortunately, these new practices lack the practical side of traditional design features. The principles of statics, dynamics, strength of materials and correct methods of construction are somehow lost in the way parts of modern buildings are made. Hopefully, this paper will lead to the recognition of the simple construction methods that are needed to mitigate the destructive effects of typhoons, floods and storm surges on health facilities.

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9. Data Acquisition and Field Survey in Cebu and Basey

9.1 Introduction

Typhoon Yolanda (Haiyan) widely affected urban areas in Philippines. It damaged 1,140,332 houses as of January 14, 2014: heavily 550,928, and moderately 589,404 (NDRRMC, 2014).

IRIDeS organized a team for research on the post-disaster recovery support and sent them to the areas affected by the typhoon and tidal wave three times in January, February, and December 2014.

The purpose of the surveys is to obtain several data, materials, and useful information for long-term post-disaster recovery research in Philippines, and to clarify specific problems toward its urban recovery.

9.2 Itinerary

The authors, members of the post-disaster recovery research team, conducted three surveys in January, February, and December in 2014. The following is the itinerary and a map showing the visited place (**Fig.9-1**).

[Reconnaissance in January 2014]

Sunday, January 19:

21:30	Arrive in Manila

Monday, January 20:

-12:00	Interview, JICA Philippines Office
-15:00	Survey of statistic data, International Statistics Office
-18:00	Gathering materials and information

Tuesday, January 21:

-12:00	Gathering supportive information for field surveys
-14:00	Meeting with travel agencies
-16:00	Gathering materials and information
-17:30	Survey of maps and geospatial data, National Mapping and Resource Information Authority

Wednesday, January 22:

09:45	Depart for Tokyo

[Field Survey in February 2014]

Sunday, February 16:

21:30	Arrive in Manila

Monday, February 17:

-11:00	Purchase of statistic data, International Statistics Office
-13:00	Meeting with Social Housing Finance Corporation
-14:00	Purchase of maps and geospatial data, National Mapping and Resource Information Authority
17:00	Depart for Cebu

18:15 Arrive in Cebu

Tuesday, February 18:

-15:30 Field survey in Medellin: Community-led Disaster Rehabilitation Project

-16:00 Interview, Kawit Barangay Office

-17:00 Interview, Municipality of Daanbantayan

Wednesday, February 19:

06:00 Depart for Tacloban

06:40 Arrive in Tacloban

-09:30 Visit to some damaged areas in Tacloban

10:00 Arrive in Basey

-17:00 Field Survey in Basey

Thursday, February 20:

-12:00 Interview, Municipality of Basey

-15:30 Field Survey in Basey

16:45 Depart for Manila

18:00 Arrive in Manila

19:30 Interview, JICA Philippines Office

Friday, February 21:

10:00 Depart for Tokyo

[Additional Field Survey in December 2014]

December 16: Arrive in Manila

December 18-19: Field Survey in Cebu and in Basey

December 20: Depart for Tokyo

Fig.9-1. Areas visited for Surveys

9.3 Data Acquisition and Statistical Analysis

Spatial information and regional statistics are essential to understand the characteristics of affected areas and to conduct effective measures for recovery and reconstruction planning after calamities. Immediately after Typhoon Haiyan stroke the Philippines in November 2013, our team began to collect various spatial and statistical datasets available on the Internet. Thereafter, during our field surveys conducted in January and February 2014, we visited the National Statistics Office and the National Mapping and Resource Information Authority in Manila, the Philippines, to negotiate about data provision. In this section, we will first provide an outline of spatial and statistical database we obtained. We will then analyze characteristics of areas affected by Typhoon Haiyan based on the datasets.

We obtained the following datasets:

Online free sources: Due to the pervasiveness of the internet and systems like Google Earth and OpenStreetMap, international collaborations about mapmaking were easily achieved. Through the accumulation of such individual and research institutions' efforts (so-called volunteered geographic information), numerous datasets were created and disseminated. For example, OpenStreetMap team started to prepare a map of Philippines before the typhoon made landfall (http://wiki.osm.org/wiki/Typhoon_Haiyan). It reported that, as crisis mapping response, over 4.5 million objects were modified by over 1,600 volunteered mappers until 11th December 2013. The maps include polygons of buildings with damage assessments and post-disaster satellite imageries in the affected areas.

At the same time, several portal sites gathered such information and provided them through their websites. Spatial datasets ranging from administrative boundaries, roads, background imagery etc. to Typhoon Haiyan path, building footprints, damage assessment etc. were obtained. A homepage of Philippine GIS Data Clearinghouse (http://philgis.org/) exits before the typhoon disaster and it aims to provide GIS datasets for education and non-profit use on volunteered basis. It distributes a wide range of thematic maps in vector and raster formats such as municipality boundaries, population counts, roads, rainfalls, elevation, vegetation etc. GIS companies such as ESRI (GIS company) not only collects various information on Typhoon Haiyan but also distribute them via their ArcGIS Online System. Some of them are downloadable as a shapefile format. In public domain, Project NOAH operated by DOST (Department of Science and Technology, Republic of the Philippines) set up Yolanda Special Site. This site converted the number of death and injured in a report of NDRRMC and provided in KML format. Currently, those maps are viewable but no longer downloadable.

A list of useful web sites is presented below:

・Humanitarian OpenStreetMap Team
URL http://hot.openstreetmap.org/projects/typhoon_haiyan

・ArcGIS Online

URL http://www.arcgis.com/home/item.html?id=b5226c1f85954be0891b07ba43 b6e952

・Project NOAH(Nationwide Operational Assessment of Hazards)

URL http://noah.dost.gov.ph/

・Typhoon Yolanda Geonode

URL http://www.yolandadata.org/

・PhilGIS (Philippine GIS Data Clearinghouse)

URL http://www.philgis.org/freegisdata.htm

・Copernicus Emergency Management Service EMSR058

URL http://emergency.copernicus.eu/

Situation Report on the Effects of Typhoon Yolanda: The National Disaster Risk Reduction Management Council (NDRRMC) published a situation report about Typhoon Haiyan every day. Over 100 reports were put on the website (URL: http://ndrrmc.gov.ph/index.php?option=com_content&view=article&id=1125%3Asituational-report-re-preparations-for-typhoon-qyolandaq&catid=1%3Andrrmc-update&Itemid=1). While contents of the reports differ slightly, they usually contain an updated list of victims and their characteristics such as age, sex, municipality and cause of death/injury. They also have statistical tables about human and housing damage and,and humanitarian assistance. We converted the list of victims and selected statistical tables to Excel format to link with our spatial databases in ArcGIS.

Census of Population and Housing 2000 and 2010 (CPH2000, CPH2010): The National Statistics Office (NSO) conducts the Census of Population and Housing every five years. The latest survey was conducted in May 2010 and already published. CPH 2010 consists of several forms. Of them, CPH Form 2 was distributed to all persons and households in the Philippines (i.e. a complete survey). We contacted the NSO about data provision in January and February 2014 and they appreciated the purposes of our data use and kindly provided CPH 2000 and 2010. Specialized software (CS Pro) for census operation was used to assist data manipulation, tabulation and export.

CPH Form 2 contains questions about both demographic attributes such as age, sex, and education level of household members and housing attributes such as type of building and construction materials of houses in which people reside. Since a large number of houses along the coast were washed away by the storm surge, we cannot survey construction materials from fieldwork and satellite imagery in same detail as from the census. CPH 2010 is the only data source to understand housing characteristics of affected areas before Typhoon Haiyan. We therefore tabulated the dataset by a selected demographic or housing variable and municipality to create thematic maps.

Datakit of Official Philippine Statistics (DATOS): DATOS is a collection of various statistics at barangay and municipality level. It contains information of (1) the number of facilities (hall, hospital, school, telephone, electric power etc.) at barangay level, (2) the number of establishments by types at the municipality level and (3) official population counts for 1980, 1990, 1995 and 2000. DATOS also includes ESRI Shapefiles of provincial and municipality, barangay boundaries for mapping datasets in DATOS as well as tables tabulated from CPH 2010.

Large scale urban maps of Tacloban and Ormoc (**Fig.9-2**): The National Mapping and Resource Information Authority (NAMRIA) published different types of maps. Large scale maps are however limited to large cities and they have not been updated frequently. CAD maps for Tacloban and Ormoc cities were fortunately available although they were last updated in the late 1990s. These CAD maps were converted to ESRI Shapefiles to overlay them with other maps. The maps contain shapes of buildings, elevation, roads, vegetation, etc. These large scale maps are useful for base maps for damage assessment and urban expansion analysis.

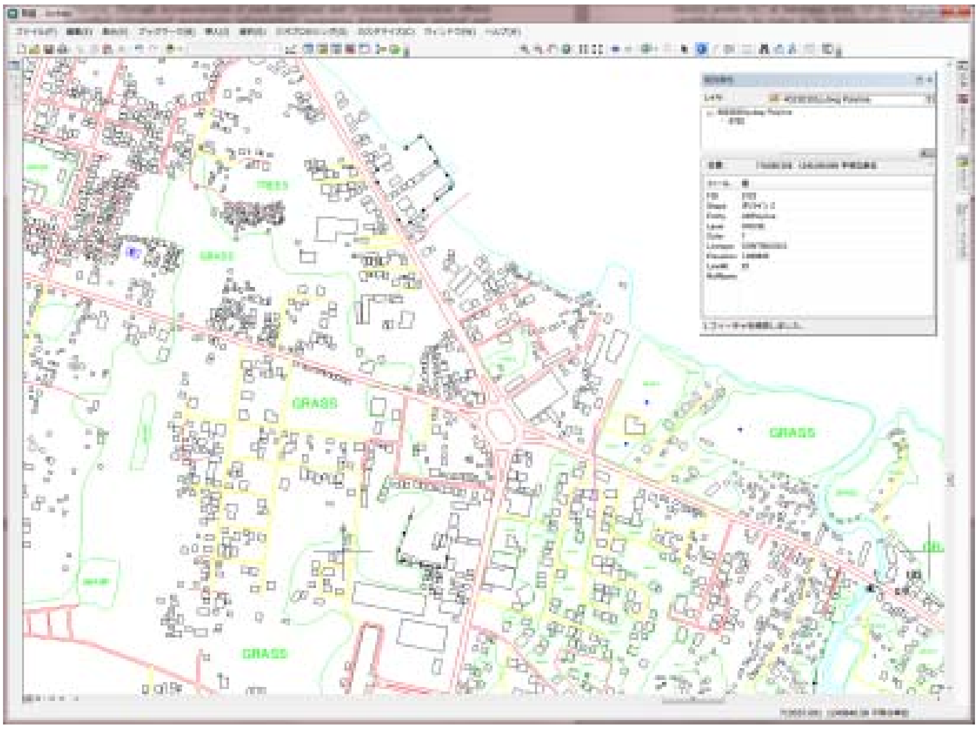


Fig.9-2. A large scale urban GIS map of Tacloban.

<u>Analysis based on datasets we obtained:</u>

By using situation reports on the effects of Typhoon Haiyan by NDDRMC, spatial distributions of housing and population suffered from Typhoon Haiyan are mapped in **Fig.9-3** and **Fig.9-4**.

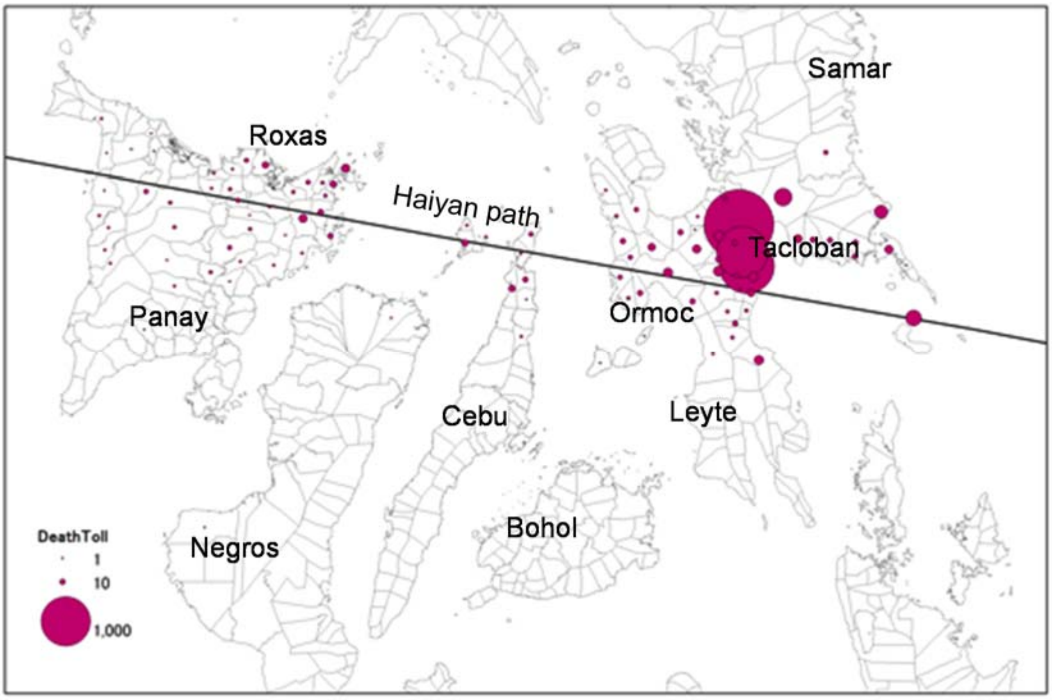


Fig.9-3. The number of death (Source: NDDRMC Situation Report).

Fig.9-4. The number of houses damaged by Typhoon Haiyan (Source: NDRRMC Situation Report).

According to **Fig.9-3**, a large number of the dead were mainly concentrated in municipalities around Tacloban City where an extremely high storm surge and strong wind speed were recorded. On the other hand, the number of houses damaged is larger not only around Tacloban City but also in municipalities along the storm track. Inland municipalities also had housing damages possibly because strong wind destroyed rural houses constructed by light weight natural materials **(Fig.9-5**).

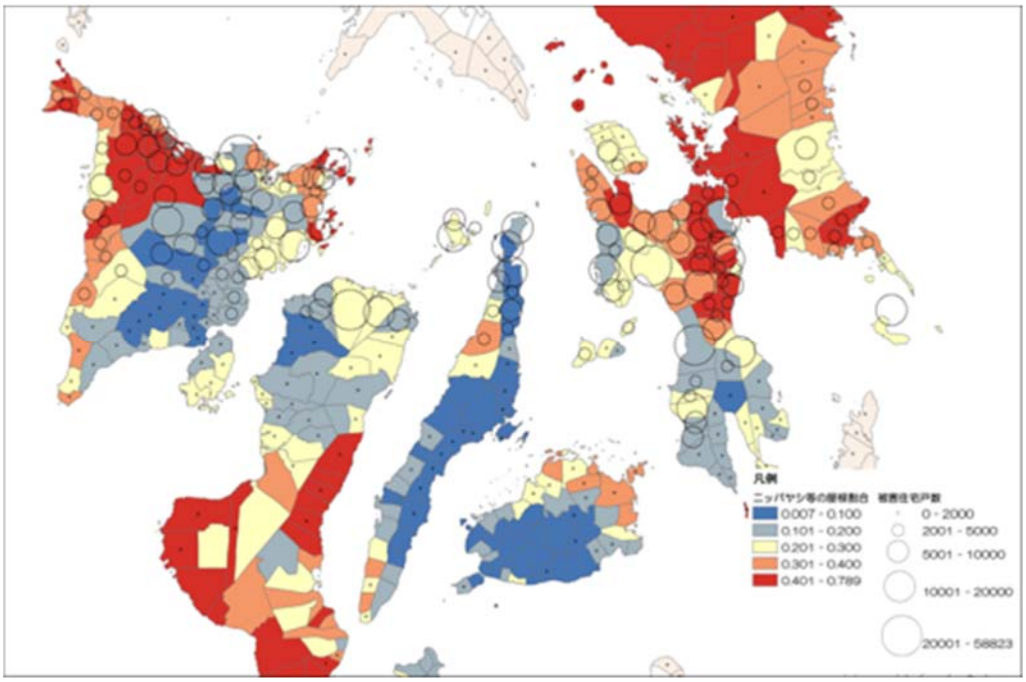


Fig.9-5. Proportion of houses with cogon/nipa/anahaw roof (Source: CPH2000).

