DISASTER MITIGATION

International Journal of
Sustainable Future for Human Security
J-SustaiN Vol. 3, No. 1 (2015) 37-45
http://www.j-sustain.com

Typhoon Haiyan 2013 Evacuation Preparations and Awareness

Miguel Esteban[a*], Ven Paolo Valenzuela[b], Nam Yi Yun[c], Takahito Mikami[c], Tomoya Shibayama[c], Ryo Matsumaru[d], Hiroshi Takagi[e], Nguyen Danh Thao[f], Mario De Leon[g], Takahiro Oyama[c], Ryota Nakamura[c].

[a]Graduation Program in Sustainability Science, Global Leadership Initiative (GPSS-GLI), The University of Tokyo, Tokyo, Japan
[b]Centre for disaster preparedness, Manila, Philippines
[c]Department of Civil & Environmental Engineering, Waseda University, Tokyo, Japan
[d] Department of Regional Development Studies, Toyo University
[e]Tokyo Institute of Technolgy, Tokyo, Japan
[f] Ho Chi Minh City University of Technology, Vietnam
[g] De la Salle University, Manila, Philippines

Received: October 10, 2014/ Accepted: March 20, 2015

Abstract

Category 5 Typhoon Haiyan (known as Yolanda in the Philippines) made landfall in the Philippines on the 8th November 2013 at almost the peak of its power, devastating the islands of Leyte and Samar, amongst other places. The present paper analyses the degree of awareness and preparedness of the islands of Samar and Leyte in the Philippines against storm surges prior to the arrival of typhoon Haiyan. The analysis was based on field surveys and interviewed with a variety of local residents and officials conducted during field surveys in the months after the event. One of the key problems identified during the interviews was how people were not able to clearly conceptualize the concept of storm surge. Despite receiving storm surge warnings it appears that many residents and local authorities "under-estimated" the event and thought that they could evacuate at a later stage or during the storm itself. The results clearly highlight the need for better education and for development strategies in the region to focus on improving the resilience of local inhabitants.

Keywords: *Typhoon Yolanda; Awareness; Preparedness;, Resilience; Evacuation Preparations*

1. Introduction

There is an increasing worldwide awareness of the risk associated with coastal natural disasters such as tsunamis and typhoons due to the high number of severe coastal disasters documented by the world's media since the Indian Ocean Tsunami in 2004. This was arguably one of the greatest disasters of recent times, with the media widely broadcasting its consequences and introducing the word "tsunami" to the grand majority of the world's population (though some countries, such as Japan or Chile, had a long history of experience and awareness about these events[1]). Events such as Hurricane Katrina also raised awareness about the flooding that can be brought about by tropical cyclones, though in that case much of the attention was concentrated on issues regarding the weakness of the levees and New Orleans being below sea level.

Generally speaking, tropical cyclones can bring about storm surges that can cause great damage to unprepared developing countries, though even developed countries like the United States and Japan can also be greatly affected by these events [2] [3]. Typhoon Haiyan, in 2013, could be considered another defining event in raising awareness about storm surges, not only in the Philippines but within the entire world.

Category 5 Typhoon Haiyan (known as Yolanda in the Philippines) made landfall in the Philippines on the 8th November 2013 at almost the peak of its power, devastating the islands of Leyte and Samar and causing large damage to other areas in the Visayas[4, 5]. The maximum sustained wind speeds were around 160 knots, the largest in the recorded history of the Western North Pacific. The strong winds, together with the typhoon's extremely low central pressure (895hPa), generated a huge storm surge which engulfed several coastal towns and caused particularly large damage to Tacloban city. The typhoon's strong winds caused devastating damage to the vegetation, leaving behind bare mountains and flattened fields only dotted with the rare dead tree trunks that were left standing. Most infrastructure suffered some degree of damage and all informal dwellings were torn apart, with their components scattered throughout the surrounding countryside. Even well-built schools and other government buildings suffered serious damage, with their roofs being blown away and most windows shattered, and generally speaking few human constructions in the area surveyed survived intact.

As a result, Haiyan caused a great number of casualties, with an estimated 6,201 individuals reported dead, 28,626 injured and 1,785 still missing [4]. It was one of the deadliest disasters to have affected the country, surpassing that of the 1991 floods in the Ormoc region in western Leyte, where 5,101 people were killed by Tropical Storm Thelma. The number of damaged houses is estimated at 1,140,332, with 550,928 of them being completely destroyed [4], and this indeed could prove to be the most expensive disaster in the history of the Philippines [5].

Following each coastal disaster, be it a tsunami or a storm surge, there is typically a major drive to increase disaster preparedness through the construction of defence structures, relocation of communities away from danger zones and the improvement of evacuation systems [1]. Essentially, in flood risk management a number of different types of measures to protect against disasters can be attempted, which leads to the concept of multi-layer safety [6]. Multi-layer safety introduces the integration of flood risk probability-reducing measures and loss-mitigating measures in a flood protection system [7]. The degree to which such a multiple-layer system is developed in various countries varies depending on the level of priority, awareness and preparedness [1]. Developing countries, such as the Philippines, whose resources for constructing infrastructure are limited, often only use loss-mitigating measures, which are typically cheaper and smaller in scale than prevention structures.