In order to understand characteristics of the dead, we first tabulated counts by sex or age categories of victims and then estimated the total counts of the dead and injured per 10,000 people (**Fig.9-6**) based on population in CPH 2010. Our initial survey revealed males and the elderly are more likely to have suffered from Typhoon Haiyan. In particular, people aged 70 years old and over are ten times more likely to be killed.

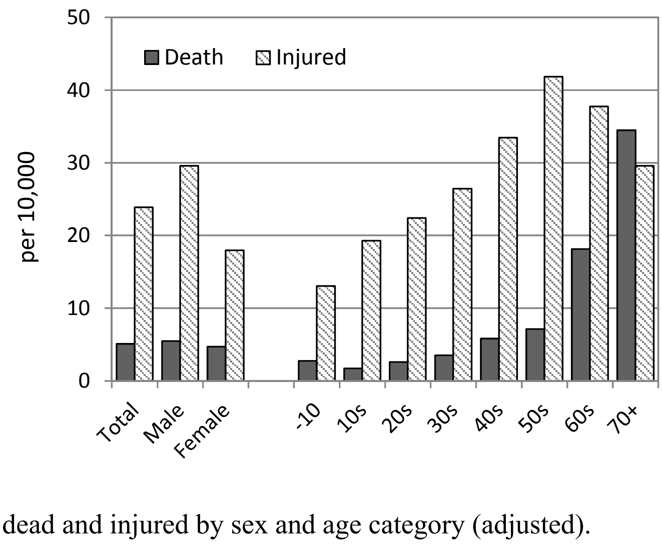
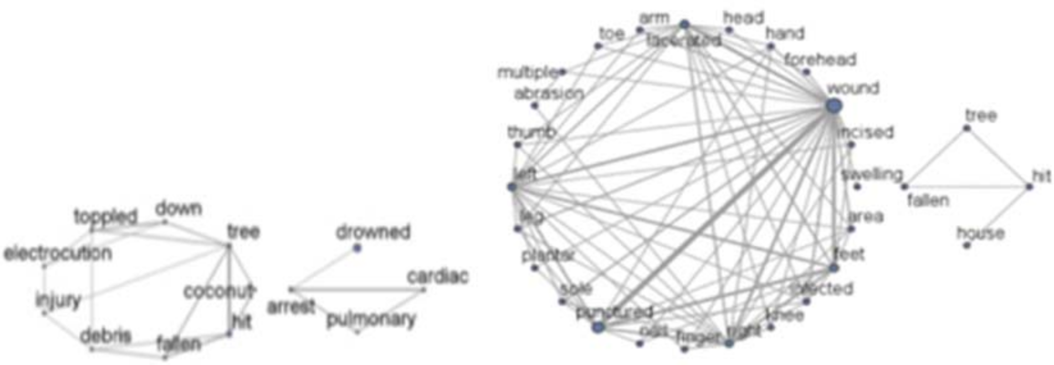


Fig.9-6. The number of the dead and injured by sex and age category (adjusted).

We experimentally applied text mining to words used to describe causes of death or injury in the list of victims for estimating possible causalities. **Fig.9-7** presents co-occurrence of words after excluding "previously reported unidentified". Ranked by the number of times they appeared in the list, words are classified into three groups. The first group relates to “drown” (including “drowning”) which suggests that people were killed by storm surge. The second group includes words like “cardiac” and “arrest”, which also suggest an association with “drown” to some extent. The third group contains “tree”, “debris”, “hit”, “fallen” and “toppled”. Since these words were used concurrently, many people were possibly killed by collision caused by strong wind. On the other hand, “wound” (including “wounded”), “punctured” and “lacerated” appeared often with words relating to human body parts. These co-occurrences imply that people became injured during their evacuation.



causes of death causes of injuries

*Size of circle represents the number of times a word appeared in the list.

Fig.9-7. Co-occurrences of words used for describing causes of death and injuries in the list of victims.

To understand relationships between the number of death or damaged houses and regional vulnerability at the municipality level, we further conducted a statistical analysis based on a negative binomial regression model. The 259 municipalities highly affected by the Typhoon Haiyan were included as a study area. Our major findings are as follows:

(1) The number of death and damaged houses are determined by not only physical characteristics such as distance from the Typhoon Haiyan and structure of buildings but also social characteristics such as regional poverty and education level. Such social vulnerabilities lead to expanding and exacerbating damages by the typhoon because poverty deprives of educational opportunity and it results in living in makeshift houses in coastal area and having less preparation and ability against disasters.

(2) In the study area, the degree of urbanization negatively relates to the number of damaged houses. However, urbanized municipalities with high poverty rate increased risk of the damages. This result indicates that since rapid urbanization is often accompanied by expansion of poor neighborhoods along the coast where vacant land is only available near the city center, deprived people have to build houses on high-risk areas without appropriate disaster protection such as sea walls.

(3) We estimated that, in the study area, to increase a proportion of concrete houses by 10 percent will save over 180,000 houses. In addition, to reduce poverty rate by 5 percent or to increase a proportion of high school graduates will save over 1000 people and 2000 people respectively. In the long run, it is necessary for the Philippine

government to continue comprehensive efforts to improve both housing qualities and human capitals to reduce disaster damages overall.

9.4 Field Survey in Basey

(1) Outline of the survey

Municipality of Basey is located in Samar Island, the northeast of Tacloban. According to a material obtained in the field survey, Typhoon Yolanda caused 235 casualties including missing people, and 714 injured people, and affected 15,583 families and 50,423 people in the municipality. The number of heavily damaged buildings is 7,175 and moderately damaged is 5,048.

The post-disaster recovery research team carried out field surveys to record the building damage conditions in Basey (**Fig.9-8**) in February for long-term post-disaster urban recovery monitoring. The team visited the Municipality Office to get information on the regional damage in order to understand the data obtained by the survey. We also interviewed people living in the coastal areas and in temporary housings who were affected by the typhoon.

Fig.9-8. Map of Basey used for the Field Survey

(2) Record of building damage conditions

The building damage recording method the team applied in the survey was as follows.

At first, we defined the boundary of objective areas that were affected by the typhoon and determined the driving route based on the map (**Fig.9-8**). Then we took a record of all buildings in the area with GPS driving recorder on a car. **Fig.9-9** is a building distribution map in terms of building materials in Basey. The building damage conditions are classified into four categories: completely damaged, heavily damaged, moderately damaged, and slightly damaged (**Fig.9-10**).

These obtained dataset will be useful for building damage analysis.

Fig.9-9. Building distribution map in terms of building materials in Basey

Fig.9-10. Damaged and restored buildings in Basey

(3) Recovery conditions as of February 2014

As well as the recording of damage condition, the team visited Municipality of Basey and interviewed Municipal Mayor, a staff in City Planning Department, and victims to understand recovery conditions and problems they were facing (**Fig.9-10**).

One of the significant problems for affected residents living in coastal areas was landownership. The government would adopt building regulation in the coastal zone within 40m from the coastline. It would influence their recovery situation and resettlement.

Another problem for the victims was a criterion to live in a temporary house such as the number of children they have. There is a temporary housing place on the outskirts of the town (**Fig.9-8**) and each household area of the house is about 6m^2. Some people who lost their houses had to keep living in a damaged area because they did not meet the criterion.

The recovery plan was under consideration when the survey was conducted.

Fig.9-10. Gathering information in the Municipality Office and temporary housing

9.5 Field Survey in Cebu

(1) Outline of the survey and building damage conditions

The north of Cebu is non-tourism development zone as compared with other areas in Cebu island. According to NDRRMC report (2014), the number of damaged houses remained at 24,373 houses (18,752 completely / 5,621 slightly) and 8 persons were killed in the north of Cebu (Total amount of Municipality Daanbantayan and Medellin) by typhoon Haiyan. When we conducted a field survey in February 2014, we found collapsed buildings everywhere (**Fig.9-11**, **9-12**). Our team conducted interviews focusing on how to provide recovery support for victims by NGO and the local government in Barangay Kawit (**Fig.9-13**).

Fig.9-11. Completely damaged buildings in Barangay Kawit, Cebu (before and after repairing)
Basketball gymnasium (left) and private concern (Right)

Fig. 9-12. Slightly damaged buildings (roof and windows) in Medellin, Cebu

Fig. 9-13. Field survey area in Cebu

(2) Recovery conditions as of February and December 2014

As of February 2014, the affected area in Cebu conducted self-reconstruction by victims. In addition, NGO provided temporary employment and housing reconstruction support, and local governments of Cebu provided the food supply assistance. However, we could not confirm financial assistance, localized recovery, or reconstruction plans for the affected areas in Cebu by the governments.

After 10 months (As of December 2014), we could be confirmed the progress of some completely damaged buildings repaired like **Fig.9-11**. However, some of public facilities were recovered half of the total due to luck or fund.

(3) Support activity by NGO

In Barangay Kawit in Cebu, we contacted NGO staffs (Joint team of Lihok Filipina Foundation, Pagtambayayong Foundation and PhilDHRRA) to inquire about support for the victims. They were providing temporary employment support (Clean up the shack, Php300.00/day), housing support (Construction of starter houses, Php8,000.00/unit and repair of housing units, Php4,000.00/unit) and others (**Fig. 9-14**) for the victims. In addition, the standard of support should be made for the victims was determined by DSWD (Department of Social Welfare and Development) based on damage level of housing etc.

Temporary houses (Starter houses provided by NGO) were located in the area 200m away from the coast. The

Community-Led Disaster Rehabilitation Project (Barangay Kawit, Medellin, Cebu)
Project Duration: December 2013 – April 2014

Project Components

Employment Generation & Livelihood (Cash for Work)
Php 300.00/day inclusive of 3 months SSS and 1 year Insurance
Construction of Starter Houses @Php8,000.00/unit
Repair of Housing Units @Php4,000.00/unit
Construction of Communal Toilet & Bath @Php60,000.00/unit
Provision of Hygiene Kit @Php50,000.00/Toilet
Information and Education Inputs/Activities
Psychosocial activities and support

Fig. 9-14. Support for victims by NGO in Barangay Kawit, Cebu

houses were composed of simple structures such as wooden frameworks, tin roof and walls, and the material used were blue tarpaulin, wooden board and bamboo fence etc (**Fig.9-15**). To conduct this project, NGO faced two problems: how to provide clean water, and how to collect the fund and materials since Philippine Government didn’t establish a housing support system.

As of December 2014, we could be fined the start of constructing Permanent houses in Daanbantayan and Bogo city. In case of Daanbantayan, permanent houses are provided by UN-Habitat and constructing the method of lightweight steel-frame building (**Fig. 9-16**).

In another case of Bogo city, there are constructed new residential area called the “Yolanda Village”.

At this area, it's already started to relocate the victims (**Fig.9-17**).

Fig 9-15. Temporary houses (Starter houses provided by NGO) in Barangay Kawit, Cebu

Fig. 9-16. Permanent houses provided by UN-Habitat in Daanbantayan, Cebu

Fig. 9-17. Permanent houses located in Bogo city, Cebu

(4) Support activity by Government

According to Barangay officers in Kawit, they provided food support for the victims, but they did not establish housing support system by government. Therefore, they needed to depend on NGO for the main part of housing reconstruction assistance.

To start recovery process, Philippine Government decided to set “no-build zone” by Recovery Plan (2014) in order to prohibit housing constructions within 40m from the coast and ensure the safety for residents. However, the residential area has already existed in the coastal area in Kawit before Typhoon Haiyan. Barangay Captain tried to encourage residences to move inland, but it was not so effective for them. Therefore, barangay officers think it is hard to keep no-build zone.

References

National Disaster Risk Reduction and Management Council (NDRRMC) (2014): Effects of Typhoon “Yolanda” (HAIYAN), NDRRMC Update –Sitrep No.108, April 3, 2014.

10. The Post-Disaster Phase of Transitional Settlement: A Perspective from Typhoon Haiyan in the Eastern Philippines

Group members

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2. Dr. Joanna Faure Walker (UCL-IRDR)
3. Mr. Joshua Macabuag (UCL-EPICentre)
4. Assoc. Prof. Anawat Suppasri (Earthquake induced Tsunami Risk Evaluation, IRIDeS)

10.1 Collaboration between UCL-IRDR and Tohoku University IRIDeS

The field mission to the Philippines to assess post-disaster recovery was part of an ongoing collaboration between University College London Institute for Risk and Disaster Reduction (UCL-IRDR) and Tohoku University International Research Institute of Disaster Science (IRIDeS). It was planned following a symposium on disasters held by UCL-IRDR and IRIDeS in London during November 2013. Prior to that, a UK-Japan workshop on disaster risk reduction entitled "Learning from the 2011 Great East Japan Earthquake" took place in Tokyo during October 2012 (Faure Walker et al. 2013). UCL-IRDR, UCL EPICentre, and IRIDeS members also collaborated as part of the EEFIT team which assessed the recovery process two years after the 2011 Great Eastern Japan Earthquake and Tsunami (EEFIT 2013). The text in this chapter is included within the IRDR Special Report 2014-01 "The post-disaster phase of transitional settlement: A perspective from typhoon Yolanda (Haiyan) in eastern Philippines".

10.2 Mission Aim

The aim of this field mission was to compare the effects of domestic and imported aid and assistance on the quality and speed of recovery. Another aim was to assess vulnerability during the transitional phase between the initial emergency and long-term recovery and reconstruction. The mission focused on households and the physical structures in which they live. It also considered socio-economic influences upon resilience and the role of insurance in reducing the impact or increasing the rate of recovery. Specifically, the team carried out systematic surveys of the quality of building repairs and reconstruction processes in conjunction with questionnaire surveys of the householders who inhabited the structures. In addition, key professional personnel were interviewed.

10.3 Survey Methods

A brief fieldwork campaign was conducted during March 2014, four months after the typhoon. Some 160 households were surveyed in 12 coastal Barangays (districts) of Tacloban, Palo and Tanauan in the province of Leyte, a part of the Philippine region of Eastern Visayas. According to 2010 census data, the survey covered about 2, 5 and 5 per cent of the population of these municipalities, respectively. The questionnaires were accompanied by a structural engineering survey of respondents' living quarters, which helped verify statements made about the processes of building shelter and established the quality of the shelters in terms of resistance to future typhoons.

Fig.10-1. Prof. David Alexander and Dr. Joanna Faure Walker interviewing a resident in Tanauan.

Fig.10-2. Joshua Macabuag and Dr. Anawat Suppasri conducting a survey of a house in Palo.

10.4 Need for Research on the Post-Disaster Transitional Phase

Research into risk and disaster reduction and post-disaster recovery is often focused on either the immediate emergency response phase or the long-term permanent recovery phase. Much less studied is the transitional phase, which begins when immediate relief winds down and continues into the start of permanent reconstruction. Some authors (e.g. Omidvar and Binesh 2012) have argued that there should be a direct passage from early recovery to final reconstruction, with the elimination of the transitional phase. Others (e.g. Alexander 2013) have probed the ways in which transition can become consolidated and institutionalised such that it reduces the impetus for full reconstruction. Meanwhile, evidence is mounting that attempts to shorten the duration of the transition between emergency response and full-scale reconstruction may involve skimping on design and consultation processes. As a result, policies may be implemented that are dysfunctional and do more harm than good (Ingram et al. 2006).

10.5 Themes

Regarding the emergency phase of the typhoon disaster, we were interested in assessing the effectiveness of warning messages and evacuation procedures, as well as that of aid and assistance. With regard to the families that lived in the path of the storm, we examined how socio-economic status affected recovery, and the extent to which employment suffered. We enquired into the means by which shelter was provided and constructed, and evaluated its effectiveness and safety in the face of continuing natural hazards. We were particularly interested to find out whether families had received expert help when shelter was reconstructed, and, if so, what impact this may have had on the safety of transitional dwellings. We also looked into the security and tenure of families, especially in the light of the Philippine Government's declaration of a 'no-build' (i.e. set-back) zone that will stretch 40 metres inland from the shore. Finally, we asked what future prospects families envisaged after their homes had been severely damaged or destroyed by the typhoon.

Various secondary questions arose from our survey work in the barangays. Was expertise on natural hazard resistance being utilised in the construction industry in order to make temporary shelters safe against wind and water damage during typhoons? What was the level of uptake of hazard insurance and what was the degree of interest in insurance (or possibly micro-insurance) schemes that cover typhoon damage? As judged by the recipients of aid, did the Government and NGO relief agencies perform well during the early stages of the disaster? How well did they succeed in providing assistance to the needy and stabilizing the situation at the local level?

What is the relationship between transitional settlement (in particular, transitional shelter), long-term reconstruction and overall economic and human development? Did the transitional situation offer any clues regarding the outcomes in the longer term? In the areas we studied, are opportunities for development and vulnerability reduction being taken or ignored? In other words, does the ongoing process of recovery in the Philippines embody any sense of 'bounce-forward' (Manyena et al. 2011), or building back to higher standards of resilience?

10.6 Key Findings and Recommendations

Our findings relate to a variety of elements of the situation. The first of these is **evacuation** prior to the arrival of Typhoon Haiyan. The standard practice was for evacuation warnings to be disseminated to individual households by Barangay leaders. Almost two thirds of households that participated in the survey evacuated either the whole family or most of its members before the typhoon arrived, while 8 per cent evacuated during the typhoon and 28 per cent remained in situ. Fewer of the families that remained suffered major damage to their properties that did those who evacuated, which suggests that the former anticipated lower risks by not evacuating. Of the families that evacuated, 55 per cent evacuated all members, 32 per cent left some men behind, 1 per cent evacuated children while leaving the parents behind and 12 per cent did not specify exactly who in the household left. Where men remained, the principal reason appears to have been the desire to guard property. Of 37 families in which men remained behind but women did not, we were able to verify that 13 (more than one third) suffered fatalities as a result. Overall, warnings successfully reached the majority of the people we interviewed. However, in many cases families underestimated the severity of the storm surge. Hence, the dissemination of warnings was effective, but the content less so.

The **distribution of money and basic goods** is one crucial aspect of the bridge between the emergency phase, in which mere survival is the objective, and the transitional phase, in which families must start to consider how they are going to recover in the long term. Studies show (Middleton and O'Keefe 1998) that the assistance people receive must help them recover rather than destroying local coping mechanisms (including local markets and businesses) and inducing aid-dependency. We found that almost all agencies working in the Tacloban area had furnished only minimal aid to the respondents of our survey. The Philippine Government provided basic foodstuffs, while INGOs gave hygiene kits and cooking utensils. Limited cash-for-work schemes were operated over a brief period. Over a period of two months, one INGO, acting independently of the others and of the Government, distributed cash to families. The grant varied from US$175-350 according to family size. Many of our respondents received it. Cash distributions are the subject of varied opinions in the literature (cf. Mattinen and Ogden 2006, Willibald 2006). Cash hand-outs may encourage corruption and heighten security risks. We found no evidence of these problems and instead that cash was highly beneficial in enabling people to buy building materials, subsistence foods, goods to sell in a small business or items such as fishing boats or rickshaws. However, like Mattinen and Ogden (2006), we also found that the influx of cash stimulated inflation in the price of building materials, which increased by between 20 and 100 per cent with respect to what it was before the typhoon. However, some of the increase can be attributed to a shortage of sawmill capacity. It would have helped if the Philippine Government and local authorities have endeavoured to control prices.

As mentioned in chapter 9, even though the idea of prohibiting development along the shore existed before typhoon Haiyan with the PD 1067 of 1976, the Philippine Government has again decreed that an area that stretches 40 metres inland from the current coastline will be designated as a **no-build zone** (known in other parts of the world as a ‘set-back line’), in which reconstruction will be prohibited and from which existing settlement will eventually be relocated. Local governments have been given the option to adopt or reject this measure. We found that 94 per cent of interviewees knew where the no-build zones were, and hence we conclude that the system of using large signs to indicate the no-build zones has been effective. However, despite its ease of communication, we question whether the 40m no-build zone policy is unreasonably simplistic. It does not reflect variations in hazard level with topography and may therefore lead to the underestimation of the risk in some places and its overestimation, leading to unnecessary relocation, in others.

The survey found that 99 per cent of householders interviewed did not have **property insurance**, which is consistent with national penetration rates of barely 1 per cent (de la Cruz Tendero 2013). Of those interviewees who lacked insurance, 34 per cent stated they would like it in the future, 20 per cent said it was too expensive and 38 per cent were unable to decide because they lacked basic information on the topic. Hence, we recommend that insurance companies and local government work to educate the population of high-hazard areas about whichever insurance options are available. Furthermore, we encourage those who are investigating alternative low-cost insurance options (possibly micro-insurance) to continue their work.

We were interested in **the pace of temporary and permanent reconstruction**. At the time of the survey, March 2014 (four months after the typhoon), 99 per cent of respondents had started temporary reconstruction, but 87 per cent had not begun the process of reconstructing their accommodation permanently. Half of the latter cited lack of money as the reason. Given the choice, 79 per cent of interviewees would reconstruct in situ, and this proportion rises to 90 per cent when one considers only households located outside the 'no-build zones.' More than half of the dwellings that we examined were built without the aid of professional advice or help. In very many cases, householders built their own transitional shelter, possibly with the aid of a local carpenter, whose qualifications and skills were probably minimal.

Those respondents who were awaiting relocation had little or no idea about to where they would be relocating or when it would happen. In terms of the demand for housing, the production of temporary shelters and the inability to start permanent reconstruction made the transitional phase of recovery inevitable, whether or not it was desirable in terms of the pathway to a stable, permanent reconstruction. It would have been helpful if local governments could have given householders more information about their plans for relocating them.

Fig.10-3. A ship that destroyed homes and subsequent transitional shelter constructed within the no-build zone in

Tacloban City.

The survey was particularly concerned with the **quality of reconstruction**. We found that shelter built by householders without the aid of training or expert advice led to the proliferation of structures that are vulnerable to typhoons and storm surges, possibly also tsunamis, which could happen during the life of such structures. Philippine and international NGOs had formulated advice on good construction practice, but we found that it did not reach the householders that we interviewed. Even those dwellings that were built by carpenters with some experience in the construction industry lacked basic measures to ensure safety and robustness. Hence, in relation to the risk of future natural hazards, communities did not appear to be "building back better."

In general, the dwellings we surveyed lacked bracing to ensure lateral stability and tended to have foundations that were too shallow. Connections between roofs and frames were inadequate and steel sheets used as roofing material had little to restrain them against high winds. Regarding timber frames, structural members had inadequate connections, and the sizes of timber used tended to be inadequate and inconsistent, especially where the lumber was salvaged from the post-typhoon wreckage.

Reinforced concrete suffered from poor compaction, over-sized aggregate, inadequate rebar cover, the use of smooth steel bars (however, mainly in older constructions) and an excessively sparing use of reinforcement. Where cinder-blocks were used as a construction material, they tended to be low quality and hence weak. Walls were too thin and few ties existed between blocks and vertical posts.

As structures that were near to each other tended to be built using similar construction techniques, it seems that both defects and strengths were disseminated locally in either active or passive mode. The Philippine Technical Education and Skills Development Authority (TESDA) runs training schemes in the form of short courses on key skills. It is intended that those who attend the courses will pass the knowledge on to others in their barangays. Unfortunately, the householders we interviewed did not seem to be aware of these programmes.

Training programmes are needed in the early stages of the transitional recovery phase. In this respect, the TESDA programmes are promising, but they need to be more numerous and more widely accessible to beneficiaries. Community-level awareness programmes involving posters and local talks can be used to demonstrate basic principles and essential details of construction. They should be used to ensure that householders understand bracing for stability, frame connections (e.g. using more one nail per connection) and roof connections (abundant use of hurricane straps and better securing of the elements of roofs). Those authorities who commission reconstruction programmes need to be given presentations and other forms of awareness programmes. They include councillors and other community representatives, municipal staff and NGO operatives who are responsible for recovery and reconstruction processes.

More detailed training is needed for those people who are professionals in the construction trade, as they can be expected to put the lessons directly into practice and retain the knowledge in their future work. Training for all professional people in the construction trades is an unrealistic goal because it would be too expensive. However, with careful management, a 'cascade system' can be used in conjunction with a construction programme that uses the "supervised self-build" model. "Training of trainers" can include mentoring processes, transfer of skills and the consequent dissemination of expertise. Examples of appropriate schemes are given in Macabuag (2010) and

Macabuag et al. (2012).

Construction Quality

General

Lack of lateral stability systems (e.g. bracing)	

Roof

Poor holding down of roof sheeting	

Timber

Inadequate and inconsistent member sizes (often because using salvaged timber)	

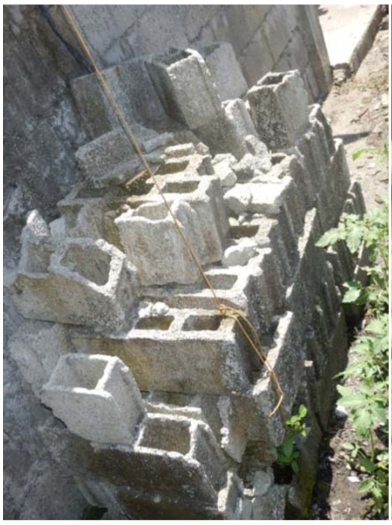
RC

Poor compaction	
Oversized aggregates	

Smooth bars	
Inadequate cover	

Block

Thin and lightly reinforced block walls	

Weak blocks	 
Overly light reinforcement	
Few ties between blocks and vertical posts	

10.7 Conclusions

The transition between emergency assistance and permanent recovery is a critical phase (Leon et al. 2009). It can determine the course of reconstruction and recovery, and contribute much to its eventual success or failure. During this period, survivors can be either lifted out of poverty and destitution, and protected against further hazard impacts, or left to languish in a state of perennial vulnerability.

Our survey showed some positive aspects of the emergency phase, particularly in the dissemination of warnings and decision to evacuate. Not all evacuation ended in success, in that the storm surge was high enough to overwhelm places such as the Tacloban Convention Centre, in which many families were sheltering. Transitional shelter was mostly erected over a period of three months, during which many people lived in precarious, makeshift conditions. Some continued to live in tents four months after the event, but repair of local infrastructure and provision of basic housing were moving ahead.

Our main finding is that, among the people and families we interviewed, natural hazard vulnerability was reproduced during the transitional phase, while employment stagnated and long-term prospects were, for many interviewees, unfathomable. Hence, an opportunity to create safety and the conditions for a “bounce-forward” recovery essentially lost, or at least deferred until an unpredictable future.

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11. Path to "Build Back Better": involvement of local stakeholders in future disaster risk reduction and planning recovery and implementation

Group members

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Objective

The main research interests of the participating researchers in this mission are community resilience, post-disaster planning and policies as well as role of local stakeholders in disaster risk reduction (DRR). Field mission aims were to learn: i) how are governments (both national and locals), Civil Society Organizations (CSOs), private sectors and communities had prepared against disasters in the past, responded as well as been recovered after Typhoon Haiyan; and ii) what are the emerging issues in recovery, in particular on resettlement and livelihood rebuilding practices.

Activities

The team visit to Manila, Tacloban and Ormoc took place 4-13 March 2014, with a follow up trip to Manila and Tacloban in February 2015. The research was primarily based on interviews with government officers, CSOs, private sector representatives, and community leaders. The list of interviewees include: the Center for Disaster Preparedness (CDP), Corporate Network for Disaster Response (CNDR), Asian Disaster Reduction and Response Network (ADRRN), the Eastern Visayas Network, Help Direct Initiative, the National Disaster Risk Reduction and Management Council (NDRRMC), Office of Civil Defense (OCD), Department of Public Works and Highways (DPWH), Philippine Institute of Volcanology and Seismology (PHIVOLCS), SRDP, Oriental Consultants, United Nations Development Programme (UNDP), UN-Habitat, Office of the Presidential Assistant for Recovery and Rehabilitation (PARR), City Government of Tacloban, City Government of Ormoc, Tacloban City Councilor, Barangay leaders from Barangay Uban, Barangay 68, Barangay 64, Barangay 59-B, Barangay 88, Barangay 31, Barangay 61, and Barangay 56-A in Tacloban, and the Barangay Luna, Guintigui-an, Quezon. Jr, Linac, Valencia, Bagong, San Antonio, and Canuntog in Ormoc. Interviews on landownership, evacuation and resettlement process, and future prospects on resettlement to the coastal residents in Tacloban City were also conducted in the second trip.

11.1 Challenges and opportunities in involvement and contribution of local stakeholders (LGUs, civil society organizations, private sectors etc.) in disaster response and recovery

11.1.1 Future disaster risk reduction (DRR) strategy in the Philippines: strengthening the DRR capacity of local government units (LGUs)

The Philippines Disaster Risk Reduction and Management (DRRM) Act or the Republic Act No. 10121 was enacted in 2010 in order to strengthen the country's institutional capacity for DRR and management and to build the resilience of local communities to disasters including climate change impacts. Under this Act, provinces, cities and municipalities have a greater responsibility in building disaster resilience of communities, and in institutionalizing DRR within their functions and operations (EMI, 2010). The Act made a paradigm shift possible in the disaster management strategy in the Philippines from the focus on emergency relief (post-disaster) to DRR (pre-disaster). This puts more emphasis on strengthening people's capacity to absorb stress, maintain basic functions during a disaster and bounce back better from disasters (DRRNetPhils, 2010).

The major characteristics of the Act are highlighted as a policy that emphasizes the needs and importance of:

- promoting involvement and participation of all sectors and all stakeholders concerned at all levels especially the local community,
- strengthening the capacity of the national government as well as the local government units (LGUs),
- mainstreaming DRR and climate change in development processes,
- recognizing and strengthening the capacity of LGUs and communities in DRR, response and recovery, and
- engaging the participation of civil society organizations (CSOs) and the private sector..

In addition, the Act transformed the then National Disaster Coordinating Council to the National Disaster Risk Reduction and Management Council (NDRRMC) and included representatives from CSOs and the private sector in the Council. Under the NDRRMC, the Regional Disaster Risk Reduction and Management Council (RDRRMCs) and the Local Disaster Risk Reduction and Management Council (LDRRMCs) were established in order to monitor and implement the action plans and ensure the integration of DRR and climate change adaptation into local development plans, programs, and budgets. Concerning the fund allocation for DRR and management, not less than 5% of the estimated revenue from regular sources is set aside as the Local Disaster Risk Reduction and Management Fund (LDRRMF) to support disaster risk management activities including post-disaster activities. Of the amount for LDRRMF, 30% is allocated as the quick response fund and 70% is allocated for DRR purposes. Furthermore, the Act encourages integrating DRR and management education in the school curricula for public and private secondary and tertiary levels of education, including formal and non-formal, technical–vocational, indigenous learning and out-of-school youth courses and programs.

While the enactment of the Act became an important chapter of the disaster management history of the Philippines and demonstrated that the Philippines has fully committed to the enhancement of DRR capacity and implementation both at national and local levels, the question of the progress and extent of the implementation of the Act still remains 3 years after its enactment. In the interview with municipalities of Tacloban and Ormoc as well as a national CSO in the Philippines, gaps were addressed in the preparedness and response capacity of cities and barangays.

City Disaster Risk Reduction Management Offices (CDRRMO) were established in both Tacloban and Ormoc and played an important role in emergency relief when typhoon Haiyan struck these cities. In Tacloban, according to the CDRRMO officer, the hazard maps to prepare for tsunamis and storm hazards were distributed and the stockpile of relief items was prepared prior to typhoon Haiyan. The contingency and disaster response plan existed. However, the resources that the city possessed, such as equipment needed for search and rescue activities were not sufficient, and in addition, most of them were washed away. A certain time was required for assistance from the national and international levels to arrive. Furthermore, in the interview of the Barangay leaders, all of them emphasized that they did not have sufficient knowledge to understand what the storm surge was and the fact that they needed to evacuate immediately.

In Ormoc, due to their former experience of the flash flood in 1991, their understanding and knowledge on disaster preparedness was high. The direct damage and impacts were also less severe compared to Tacloban. Response activities were undertaken in close collaboration with the LGUs, the private sector, and the communities. Even at the Barangay level, preparedness training and evacuation drills were provided prior to the typhoon Haiyan. It showed that the past experience of disasters can be a crucial element of awareness raising on DRR.

In the Act, the CDRRMO is provided three staff for 1) administrative and training, 2) research and planning, and 3) operations and warning. One of the national CSOs in the Philippines commented that the current capacity of the CDRRMOs was not sufficient to conduct thorough programs and tasks for disaster preparedness. Therefore, while 90% of the municipalities established CDRRMOs, most of them are not yet fully operational. Further support to the LGUs for their capacity development of DRR is urgently needed. The collaboration and joint activities/programs with CSOs and LGUs may be one of the possibilities to explore in the future.

11.1.2 Involvement and participation of new local stakeholders in disaster response and DRR

National and Local Civil Society Organizations (CSOs)

A number of international organizations were actively involved in disaster response activities after Typhoon Haiyan. In addition, the roles of the national and local CSOs in the Philippines in the disaster response should not be overlooked. In most cases of disaster response to a large-scale disaster, international organizations and agencies from outside the affected countries play a key role in the disaster response, however, the coordination and collaboration with national and local CSOs are often neglected although national and local CSOs have long-term experience working with the community for many years and understand the risks, issues and conditions at the local level. In many cases, the internationally provided assistance does not take into consideration the local culture and practices and does not have a long-term perspective and emphasis on sustainability. In addition it leads to a disaster response that does not reflect the actual needs of the communities and causes the delay of the overall response and recovery efforts. The participatory approach is crucial in the effective disaster response and recovery by encouraging the involvement of various local stakeholders.

In order to reduce the gaps in the needs of the communities and the assistance provided internationally, a CSO network in the Philippines took the lead for coordination between international organizations and national/local organizations during the response to typhoon Haiyan. The Eastern Visayas Network is a CSO network that includes various groups of women, farmers, elderly, youth organizations and multi-sectoral organization and consists of more than 30 organizations. The major objective of the network is capacity development of the member organizations regarding law, human rights, local development planning, project monitoring, budget management etc. In case of the Haiyan response, the Network played a role especially in information sharing about community needs and logistical conditions and in providing suggestions for the ways of assistance based on local culture and tradition according to the Executive Director of the Eastern Visayas Network. In addition, the Network shared the information and contacts of the national and local organizations with specific focuses and encouraged international organizations to work and collaborate with them.

Such national and local CSOs network was also supported by a regional CSO network called the Asian Disaster Reduction and Response Network (ADRRN). ADRRN consists of nearly 50 CSOs from 20 countries in the Asia-Pacific region. ADRRN has an experience of providing coordination between international organizations and national and local CSOs in other countries. ADRRN sent the assessment team to the Philippines after Typhoon Haiyan to conduct a needs assessment and analysis in coordination with national and local CSOs, governments and international organizations. The result of the assessment shared by the ADRRN Program Officer who joined the assessment team addressed the gaps in limited cultural sensitivity, lack of information sharing, fragmentation of coordination mechanism, and weak participation of local stakeholders in the coordination mechanism. Based on these findings, ADRRN proposed to establish a resource/coordination center for the national and local NGOs. These resource centers were temporally established in Cebu, Ormoc, Tacloban, Roxas and Guiuan. The Eastern Visayas Network managed the resource center in Tacloban. The major contributions of the resource centers include information sharing, capacity development of CSOs, and strengthening horizontal coordination between international, national and local organizations. They also contributed to establishing an effective coordination system for emergency response and recovery based on local leadership. In case of the disaster response to the typhoon Haiyan, these centers can be identified as an attempt at a new type of collaboration in the Philippines between the international organizations and the national and local CSOs, and it encouraged the implementation of disaster response and recovery based on a participatory approach.

Private sector

The private sector has also been actively involved in disaster response to Typhoon Haiyan. In Ormoc, the local business sector played a crucial role to distribute relief items and provide volunteers, and their contributions were acknowledged by the Mayor and Municipality. The positive aspects of the involvement of the local business sector are that they could respond to the disaster very quickly and distribute relief items that were most needed as they are also a part of the community and easily understand the actual needs. If the relief goods are mobilized locally, there is no need to wait to receive any assistance from outside. This type of preparation and contribution by the local business sector can be a good practice especially in case of a small and medium scale disasters.

In the Philippines, the initiatives of the private sector in disaster response have been seen from the 1990's. The Corporate Network for Disaster Response (CNDR) is a network of corporations, business associations and corporate foundations, whose objective is to help improve disaster management efforts of the business sector before, during and after disasters. CNDR has more than 50 members in the corporate sector and many of them contributed to the emergency response in the case of Typhoon Haiyan by distributing relief items. The disaster response has been their key activity so far, however, the situation is slightly changing gradually from disaster response oriented to disaster risk management. According to the Program Officer, CNDR has initiated community-based disaster risk management projects and the business continuity management programs as well as capacity development projects for the local governments. The CNDR secretariat provides corporate sector members with the necessary technical assistance for project planning and implementation. CNDR launched the capacity development program for the local government in Cebu in March 2014 with the funding support from the CNDR members. The way of support by the private sectors is also becoming diverse not only for the disaster response.

11.1.3 Importance of capacity development of local stakeholders

CSOs, LGUs, and private sectors

The implementation of the DRRM Act is a key for DRR and disaster risk management in the Philippines. Mainly two things need to be considered: a) how to develop the capacity of LGUs as well as other local stakeholders and b) how to motivate local stakeholders such as those from the private sector and CSOs to be involved in disaster management issues more actively, preferably DRR efforts. This is not an issue only in the Philippines. Other disaster prone countries in Asia such as Indonesia have also been facing the same challenges. In this research, the initiatives to assist the CSOs and the LGUs have been already identified. ADRRN and other CSOs network from the Philippines such as the Eastern Visayas Network initiated a project of capacity development of national and local CSOs in DRR. CNDR, which is a network in the corporate sector conducted workshops in Cebu to train the LGUs in DRR especially on project planning and implementation of community based programs. More importantly, these collaboration and joint activities among various stakeholders need to be systematic and sustainable. However, the sustainability can be one of the most challenging factors for the local stakeholders as their resources are often limited. Ideally, the assistance from the international community and the national government should be spent for these capacity development programs to build the community resilience. Once the LGUs and the CSOs developed their capacity in DRR, the knowledge can cascade down to the communities, and the communities themselves are equipped by the knowledge and skills to take action by themselves in case of a future disaster.

Communities

In an interview, one Barangay leader in Tacloban **(Fig. 11-1)** emphasized the importance of DRR training opportunities for Barangay leaders. He attended the training seminar on DRR that targeted the LGU officials and the Barangay (village) leaders prior to Typhoon Haiyan. 25 Barangay/municipal leaders were invited to this seminar, and 17 Barangay and municipalities sent participants. The training was planned and organized by the LGUs and they requested support from the national government for sending the trainers who had the knowledge and skills of DRR strategy to the program. The LGUs also mobilized the funding for the training by themselves. According to one of the Barangay leaders who participated in the training, due to the knowledge that he gained from the workshop, he was able to issue an evacuation order immediately after the warning to the communities as he deeply understood what the storm surge was, its risk, and the importance of the evacuation. At the result, there were no casualties from the village, although 167 out of 267 houses were damaged. It proved how important capacity development is, especially in the leaders as they also have the responsibility for the safety and security of the community members.

Fig. 11-1. Interview with one of the village leaders in Tacloban.

The village also had another DRR initiative by planting mangroves near the coast after Typhoon Haiyan. It was their local knowledge that the mangrove plantation could reduce the potential risks caused by a tsunami and storm surge. This time, although most of the mangrove was damaged by Typhoon Haiyan **(Fig. 11-2)**, the impact on the community was minimum since the mangroves became a buffer against the typhoon. The community members replanted the mangrove with the purpose of disaster preparedness after the typhoon, to mitigate damage from a future disaster **(Fig. 11-3)**.

Fig. 11-2. Damaged mangroves by the typhoon in the Barangay Uban (left)

Fig. 11-3. The mangroves were replanted by the community members (right)

However, there is a challenge to maintain the capacity of the LGUs and the Barangay leaders in DRR. The turnover of the LGU staff is very high and even the Barangay leaders have fixed terms, therefore, the capacity of the LGU staff cannot be stable and sustainable. In order to overcome this particular challenge, regular trainings for the LGUs and the Barangay leaders need to be organized systematically with the funding support by the national government. CSOs also will be able to provide the technical support to such a program. In order to implement the DRRMN Act, the close collaboration and cooperative framework between governments, CSOs, the private sector, and communities needs to be established in the Philippines, and further assistance from the international and national levels need to be shared with the local stakeholders for their capacity development beyond the response stage.

11.2 Planning recovery and implementation

The typhoon washed away buildings and the infrastructure of coastal cities with the main damage caused by the storm surge, and caused tremendous damage and loss to communities along the shore. In response, the Government of the Philippines is undertaking rebuilding with an emphasis on “building back better”. The National Economic and Development Authority (NEDA) published an initial recovery vision in “Reconstruction Assistance on Yolanda: Build back better (RAY)” on December 16 2014. With RAY in effect, Office of Presidential Assistance on Rehabilitation and Reconstruction (PARR) was established and mandated to coordinate the rebuilding from Typhoon Haiyan. In this vision, a “no-build-zone” policy was suggested to minimize future vulnerabilities of the affected coastal communities. This led to a long and ongoing debate at both national and local levels about how to rebuild in high-risk areas.

11.2.1 Principles for implementing reconstruction: Evolution of national discussions

11.2.1.1 National rebuilding vision

Reconstruction principles

The “Reconstruction Assistance on Yolanda: Build back better (RAY)” by the National Economic and Development Authority (NEDA) has set the stage to implement reconstruction of the typhoon affected regions. There are three principles in this recovery vision. First, it calls for efficient coordination, which combines strong central coordination and flexible implementation at the local level. At the same time, local governments are mandated with the responsibility of implementing reconstruction. Second, in order to address pre-existing poverty issues in the region, inclusiveness and sustainable livelihoods are emphasized in the reconstruction processes. Finally, the third principle includes the need to incorporate gender perspectives in reconstruction, as the starting point is already different between males and females in reconstruction, and thus, empowerment of women

Fig. 11-4. Office of PARR

in the rebuilding processes is needed for a more equitable society in the future.

There are two other key aspects in this reconstruction strategy. First is partnership with the private sector. The national government is pushing further for a partnership with the private sector upon implementing this RAY, beyond emergency relief and response that has already been successfully implemented. As partial evidence for the effectiveness of this strategy, some private foundations have already pledged to donate permanent houses for relocation sites to be developed by the government. Second is the institutional arrangement for implementing this reconstruction strategy, that the Office of the Presidential Assistant for Rehabilitation and Recovery (PARR) is designated as the coordinating body for implementing RAY. The PARR was appointed by President Benigno S. Aquino III in memorandum order No. 62 of December 6, 2013, to integrate efforts of all governments and agencies that are involved in this reconstruction as a manager and a coordinator. Their responsibility includes consultation with local governments in formulating recovery plans and programs that are required to submit the President, develop funding support for local implementation of the plans and programs, and oversee overall coordination between national agencies and departments as well as various non-governmental, private, and any entities engaged in rebuilding. The office has been set up since early January of 2014 in Bonifacio City of Taguig City, where Secretary Panfilo Lacson has been elected to be the head and rehabilitation czar. The duration of this office is confirmed until June 2016, when the six-year term of the current President Aquino III will terminate. In August 2014, the PARR finalized their initial task to finalize the "Yolanda Comprehensive Rehabilitation and Recovery Plan (CRRP)". In February 2015, the PARR have therefore decided to have their office in NEDA to collaborate with them to monitor and manage the programs and activities listed in the plan. Regional PARR offices continue to monitor the ongoing reconstruction projects in their respective regions.

Yolanda Comprehensive Rehabilitation and Recovery Plan (CRRP)

In August 2014, the PARR published the 8,000 page 8 volume, "Yolanda Comprehensive Rehabilitation and Recovery Plan (CRRP)". PARR organized this plan incorporating the recovery plans prepared by the 14 affected local governments. The CRRP was then approved for implementation by President Aquino III on October 29. The CRRP contains four cluster plans – resettlement, infrastructure, livelihood, and social services – which then include detailed projects, programs and activities for realization (**Table 11-1**). The budget for implementation is calculated at P167.86 billion ($3.8 billion[2]), to be allocated primarily from the national budget. The 14 targeted provinces are: Palawan, Masbate, Aklan, Antique, Capiz, Iloilo, Negros Occidental, Cebu, Leyte, Biliran, Eastern Samar, Western Samar, Southern Leyte and Dinagat Islands.

The private sector's participation is also crucial for implementation, and 1,289 private organizations have already pledged to contribute a total of P26.3 Billion (0.59 billion). In February 2015, the PARR considers that their role has shifted from plan development to management and monitoring. To this end, an "electronic management platform: accountability and transparency hub for Yolanda" is currently under construction to be publicly accessible online.

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2 1.00 PHP=0.0226040 USD as of February 20th, 2015 and is calculated throughout this section with this rate.

Table 11-1. Four cluster plans in the CRRP

Cluster Plans	Goals	Budget	Leading Agency
Infrastructure	"To build back better by rehabilitation and improving infrastructure to support recovery and rehabilitation as well as the enhancement of disaster resiliency of affected communities"	P13.14 Billion (20.9%)	Department of Public Works and Highways (DPWH)
Social Services	"To facilitate delivery of basic services such as education, health, and social protection services to affected communities as well as provide healthy environment and strengthen capacity to cope future hazards and disasters"	P20.40 Billion (15.7%)	Department of Social Works and Development (DSWD)
Resettlement	"To relocate affected families living in hazard prone areas to safe areas and to develop sustainable and disaster resilient settlements"	P75.67 Billion (45.1%)	National Housing Authority (NHA)
Livelihood	"To achieve inclusive, sustainable business and livelihoods in affected areas"	P30.63 Billion (18.2%)	Department of Trade & Industry (DTI)

Source: Developed from the Yolanda Comprehensive Rehabilitation and Recovery Plan (2014)

11.2.1.2 Regulating the use of coastal land

In December 2013, NEDA published a document titled "Reconstruction Assistance on Yolanda: Build Back Better (RAY) [1]", which includes an overview of the typhoon disaster, economic loss, and rebuilding plan that guides basic rebuilding procedure. The section on planning for recovery and reconstruction states: "(iii) streamline operational enforcement of 'no build zones'" [1]. Although the reasons for adopting this concept in RAY is not explained in the document, the idea to strictly control the use of land between the coastline and 40 meters inland to prohibit any development was discussed immediately after the typhoon. This concept has its root in PD 1067 (Presidential Decree 1067: The Water Code of the Philippines) that governs "the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources" enacted in 1976 [2].

Article 51 of this Decree states:

> *The banks or rivers and streams and the shores of the seas and lakes throughout their entire length and within a zone of three (3) meters in urban areas, twenty (20) meters in agricultural areas and forty (40) meters in forest areas, along their margins, are subject to the easement of public use in the interest of recreation, navigation, float age, fishing and salvage. No person shall be allowed to stay in this zone longer than what is necessary for recreation, navigation, floatage, fishing or salvage or to build structures of any kind.*

In practice however, this regulation was not fully implemented prior to the typhoon for two reasons. First, the zone was not based on clear guidance on ways to interpret coastal lines – whether the zone should be defined as an easement from the high or low tide marks. Second, there were many informal settlements along the coast that had ignored this decree. With many informal settlements occupying the land along the coast[3], local governments could not force existing settlements to move out of the easement zone. Because of these reasons, after the disaster the national government had a strong intention to enforce land use control of the affected coastal areas through rebuilding, by adopting a maximum setback width of the easement cited in Article 51, so that future loss and damage from the typhoon will be minimized (See messages in **Fig.11-5** describing different types of no build zone prepared by the local governments).

Fig. 11-5. Different messages in the "no build zone"

After the idea of a 40-meter setback was released, various responses were raised; including objections that enforcing this land use policy will disrupt economic activities of coastal communities. For these reasons, the national government is currently facing a need to develop a policy based on scientific reasoning that will help lead the affected local governments and citizens in understanding and following the setback in rebuilding. The Department of Environment and Natural Resources (DENR) and the Department of Science and Technology (DOST) at the national level have been mandated to lead this assessment, by distinguishing between "safe" and

[3] As an example, the landownership of our field visit Barangay Uban is composed 60 percent informal and 40 percent formal. Similarly, some Barangays in Tacloban City also have majority of residents who are informal settlers.

“unsafe” zones with a modeling exercise that considers inundation and landslide occurrence. In addition, climate change aspects are being included, as there are ongoing efforts by the Climate Change Commission to mainstream risk reduction related to climate change.

As debates proceeded in the first four months after the typhoon, the tone on land use has softened from “no building” to “no dwelling”. Although the national government initially sought to have no construction of any structure in the 40-meter zone, they have shifted their thoughts to only prohibit residential use in the designated zone, as this will be a more practical solution for minimizing future risk. It is important to realize that there has not yet been any revision regarding the land use of coastal zones after the typhoon, and the legal/regulatory basis for the coastal land use still relies on PD 1067 of 1976. On March 14 2014, the PARR stated that the “No Build Zone” policy in the affected area is not supported [3]. In November 2014, a joint memorandum by the DENR, Dept. of the Interior and Local Government (DILG), Dept. of National Defense (DND), DPWH and DOST with the subject “Adoption of hazard zone classification in areas affected by typhoon Yolanda (Haiyan) and providing the guidelines for activities therein” was circulated among the local governments of the affected areas to serve as a basis for rebuilding with disaster reduction principles. As of February 2015, interpretation of no-build zones depends on the LGUs.

11.2.2 Housing recovery process and situation

11.2.2.1 Plan for permanent settlement of the disaster affected population

Government support for permanent housing reconstruction in Tacloban City focuses exclusively on the construction of houses in resettlement areas, giving priority to residents of “no-building-zone” and informal settlements in coastal areas heavily damaged by Haiyan. The prioritization for residents from the most heavily damaged areas continues throughout the different phases in the process of housing recovery and settlement. The priority for residents is in order of vulnerability--the first priority if those residents with heavily damaged housing and informal settlements, then renters, and finally, land owners.

Building damage was so severe that totally damaged buildings exceeded 29,000 and partially damaged buildings accounted for more than 18,000. Among the totally damaged houses, about 14,400 houses were built in prospective no-building zones. According the information office of Tacloban City, 2,142 families were still living in evacuation centers as of mid-March, 2014.

Initial plans for rebuilding in early 2014 focused on the relocation of residents from informal settlements and those whose houses were damaged in the typhoon, and included the construction of 20,000 new permanent housing units in the northern part of Tacloban City, in the area of Eastern Visayas Regional Grown Center, (EVGRC), whose development was already part of the City’s master plan before Haiyan **(Figure 11-6).** This rationale behind the target of 20,000 new housing units is based on the number of informal settlement housing units in different locations throughout Tacloban City. According to City Housing and Community Development Office, the total number of housing units in informal settlements was 30,513 pre-Haiyan (see **Table 11-2)**. The 20,000 total households targeted for relocation as of March 2014 was based on a detailed breakdown of 14,433 units identified as being in the prospective no building zone and about 5,500 units built in zones identified as dangerous and in river basins near subdivision developments.

Fig. 11-6. Map of Tacloban City, showing locations of downtown, relocation targets (heavily affected coastal areas and all of Barangay 88) and relocation site area in the north. Date from modified OSM map.

Table 11-2. Breakdown of informal settlements in Tacloban City by location type.

No dwelling zone (along coastal zone)*	**14,433**
Subdivision	**16,080**
Danger zone/ River basin*	5,567
Other areas	10,513
Total	***30,513***

Nevertheless, in March 2014, the City's short- and mid-term plan was to construct 10,000 rather than 20,000 units. The reason for this is because the land that the City owned could only accommodates this number of units; as of March 2014, the City had 92 hectares in total[4] for developing of which 85 hectares are prepared by the City and 7 hectares were donated by the Archdiocese of Palo. As for the construction schedule from March 2014, the city was planning to develop 4,000 permanent housing units in 2014, and an additional 4,000 units in 2015, continuing until the number reaches 10,000.

11.2.2.2. System of transitional phases toward permanent settlement

In Tacloban City, the governmental scheme for housing recovery has three phases: emergency sheltering; temporary housing; and permanent housing provided in a resettlement area. Various efforts organized by NGOs and the private sector also contribute to housing support during these phases. During the first phase, emergency sheltering, typhoon affected populations are seeking to evacuate and temporary stay in a place away from home. Four months after the typhoon, in March 2014, most of the typhoon-affected population was still in this phase, with many staying in evacuation centers including schools and the Astrodome (a municipal sports facility), or in individual tents or in a larger tent city (such as those prepared in Barangay 88 near the airport). According to interviews with local city officials, everyone moved out of tents by November 2014, the 1-year anniversary of the typhoon.

The second phase is the "temporary housing" phase, where aspects of livelihoods are being reestablished, although the housing structures and/or their locations are not considered permanent. In Tacloban, various types of temporary housing structures and support were provided by different sources: bunkhouses (see **Box 11-1**) provided by the national government; transitional housing provided by NGOS; cash and/or lightweight building materials provided by NGOs for residents to use to build makeshift shelters; and rental assistance provided by NGOs to be used instead of temporary housing. The bunkhouses (wooden barracks structure) were provided by the DPWH through DSWD of the national government. As of November 2014, there were 1,053 families living in three bunkhouse sites in the city center: IPI site in Maharlika (537 families), NHA site in Caiibann (316 families) and Abucay site (200 families). All are located in the central part of the City. As of our field visit in February 2015, (**Figure 11-7**) several hundred families had started to move out from bunkhouses in the IPI (also called Motocross)

Figure 11-7. Bunkhouses in use as temporary housing in Feb. 2015, in Abucay (left) and IPI site (right)

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4 This includes 10 hectares of land that has already been developed with NHA's resettlement program

site into the first of the permanent
housing (built by Global Media Alliance –GMA, a private sector initiative) in the New Cabalawan resettlement area in the north part of Tacloban City. In this case, residents had moved out of the IPI site, and no other residents moved into the vacated bunkhouses. In fact, since the private owner of this land (the IPI site) wanted to have it back, the goal was that it would be vacated by March 31, 2015, and the City was giving the priority to the remaining families to be transferred to permanent housing by that date.

BOX 11-1. Bunkhouses in use 4 months after Haiyan

By the end of 2013, the National Government had begun preparing temporary housing (locally called bunkhouses) in the Haiyan affected cities, and least-privileged of the affected population were beginning to move in. Cities were responsible for preparing land for this temporary use to place these bunkhouses. The Department of Public Works and Highways (DPWH) is responsible for constructing the bunkhouses, which are then turned over to the Department of Social Welfare and Development (DSWD) for distribution to beneficiaries. In total, DPWH had allocated 142 bunkhouse units* in December 2013, which were planned to accommodate some 3,336 families affected by the typhoon. Targeted regions for the provision include: Tacloban City; Palo, Leyte; Ormoc City; Basey, Samar; and Eastern Samar [4]. By mid-February 2014, approximately 1,500 people had already moved into 60 bunkhouses prepared in the Eastern Visayas, in: Tacloban City (222 families); Palo, Leyte (429 families); Ormoc City (429 families); Basey and Samar (222 families); and Eastern Samar (673 families) [5].

During the first few months after the typhoon, the proposed strategies for the role of bunkhouses in the resettlement phases differed between Tacloban City and Ormoc City. Tacloban City had positioned the bunkhouses to function more as short-term shelters, aiming to house the vulnerable population – those having disabilities and financially disadvantaged – for about 6 months prior to their next settlement. On the other hand, Ormoc City was using the bunkhouses as a temporary housing for people to live for a fixed duration before moving into permanent homes. Thus, they prefer calling them "transitional shelter (houses)" rather than bunkhouses. During field reconnaissance in March 2014 other types of temporary houses were also being prepared by donors, including international and domestic NGOs as well as the private sector.


Box 11-1 Fig. 1. Bunkhouses in Tacloban City (left) and Ormoc City (Right) in March 2014.

*Each bunkhouse was initially designed to comprise approximately 24 units of dwellings, later modified to 12 units due to small size of each unit. Initially, a family with 3 to 4 members were planned to occupy 1 unit, where a unit has an area of 8.64 square meters.

Another main type of temporary housing used in Tacloban City is transitional shelters, constructed with the support of NGOs. With the exception of one site in Utap are of central Tacloban City, these transitional shelters are located in the northern part of Tacloban City, near or adjacent to the same areas planned for resettlement sites, with the idea that residents will be able to transfer from the transitional housing to nearby permanent housing without traveling a long distance or being displaced again. Transitional shelters are designed and constructed by various NGOs, and built to be used for several years, either on private property provided for free by the owner for two years for this purpose or on land already owned by Tacloban City, the Local Governmental Unit (LGU). Transitional shelters are also sometimes referred to as Bahay Kubo, or Nipa huts, a vernacular typology of a simple elevated house built from natural plant materials, since the transitional shelters are also elevated and built using economical plant materials such as coco lumber and bamboo. Transitional shelters are currently being provided with support from various donors and NGOs (See **Fig.11-8 and 11-9** for examples of transitional shelters) as shown in **Table 11-3**. According to data from the City Housing and Community Development Office, there were 436 transitional shelters completed Nov. 2014, with plans to construct additional 1,095 units. As of Feb 2015, there were more than 500 families living in transitional shelters, and construction of additional units was still ongoing.

Fig. 11-8. Transitional Shelters in New Kawayan, in the north part of Tacloban City, March 2014

Fig. 11-9. Transitional Shelters in Tagpuro, in the north part of Tacloban City, Feb 2015

Table 11-3. Temporary Housing Settlements in North Tacloban City (already built, or under construction)

Site Name	**Beneficiaries**	**Land ownership**	**House Building**
New Kawayan (Site 1+2)	76 families	Private	Operation Compassion
New Kawayan (Duplex)	100 families	LGU	Tacloban City
New Kawayan	49 families	LGU	Operation Compassion- GAIN
Sto. Niño	60 families	Private	Operation Blessing
Tagpuro	86 families	Private	Operation Blessing- IOM/DSWD
Badato	65 families	LGU	Operation Compassion- PDRF
Total	436 families		

Data Source: City Housing and Community Development Office data as of November 7, 2014

In addition to transitional shelters, some NGOs are providing other forms of support during the temporary housing phase, including lightweight building materials (a "shelter kit") that residents can use to construct a temporary shelter for themselves. Many residents who are still living temporarily in their former *barangays*--and those whose houses are/were in the no-build zone--were recipients of this support, and others rebuilt their own makeshift shelters using materials they salvaged. Some NGOs required that residents have land, or permission to use land, outside the no-build zone in order to receive the shelter kits. Rental subsidies are another form of housing support provided by NGOs, specifically Catholic Relief Services (CRS), who are providing money for residents to rent private apartments for up to 2 years, which also requires proof of ownership from the owner and an agreement to lease the unit to the affected residents.

The third and final phase of housing recovery is permanent housing, when the typhoon-affected population is settling into permanent houses. The construction of permanent housing is occurring through several types of combinations of support for the provision of land, land preparation, and housing construction. Some of the land used for the development of resettlement sites was already owned by Tacloban City, planned for future development, and some land was already owned by the National Housing Authority, planned for residential relocation (pre-Haiyan) projects. Almost all site development in the resettlement sites is done by contractors hired by NHA. For the construction of the houses, some are built by NGOs (**Tables 11-4, 11-5, 11-6**) or with private donations, such as the first houses to be finished in the resettlement area built by the Kapusa foundation, supported by Global Media Arts Network (GMA Network) (**Fig. 11-10 and 11-11**). The majority of houses will be built by the National Housing Authority, who use a standard row house design of 4 meters x 5.5 meters, with a total floor areas of 22.5 m.[2] For houses built by other agencies or organizations, building designs must be approved by NHA. The result is that although there are some variations in design and construction materials, the size of the houses is very similar.

Table 11-4. Donor Pledges as of March 2014 for houses and community facilities for permanent relocation sites.

Partner/Donor	Pledge	Area/Location
Philippines Red Cross	5,000 units	New Kawayan
GMA Foundation	400 units	Sto. Nino
Habitat for Humanity	852 units	Sto. Nino
SOS Children's Village Tacloban, Inc.	254 units	Palanogl 2
Zonta	20 units	Tacloban North
Kimse Yokmu	30 units	Tacloban North
DSWD	134 units	undecided
Habitat	2,500 units	undecided
Lions Club International	50 units	undecided
Philippines Institute of Civil Engineers	50 units	undecided
Unknown	871 units	unknown
Total	**10,161 units**	

Source: Tacloban City Information Office (March 2014)

Table 11-5. Ongoing Permanent Housing Projects in Tacloban City as of Nov. 2014 (on City property)

Partner/Donor	Pledge	Area/Location
GMA Foundation	400 units	Sto. Nino, Brgy 106
Habitat for Humanity	177 units	New Kawayan, Brgy 101
Lions Club International	200 units	Sto. Nino, Brgy 106
Philippines Institute of Civil Engineers	50 units	New Kawayan, Brgy 101
Total	**827 units**	

Source: Tacloban City Housing and Community Development Office

Table 11-6. Future Permanent Housing Projects in Tacloban City as of Nov. 2014 (on City property)

Partner/Donor	Pledge	Area/Location
Habitat for Humanity	399 units	New Kawayan, Brgy 101, and Sto. Nino, Brgy 106
UNDP	55 units	San Isidro, Brgy 105
NHA	500 units	New Kawayan, Brgy 101
Total	**954 units**	

Source: Tacloban City Housing and Community Development Office

In addition to the 1,781 houses (**Tables 11-5** and **11-6**) that have been built or are planned for land owned by Tacloban City, construction has also started on some of the 11,211 houses planned to be provided by the National Housing Authority on 106 ha in multiples sites, and the construction of 480 houses is also planned for land purchased by NGOs. As of February 2015, around 200 permanent houses have been completed, with the vast majority having been built by GMA, and approximately 100 families have moved into permanent housing in the resettlement areas.

Fig. 11-10. Land development in March 2014 for the construction of permanent housing in the North Tacloban resettlement site.

Fig. 11-11. New Permanent housing built by Kapusa Foundation (support from GMA) in North Tacloban.

Fig. 11-12. In the same North Tacloban resettlement site there are also houses built by Habitat for Humanity

Fig. 11-13. Ridge View Park, one of the many resettlement sites with housing built by NHA.

11.2.3 Land use update and implementation status

11.2.3.1 Plans and ordinances related to rebuilding and development

Rebuilding Tacloban city more resiliently has been the one of the main points emphasized by the City after Typhoon Haiyan. Towards this aim, several plans/ordinances have been developed/adopted or are currently being prepared to meet this purpose. Three key ordinance and plans include: i) no-build zone ordinance, ii) Tacloban Recovery and Rehabilitation Plan, and iii) Tacloban City Comprehensive Land Use Plan.

- **An Ordinance Providing for a 40-Meter No-Build-Zone for Residential Housing within the Territorial Jurisdiction of the City of Tacloban (Ordinance No. 2013-12-15A)** was adopted on March 12, 2014. The ordinance is called “No build zone” Ordinance of the City of Tacloban, and aims to “prevent repetition of large number of casualties that occurred after Super Typhoon Yolanda brought massive storm surges that flattened seaside communities (Tacloban City, 2014).” Practically, this ordinance prohibits the location of the residential buildings within 40 meters from the shoreline.
- **The Tacloban Recovery and Rehabilitation Plan (TRRP)** was published on May 22, 2014 in partnership with UN Habitat. The recovery plan emphasizes five areas in rebuilding, including: i) shelter for affected families, ii) social services to improve residents' quality of life, iii) economic revitalization to support the affected population, iv) physical infrastructure to repair and rehabilitate damages, and v) and environmental protection of the coastal area. This plan also envisions strategic land use, which targets the northern part of Tacloban City as a new development area and the central part of the City, particularly the coastal areas devastated by the typhoon including the airport area, for industrial and environmental use. The cost proposed for the implementation of this recovery plan is P 25.6 billion (US 0.57 billion). The TRRP aligns with the RAY objectives and goals that are provided by the national PARR.
- **Tacloban City Comprehensive Land Use Plan (CLUP) 2013-2022** was adopted just before the typhoon. The plan is prepared in three (3) volumes, including the land use plan of the city, zoning ordinance, and development plans of four emphasized sectors (social, economic, infrastructure and utility, and institutional capacity) as the tool for a long-term development. The CLUP is currently under review to incorporate hazard consideration for the purpose of mainstreaming disaster risk reduction, and is led by the city in collaboration with UN Habitat and other key relevant organizations. The idea of mainstreaming hazard planning is reflected in a memorandum circular jointly published by the national departments of environment and natural resources (DENR), public works and highways (DPWH), interior and local government (DILG), and science and technology (DOST), in November 2014. It provides a general guideline for hazard zone classification, classification criteria and recommended activities in different zones.

On the ground, the City government replaced the temporary “No building zone” signage to the permanent ones that state "no build zone" (**Fig. 11-14**). With this construction, residents are aware of whether or not their homes are in the designated zone. Some buildings are stranding on the line which defines the 40 m zone; these are counted as the households targeted for relocation.

Fig. 11-14. 40m No build zone marker in Barangay 56-A

BOX 11-2. City's different interpretation in incorporating future risks

In March 2014, both cities of Tacloban and Ormoc were adopting assistance and programs prepared by the national departments and agencies as well as private sector as much as possible, aligning to the strategies stated in "Reconstruction Assistance on Yolanda (RAY)" for better outcomes. One of the key findings here was that there exists a significant difference between how each local government –Tacloban City and Ormoc City – are taking into consideration future risks in rebuilding; Tacloban City was seriously considering the 40 meter setback of the "no build zone" although it is not yet been decided legally, while Ormoc City is not emphasizing the incorporation of this zone in rebuilding, except for in regards to existing informal settlements along the riverbanks. The reasons for this clearly emerged from their different experiences; Tacloban City faced tremendous loss and damage caused by the storm surge, while Ormoc City's loss and damage were mainly from the strong wind** in this typhoon. In addition, Ormoc has an experience of flash flood disaster back in 1991, which caused approximately 5,000 deaths and 3,000 missing, making flooding along the river a higher concern than storm surge. On a different note, although always challenging under compressed time in recovery, both city governments are investing efforts to reduce the stress of the affected population in transition. Some efforts include: putting the temporary housing sites and the permanent housing site adjacent to each other so that a big move will be unnecessary; and providing additional care about space and details about utilities when setting up the temporary housing.

**Damage caused by typhoon Haiyan in Ormoc City was also devastating. Number of death was 38, population displaced reached 97 percent of the total households (total households: 43,729), and 96 percent (or 42,303) houses were somehow damaged (totally damaged houses: 73 percent (or 31,921); partially damaged houses: 23 percent (or 10,382)).

11.2.3.2 Local status: Interviews with coastal Barangay residents

Although key planning documents and ordinances were developed in the first year after the typhoon, the actual status of Tacloban City 15 months after Haiyan, particular the situation for those residents targeted for resettlement, is understudied. A focus group interview of coastal barangay leaders, and a set of interviews to the coastal barangay residents were carried out to understand the current status of rebuilding and resettlement. The questions addressed to these interviewees included: landownership, evacuation and resettlement process, and future prospects of resettlement.

Targeted areas

Six coastal Barangays in the central part of the city were selected for interviews. These include: Barangays 68, 31, 54, 56-A, 61 and 88 (**Fig. 11-15**).

Methods

Door to door interviews of 12 samples in each of the six barangays were conducted, totaling 72 responses. Targeted interviewees included households living in or near the “No build zone”, a zone of 40-meter setback from the shore. Respondents included both those who are in and outside the no-build zone. The 40-meter zone is identifiable with the permanent makers installed by the Tacloban City following the no build zone ordinance. To the extent possible, interviews targeted household heads while balancing a mix of Barangay residents including men, women, young and old. Interviews were held on both weekday and weekend days for this purpose.

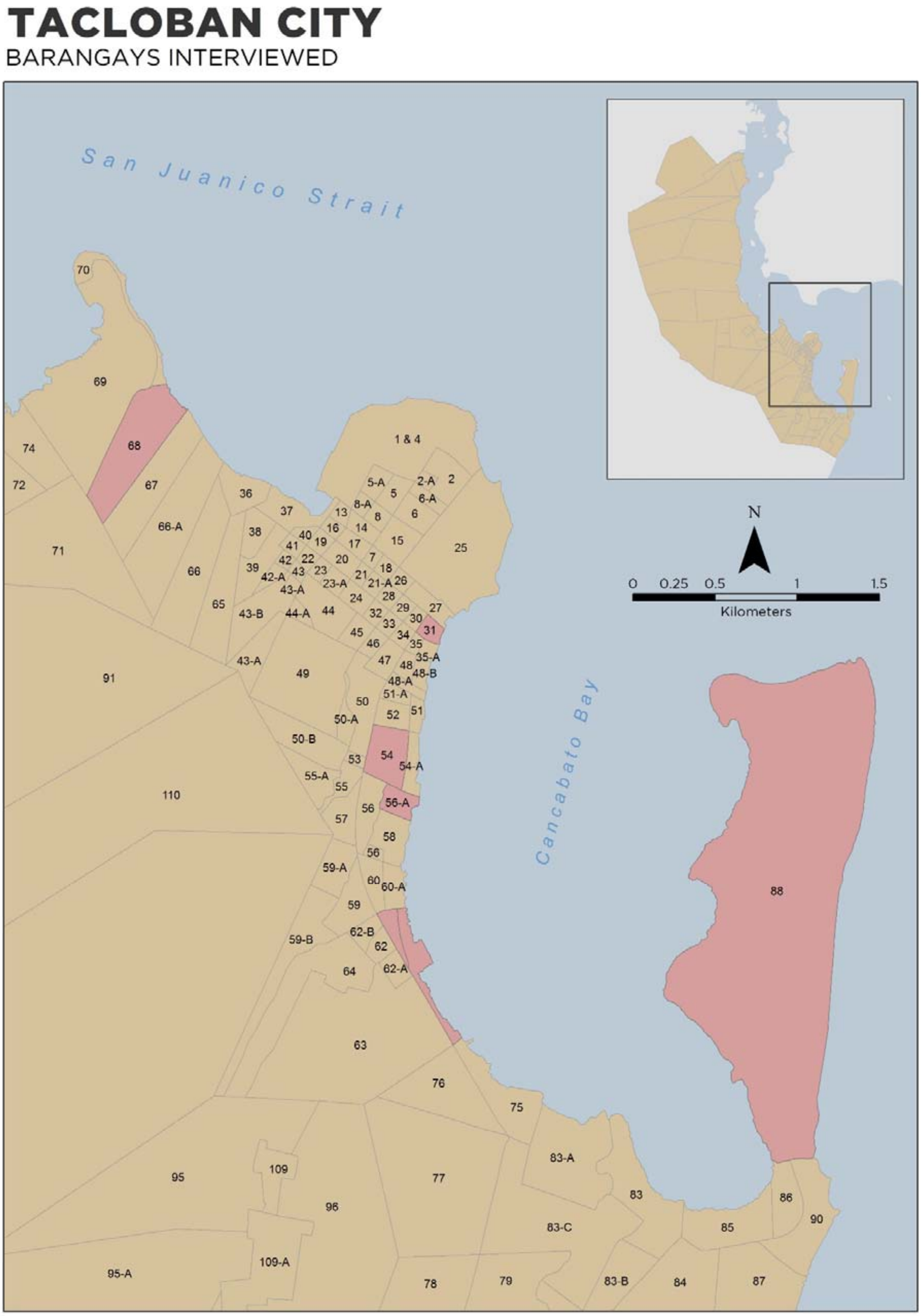

Fig.11-15. Map showing Barangays interviewed. Note: Some barangay boundaries differ from boundaries shown in this map, particularly 54 and 56-A.

Table 11-7. Current situation of the targeted Barangays

Brgy. No.	Current status of the coastal households	Buildings in the No-Build Zone
68	Majority of the former residents returned to their original land in a month or two and are informally sited with light/temporary housing materials. Among these, 40% are in the no build zone. - Total households (current): 507 - Households back in barangay: N/A - Households in temporary housing: 27 in bunkhouses - Households in no build zone: 200+	
31	Households are informally sited with light/temporary housing materials. Approximately 60% of the barangay members are currently in temporary shelters (bunkhouse). - Total households (current): 147 - Households back in barangay: 61 - Households in temporary housing: 86 in bunkhouses - Households in no build zone: 54	
54	The majority of the informally settled former residents returned to the original land after a month to three months. Current buildings are built with light materials. - Total households (current): N.A. - Households back in barangay: N.A. - Households in temporary housing: N.A. - Households in no build zone: N.A.	
56-A	Almost all barangay members are informally settled back in houses build with light materials. They returned within a week. Some members are in temporary housing (using CRS apartment system). - Total households (current): 178 - Households back in barangay: 165 - Households in temporary housing: Some in CRS apartments - Households in no build zone: 164	
61	Approximately 32% of the members are in temporary housing. Among those who returned, about 75% are in the no-build zone. - Total households (current): 397 - Households back in barangay: 270 - Households in temporary housing: 127 - Households in no build zone: 200	
88	Approximately 34% of the members are in temporary housing or in permanent resettlement houses. Among those currently in the Barangay, about 40% of them are in the “danger” area. - Total households (current): 2,300 - Households back in barangay: 1,520 - Households in temporary housing: 580 - Households in new permanent settlement: 200 - Households in “danger” area: 1,089	

Current Barangay situations

All targeted barangays are currently revising their profiles (a demographic and building summary that each barangay prepares) as of March 2014. Barangays' statuses as described in the interviews are summarized in **Table 11-7**. Many barangay residents were not equipped to answer all the questions. The interviews also clarified that there are several different interpretations of post-Haiyan land use at the Barangay level. These include: No building zone, dwelling zone and no-dwelling zone, and danger area.

Initial findings

The interviews confirmed that the majority of residents currently residing in the original barangay are waiting for permanent housing to be provided by the government. Many are still hopeful about the provision of the permanent housing units. Coastal residents are aware of their informal residence status, and also about the no-build zone policy to be implemented. The following five key points suggest that the heavily-hit Tacloban coastal communities are willing to relocate and rebuild in a way in which there will be less future typhoon damage.

- The majority of the residents in the no-build-zone are informal settlers. They are aware of their informal settlement status. At the same time, the majority of them are aware of the no-build zone policy, after learning about it from local government officials, barangay leaders, and signage that was posted after Haiyan. They are also aware of their eligibility for relocation to the north part of Tacloban City. Most of the eligible residents at this time are seeking to relocate if the government provides them the housing as promised.
- Almost all residents who needed to returned to their original neighborhoods and lots in similar configurations as to their situation before Haiyan. The majority of the respondents did not have anywhere else to go besides returning to the original community. No shuffles of neighborhood members were observed pre- and post-Haiyan.
- Evacuation and resettlement patterns vary by barangay. Earlier return to barangays begun within a week after the typhoon, and the longest took about a year. The majority of the returnees came back within three months. In addition, there are residents in some barangays who never returned, and are currently in temporary housing or permanent housing.
- Within the barangays investigated, Barangay 31, 61, and 88 have a significant amount of residents participating in the resettlement scheme as of February 2015. These populations are in temporary housing, mainly in the bunkhouses provided at an earlier timing by the national DPWH and DWSD, and located in the city center. Some residents are in transitional shelters that were provided later. Some of the residents from Barangay 88 have begun to move into permanent housing in the resettlement area in the north of Tacloban.
- The majority of the residents are willing to relocate only if the government provides their permanent residences, and they are uncertain of their ability to pay the small monthly fee that will be required in the future for the majority of permanent housing (from NHA). On the other hand, going through temporary housing solutions – as in the case of planned resettlement scheme by the city government – was not attractive to them, because it did not guarantee a permanent home.

11.2.4 Reflection

Field reconnaissance in March 2014 and February 2015 highlighted the seriousness for the disaster-affected areas to rebuild in a more resilient way. Although the national government became less persistent with the control of hazardous areas, Tacloban City for example, continued with their "no-build-zone" policy. At an initial stage of rebuilding, the City officials were themselves questioning the provision of permanent houses to those who are in need. The land available to the City government and the number of permanent units needed seemed way too large for their capacity. Nevertheless, the City has found better approaches and some solutions to these issues within a year. Support from and involvement of the national government, private sectors, and non-governmental organizations inside and outside the Philippines enabled Tacloban City to secure almost all land areas and housing units that are currently counted. Barangay members are also aware of the government efforts, and are still hope to benefit from this program. Many members are even willing to change their means of living, if that supports their long-term survival in new relocation area. To this end, some NGOs have begun conducting livelihood training programs for the relocating residents, some of whom used to be fishermen, pedicab drivers, or were jobless. As recovery continues, it is an ultimate hope that information on City rebuilding continues to be shared and the trust between the local government and barangay members continues to be nurtured toward the rebuilding of a stronger and more hazard resilient city.

Acknowledgements

The authors appreciate support provided by Tohoku University. We also extend appreciation to all of those who shared their time and knowledge, especially those who helped our field interviews listed in the activities section.

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2. Tw[14(en(at)5.9(ccov)hared)d J(ty)67ler

12. Geological traces of the 2013 Typhoon Haiyan in the Southeast coast of Leyte Island

12.1 Backgrounds and Aims

Geological surveys are one of the key activities to study historical and prehistoric events prior to 2013, or to estimate the recurrence interval and the local size of the super typhoon. As shown in **Fig. 12-1,** a record of the previous super typhoon in 1897 can be found in the Catholic Church in Tanauan in Leyte Island mentioning that the church had “Withstood hurricane and tidal wave of 1897”. Soria et al. (2014) reported that the maximum heights of the storm surge by the 1897 event observed in Tacloban and Tanauan were approximately 4 m and 5 m respectively. Therefore, the objective of our geological survey was to investigate the possibility of sand deposits transported by the 1897 or older events and to clarify characteristics of the 2013 storm deposit.

Fig. 12-1. Catholic Church in Tanauan and the record on the great typhoon in 1897.

12.2 Guideline of the geological survey

The survey was conducted during 8-11 May 2014, six months after the typhoon in order to 1) avoid the disturbance of activities related to the rescue and damage surveys and 2) collect high quality samples before the arrival of the next typhoon season as the precipitation amount increases yearly from June. We chose Tanauan and Tolosa in the Southeast coast of Leyte Island because there are non-populated plain areas which are suitable for the geological survey, rather than larger cities such as Tacloban and Palo. Locations of our transects are shown in **Fig. 12-2.** However, from interviews with local residents and governmental officials, we learned that serious sandy beach erosion is occurring in the east coast of Leyte Island that might not allow us to find the sand deposit of the previous event which occurred in 1897. We observed the deposit at 27 sites along the Tanauan transect (**Fig. 12-3**) and 19 sites along the Tolosa transect (**Fig. 12-4**), respectively. Sandy beach and dune distributes near shore along 2 transects are shown in **Fig. 12-5**. As

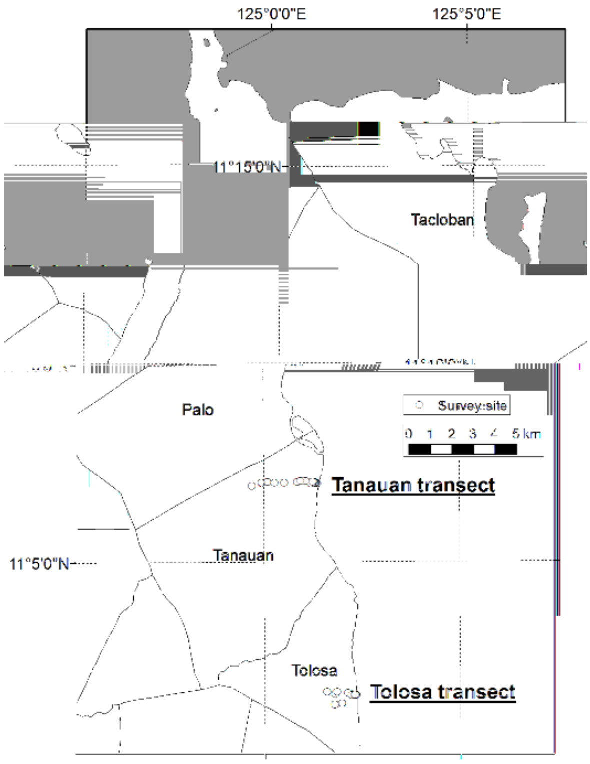

Fig.12-2. Tanauan and Tolosa transects.

expected, we could not find any sand deposits from the storm surge in 1897. We also surveyed the flow depth (height from the ground) and inundation limit on the basis of interviews with local people and field observations of watermarks. Along the Tanauan transect, the flow depth near the shoreline (330 m inland) was 3.6 m and the maximum inundation distance was 3.1 km. Along Tolosa transect, flow depth near the shoreline (120 m inland) was 3.8 m (**Fig. 12-6**) and the inundation distance was 1.4 km.

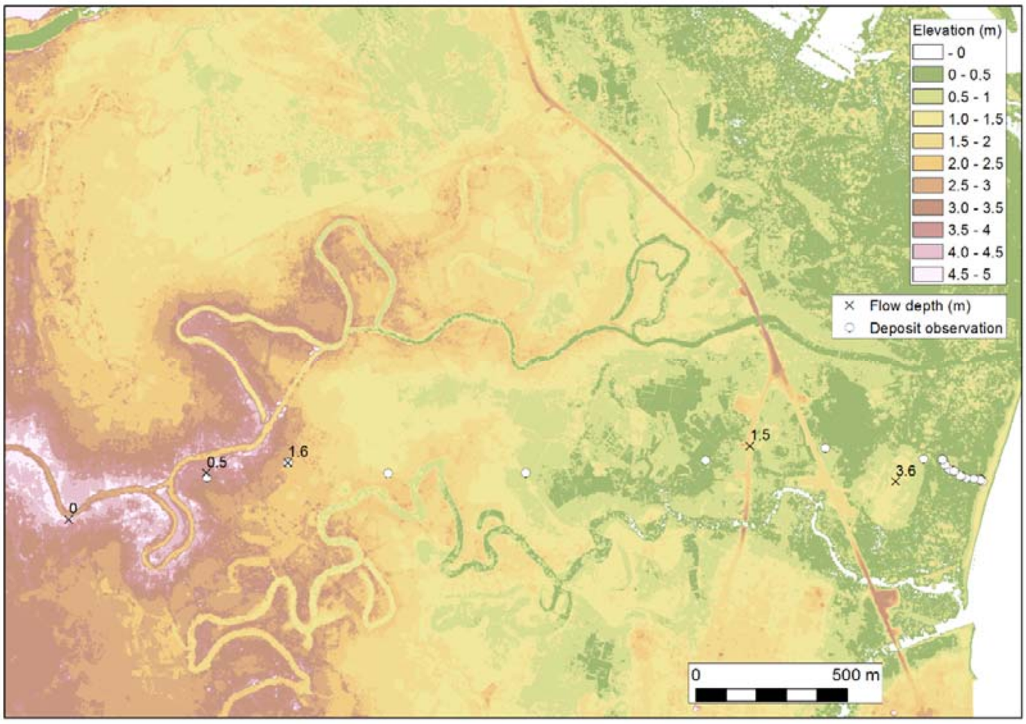

Fig. 12-3. Survey sites (circle) and flow depth (m) (cross) along the Tanauan transect.
Elevation data is 1 m mesh digital elevation data after the typhoon provide by JICA (2014).

Fig. 12-4. Survey site (circle) and flow depth (m) (cross) along Tolosa transect.

Fig. 12-5. Sandy beach and dune near the shore along the Tanauan transect.

Fig. 12-6. 3.8 m depth of inundation measured at 120 m inland along the Tolosa transect.

12.3 Results

12.3.1 Tanauan transect

The inundation extent was 3.1 km along this transect. The flow height was generally stable at 3.2 to 4.9 m from the shoreline to the inundation limit (**Fig. 12-7**). On the other hand, the flow depth decreased landward from 3.6 m to 0 m. The thickness of storm sand (**Fig. 12-8**) ranged from 0.1 to 80 cm and generally decreased inland (**Fig. 12-9**). Maximum extents of sand layer (more than 0.5 cm thick) and patchy sand (1 mm thick) were 0.15 km and 0.18 km from the shoreline, respectively. Between 0.18 km and 3.1 km from the shoreline, no sand deposition was observed.

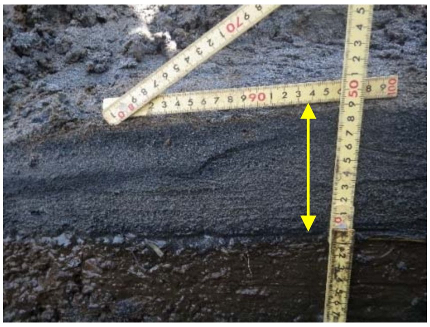

Fig. 12-8. 10 cm thick sand layer at 50 m from the shoreline along

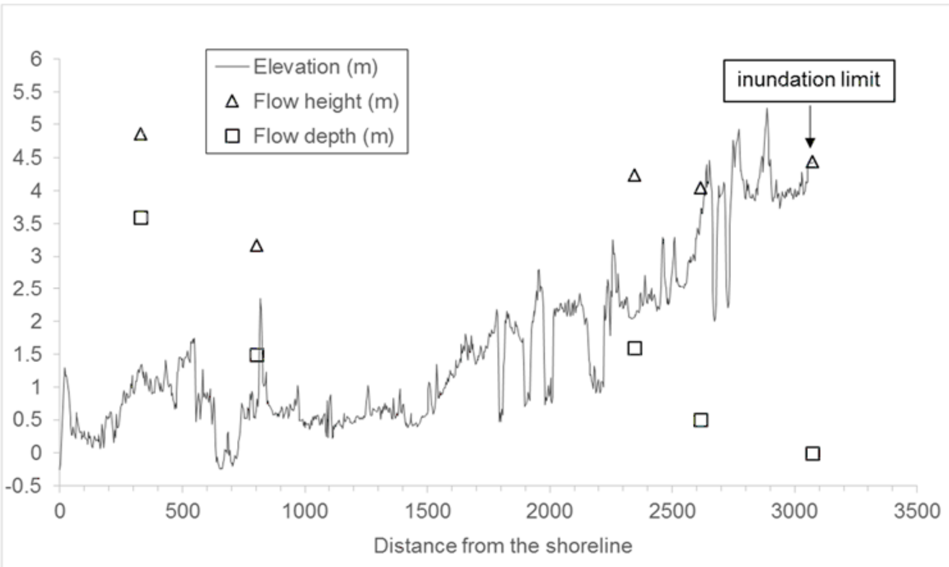

Fig. 12-7. Elevation (m), flow height (m), and flow depth (m) along Tanauan transect.

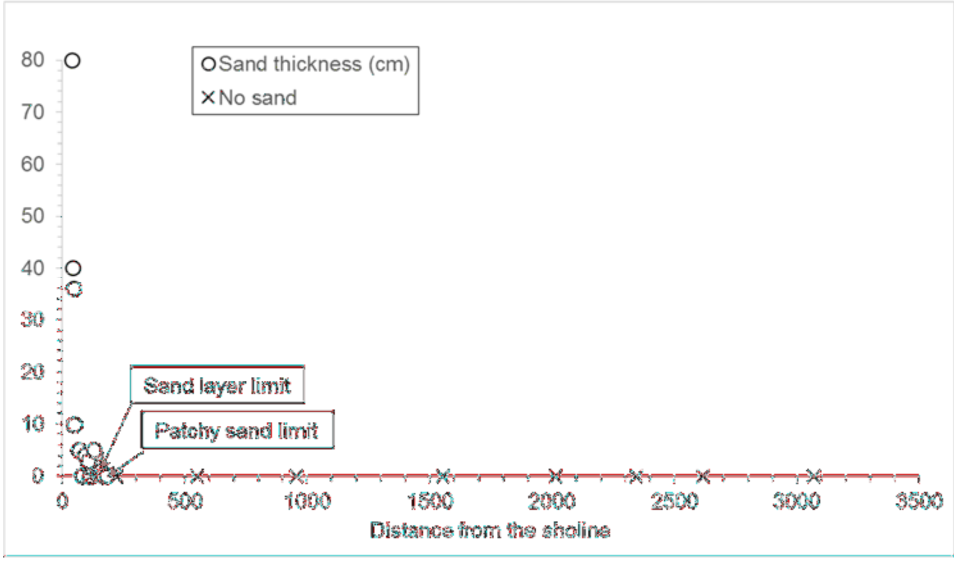

Fig. 12-9. Sand thickness (cm) along Tanauan transect.

12.3.2 Tolosa transect

The inundation distance was 1.4 km along this transect. The flow height decreased inland from 4.7 to 2.4 m (**Fig. 12-10**). The flow depth was decreased landward from 3.8 m to 0 m. The thickness of storm sand such as **Fig. 12-11** ranged from 0.1 to 10 cm and generally decreased inland (**Fig. 12-12**). Maximum extents of sand layer and patchy sand were 0.13 km and 0.15 km from the shoreline, respectively. Between 0.15 km and 1.4 km from the shoreline, no sand deposition was observed.

Fig. 12-11. 4 cm thick sand layer at 100 m from the shoreline along Tolosa

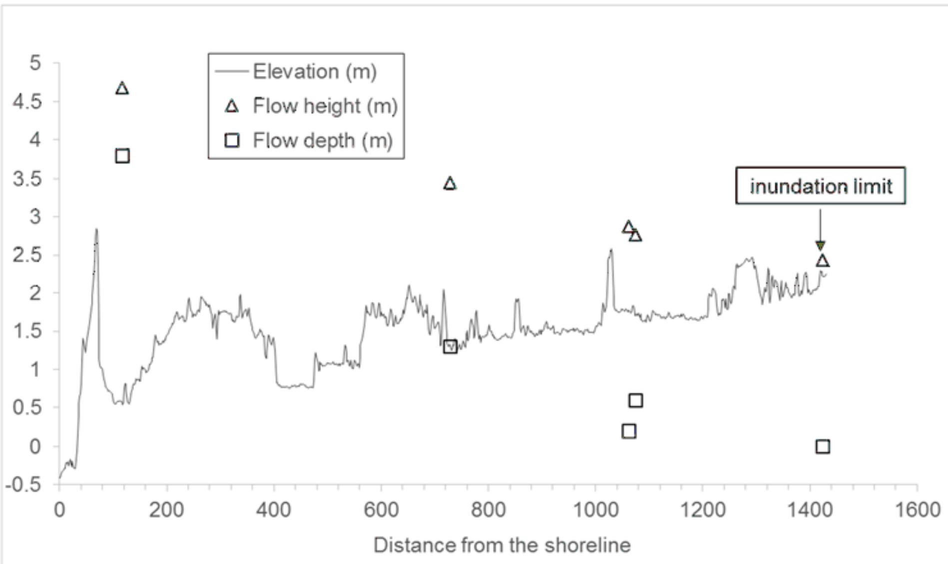

Fig. 12-10. Elevation (m), flow height (m), and flow depth (m) along Tolosa

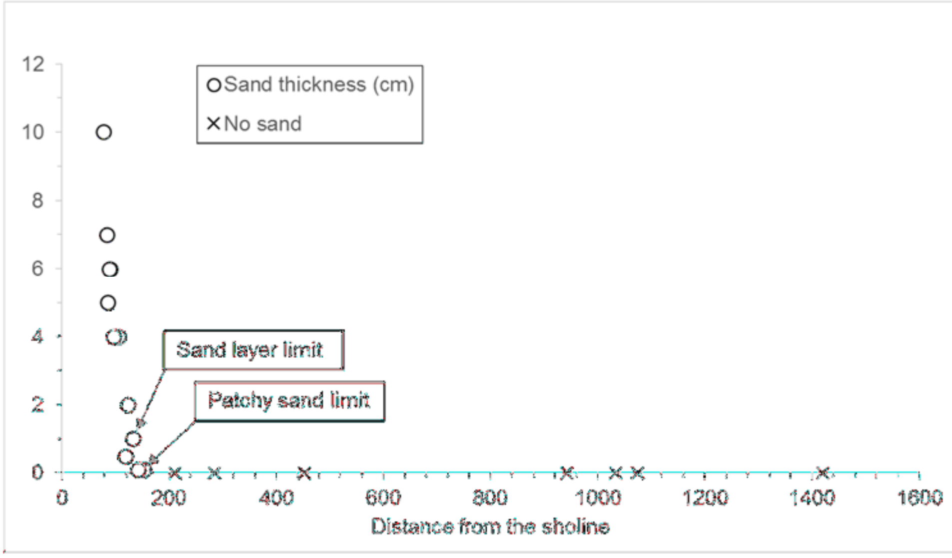

Fig. 12-12. Sand thickness (cm) along Tolosa

12.4 Discussions and Conclusions

Along the Tanauan and Tolosa transects, the sand thicknesses of the 2013 storm deposit varied ranging from 0.1 cm to 80 cm becoming thinner inland. Inundation distances of the storm event ranged from 1.4 km to 3.1 km, while maximum inland extents of the sand layer varied from 0.13 to 0.18 km (7-8% of inundation extents). This distribution trend is significantly different from that of tsunamis. For example, the 2011 Tohoku-oki tsunami inundated 0.6-4.0 km inland at Sendai Plain and the maximum inland extent of the sand layer distributed up to 0.6 to 3.0 km (57-76% of inundation distances, Abe et al., 2012).

Wave period and flow speed relate to the ability to transport sediments for a long distance and duration. In fact, short wave periods (around 10 seconds) and low flow speeds (less than 1.0 m/s) were estimated along the Southeast coast of the Leyte Island during the 2013 storm wave event (Bricker et al., 2014). Based on these observations, we infer that the 2013 storm surge and waves, unlike tsunami waves, did not have sufficient energy to transport sediments over a long distance. Therefore, the maximum inland extent of sand layer as a proportion of inundation extent may be key evidence to differentiate deposits formed by tsunami and storm waves.

In this survey, we could not find deposits by the 1897 event or older events. This is because severe coastal erosion has occurred in the survey area, and hence possible deposits of previous storm events may have disappeared due to the erosion. Future research is required at a location where coastal landform is stable in order to find the paleo-storm deposits.

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13. Disaster education program in the Philippines

13.1 Introduction

Typhoon Haiyan, known in the Philippines as Typhoon Yolanda, struck in 2013, causing a considerable amount of damage. Based on the fact, reduction and avoidance of potential losses from disasters have received much attention. Disaster education for children is a main disaster-prevention topic in the education (http://www.mext.go.jp/component/a_menu/education/detail/__icsFiles/afieldfile/2013/05/15/1334780_04.pdf). Disaster education is defined simply as disaster risk reduction education (Shaw et al., 2011). Petal (2008) argued that the mission of disaster-risk reduction education, both for children and for adults in all walks of life should serve to (1) convey an understanding of natural and environmental conditions and human actions and inactions that engender disasters, to stimulate changes in individual and group behavior, and (2) to motivate advocacy and raise expectations of social policy to reduce these threats. Moreover, disaster education should not merely teach ‘‘natural hazards’’ or organize ‘‘campaigns for risk awareness,’’ but should guide people to a discovery of their own solutions and their own capabilities.

The Hyogo Framework for Action 2005–2015 (HFA) (http://www.unisdr.org/we/coordinate/hfa) is a 10-year plan to make the world safer from natural hazards. HFA has five priorities for action to reduce disaster losses. The ultimate goal of HFA is to reduce loss of life and social, economic, and environmental assets substantially when a disaster strikes. Especially, the priority for action 3 of HFA emphasizes the roles of ‘‘Knowledge and Education’’ and highlights formal and non-formal education and awareness-raising as important aspects of disaster risk reduction. Following the adoption of HFA, various educational materials were developed in the form of booklets, handbooks, textbooks, posters, activities, games, and practices.

Based on these facts, our teams conducted disaster education for children in the Philippines. In this project, we specifically assessed group activities, Quizzes and disaster drills as educational tools because games might enhance learner motivation and because previous studies showed the beneficial effects of games on education (Shaw et al., 2004; Shiwaku et al., 2007). In the disaster education field, previous studies also underscored the beneficial effects of a combination game of a board game and quizzes related to disasters (Disaster Awareness Game) on disaster education (Shaw & Takeuchi, 2009). This report describes the preliminary results of our disaster education in the Philippines.

13.1 Locations of school and schedules

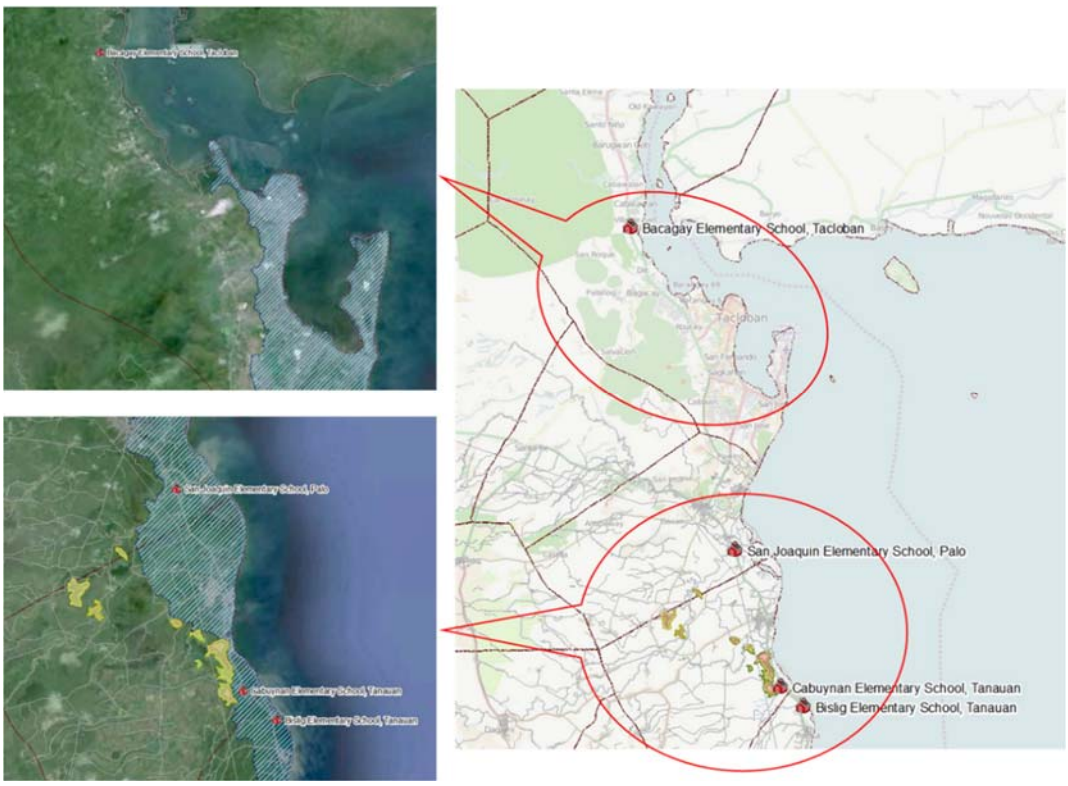

Fig. 13-1. Locations of schools

Table 13-1. Schedule of disaster education

Date and time:	27 August 2014, 10:00–12:00
School:	San Joaquin Central School in Palo II District
Address:	Barangay San Joaquin, Palo Municipality, the Philippines
Date and time:	27 August 2014, 14:00–16:00
School:	Bislig Elementary School
Address:	Barangay Bislig, Tanauan Municipality, the Philippines
Date and time:	28 August 2014, 09:30–11:30
School:	Bacagay Elementary School
Address:	Barangay Bacagay, Tacloban city, the Philippines
Date and time:	29 August 2014, 10:00–12:00
School:	Cabuynan Elementary School
Address:	Barangay Cabuynan, Tanauan Municipality, the Philippines

13.3 Method

We conducted disaster education workshops at four elementary schools (**Table 13-1** and **Fig. 13-1**). About 200 students participated in the disaster education. Details of disaster education programs were presented in **Table 13-2** (see **Fig. 13-2**). Because of locations and time, we prepared two disaster education programs. For San Joaquin Central School in Palo II District and Bacagay Elementary School, disaster education program included 1) a lecture, 2) group work using a Hazard map, 3) Group work using a Gensai Pocket Yui, and 4) quizzes of knowledge and behaviors related to disasters. For Bislig Elementary School and Cabuynan Elementary School, the disaster education program included 1) a lecture, 2) group work using a Hazard map, 3) Group work using a Gensai Pocket Yui, and 4) quizzes about knowledge and behaviors related to disasters. Before and after disaster education programs, students answered some questionnaires such as attitudes related to disasters and the usefulness of disaster education.

Table 13-2. Programs of disaster education

Program	Contents	Aims of programs
Lecture	Lectures about disasters using pictures, movies, and CG	To learn mechanisms of disaster, history of disasters in the world, and behaviors for coping with disasters
Group work using a Hazard map	Disaster Imagination Game (DIG) using hazard map participants lives in	To seek areas for evacuation and to recognize the Haiyan typhoon damage areas
Group work using Gensai Pocket Yui (Handkerchief)	Lectures using Gensai Pocket Yui. Activities to learn how to use the Gensai Pocket Yui	To think about disaster responses using a handkerchief
Quizzes of knowledge and behaviors in disasters	Quizzes for knowledge and behaviors related to disaster	To verify knowledge about disasters and to learn appropriate behavior in disaster
Evacuation drill Note: only for Bislig Elementary School and Cabuynan Elementary School	Evacuation drill from school to a safer place	To learn the evacuation route from a storm surge

Fig. 13-2. Disaster education program using hazard map (upper left), quiz (upper center), lecture (upper right and bottom center), Gensai pocket Yui (bottom left), and group photo (bottom right).

13.4 Evacuation drills

Evacuation drills were performed after the education class at two schools in Bislig and Cabuynan (**Fig. 13-3**) with two participants of Tanauan municipality officers. The Bislig Elementary School is very close to the coast. A storm surge overtopped all one-story school buildings. Approximately 50 students were evacuated to a small hill area next to the sea less than 10 min. We discovered two main problems during the evacuation. First, children were forced to walk along the beach and cross a small river to approach the hill (**Fig. 13-4-Left**). Second, the hill slope is steep enough that an adult would be unable to climb it (**Fig. 13-5-Left**). This was an excellent opportunity to present these shortcomings related to evacuation to both municipal officers to find ways to solve these problems (**Fig. 13-6-Left**).

At Cabuynan Elementary School, although the school is located next to the main road to Palo and Tacloban far from the sea, the storm surge flow depth was about one meter at the school. In August 2014, the school building had only one story but the construction of a two-story school structure was underway, which would allow school teachers, students, and nearby residents to use it as an evacuation building. The small hill behind the school was selected as an evacuation place. The school has access to the hill as an emergency passage through the village (**Fig. 13-4-Right**). The location of the storm surge inundation limit is presented in **Fig. 13-5-Right**. It took less than 20 min for 50 students to reach the hill (**Fig. 13-6-Right**).

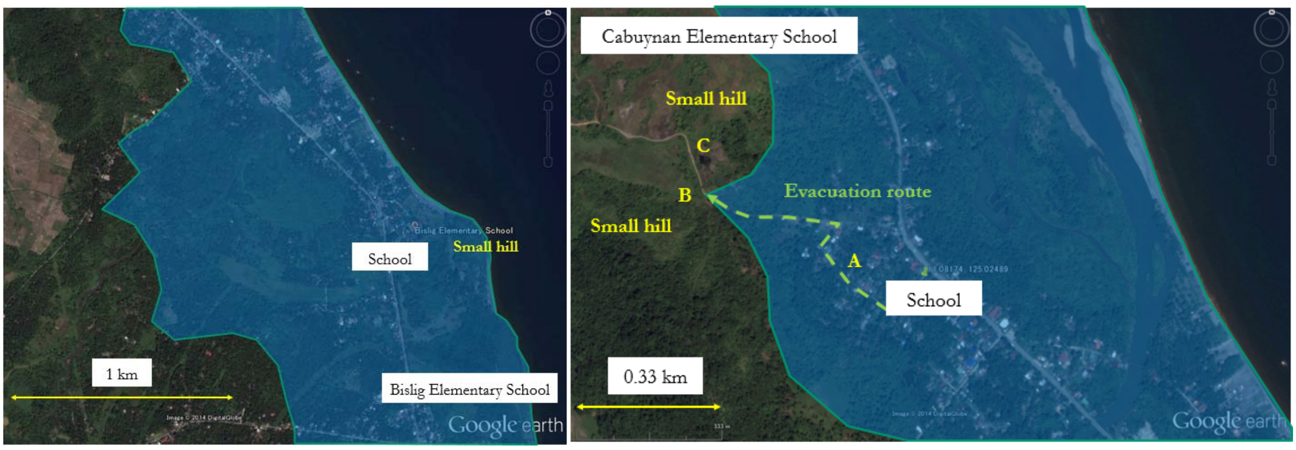

Fig. 13-3. Area maps of Bislig and Cabuynan elementary schools and evacuation routes.

Fig. 13-4. Evacuation routes from Bislig (Left) and Cabuynan (Right) elementary schools to evacuation areas (small hills).

Fig. 13-5. Very steep slope of the hill near Bislig Elementary School (Left) and the storm surge inundation limit behind Cabuynan Elementary School (Right)

Fig. 13-6. Completion of evacuation drills on the small hills near Bislig (Left) and Cabuynan (Right) elementary schools

13.5 Preliminary results

We presented the preliminary results of the pre- and post-questionnaires administered at each school. **Fig. 13-7** shows the proportion of answers for Question 1 (Natural disasters such as a storm surge are scary). The question was related to negative feelings related to a storm surge. The results indicated that negative feelings related to storm surges decreased after disaster education. Question 2 was related to attitudes for disaster education (**Fig. 13-8**). After disaster education, the positive attitudes about disaster education at the three schools (San Joaquin central, Bacagay elementary, and Cabuynan elementary schools) had increased. However, the attitudes about disaster education at Bislig Elementary School were not changed by the disaster education. It is noteworthy that the Bislig Elementary School students already had a positive attitude about disaster education before education.

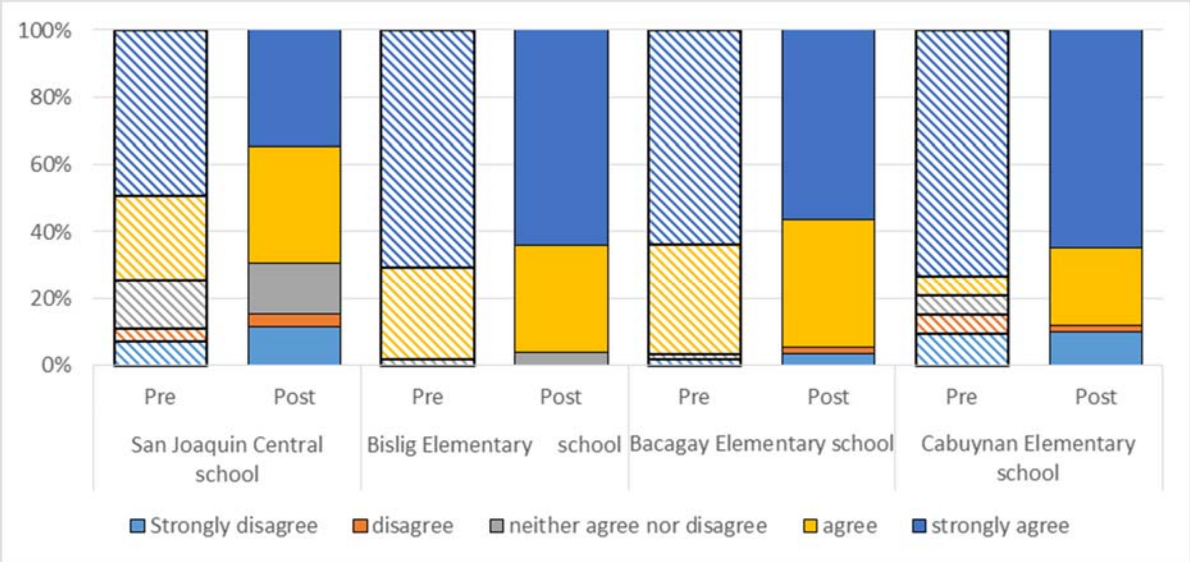

Fig. 13-7. Summary of responses to Question 1: Natural disasters such as storm surges are frightening.

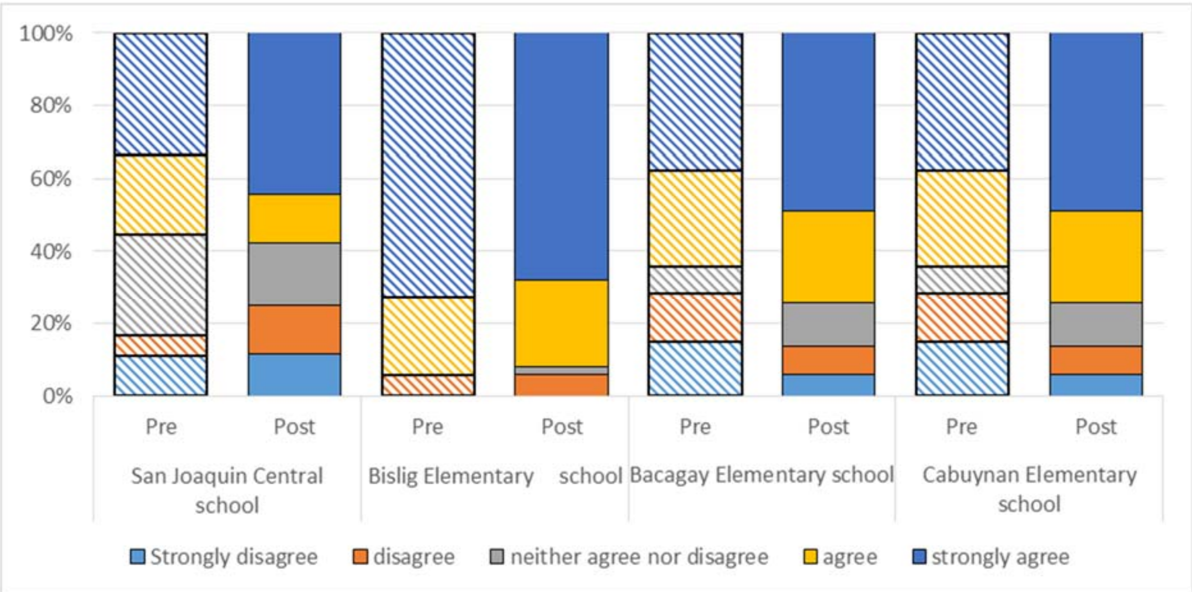

Fig. 13-8. Summary of responses to Question 2: What I heard, saw, and learned today will be useful.

13.6 Conclusion

This chapter described disaster education activities for children in the Philippines. We derived two main preliminary results. First, this disaster education program, which can reduce negative feelings related to storm surges, presents the possibility that disaster education can help to improve mental health in the Philippines. Second, after disaster education, the students had a positive attitude about disaster education. The positive attitude for the disaster education might increase motivation to participate in disaster education programs, which can increase the capacity to address disasters.

Our disaster education programs have two strong points. First, our education programs include lectures about disasters and activities such as group work using a Hazard map and a Gensai pocket Yui, which might improve knowledge of mechanisms related to natural disasters and discovery of their own solutions and their own capabilities during disasters. Those contents fit with the concept of action 3 of HFA. Second, we used pragmatic activities. For example, we used a real hazard map and conducted evacuation drills, which are pragmatic activities that can attract student interest. Additionally, they can prepare students for future disasters.

In conclusion, we demonstrated the beneficial effects of disaster education for children in the Philippines. Nevertheless, some limitations apply. First, our programs specifically addressed only storm surges. Education programs must be undertaken for other disasters such as typhoon and tsunami events. Second, our report demonstrated the short-term effects of disaster education on the feelings and attitudes related to disasters. Future studies should investigate the duration of beneficial effects.

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