In the present paper the authors will attempt to analyse the degree of awareness and preparedness of the islands of Samar and Leyte in the Philippines against storm surges prior to the arrival of typhoon Haiyan. The degree of awareness and preparedness can be reflected by a number of factors, depending on the willingness to evacuate, protection measures implemented and the various measures taken by authorities or individuals [1]. In order to attempt such an analysis the authors conducted field surveys and interviewed a variety of local residents and officials, as detailed later. The results will showcase the importance of improving education and disaster prevention efforts into the development agenda. Given the large number of typhoons affecting the

Philippines every year it is clear that such efforts to improve the resilience of coastal communities are imperative for the sustainable development of the country.

2. Survey Background

A storm surge field survey was conducted by a 16-member multidisciplinary team of coastal engineering and social science academics and practitioners. The surveys began approximately one month after the typhoon made landfall and went on for one week, covering over 150km of coastline in the islands of Leyte, Eastern Samar and northern Cebu. Figure 1 shows the location of the areas surveyed in Leyte and Eastern Samar, which were the worst affected areas and the target of the research described in this research. . The survey had a dual purpose: to determine the storm surge inundation height and understand the behaviour of the authorities and population during the event. Details and characterization of the storm surge was studied in detail by the authors elsewhere [8]. Thus, the present paper will focus almost exclusively on explaining the behaviour of authorities and population during the event.

The area surveyed was generally characterized by being composed of relatively low grounds next the sea, were most human settlements were situated. Hills could be found in various coastal areas, and though modest in height, would have prevented the storm surge advancing, though most of the settlements were located in the lower ground between the hills. Thus, the number of people living in hazardous areas was high, especially considering that informal settlers often colonize the coastal area in places like Tacloban.

2.1. Characterization and history of typhoons in the Philippines

The area most frequently affected by tropical cyclones is that of the North-western Pacific Ocean, and annual TC landfall (TCL) numbers in the Philippines varies from 3.6 to 6.0 in the period between 1902 and 2005 [9], with about half of the world's strongest typhoons measured at landfall over the past 80 years having hit the country [5]. Brand and Blelloch [10] investigated the typhoons that directly hit the Philippines and found that around 50% cross in the October- November period. However, in recent times no large storm surge has affected the Philippines. Thus, although the country has been increasingly investing in natural disaster preparedness and the authorities carried out expensive preparations in the days before Haiyan arrived, the population was surprised by the power and characteristics of the storm surge.

2.2. Physical damage due to the storm surge and awareness

Damage patterns due to the storm surge correlated strongly with inundation depth. In places where the storm surge was lower than 2m it generally did not cause any flooding, as houses along the coastline are usually situated on ground higher than 2m, or placed on wooden stilts above this level. Storm surges above 2-3 m started to cause damage to housing, especially to the many informal wooden settlements located close to the coastline, particularly vulnerable as they were composed of densely placed wooden houses or shacks. All interviews were conducted in locations where the flooding was higher than 2m.

The most severe damage observed in Leyte was around Tacloban city, situated in the inner side of Leyte Gulf, in what is termed San Pedro Bay. At this city inundation levels were consistently in excess of +5m, and in places as high as +7m. Measured storm surge heights gradually decreased as the team travelled eastward or southward of Tacloban city, with the damage due to the storm surge gradually subsiding (see Fig. 1). In Tacloban it was not only wooden houses suffered damage, but also more solid concrete constructions, ships, or oil tanks. Large wind speeds also contributed to further devastate the area and throughout the entire region the roofs of even the sturdiest houses and buildings were blown off, with everything else reduced to rubble, including most of the vegetation.

There are a number of reasons explaining why the storm surge was particularly large in Tacloban: (1) the severe typhoon intensity was characterized by extremely low pressures and high winds, (2) the V-shaped shape geography of the area funnelled the mass of water, with the shallow depths of San Pedro Bay amplifying the surge heights, and (3) the typhoon track resulted in the wind blowing from south to north, pushing the water mass towards the end of the bay.

In order to discuss awareness, the authors will use the theory of multi-layer safety as a framework for the discussion of countermeasures [1] [6] [7]. Typically three safety layers can be distinguished:

-Layer 1. Prevention, consisting of measures such as dykes or breakwaters to avoid penetrating into the land

-Layer 2. Spatial solutions, which consist of placing residential areas away from areas which are potentially hazardous

-Layer 3. Emergency Management and Evacuation, consisting of preparing plans to evacuate residents in the events of a disaster, through the elaboration or risk maps, early-warning systems and the provision of medical help to those affected.

Based on the authors' consultation with authorities following the disaster (as will be detailed later) it was clear that a law banning the construction of houses within 20m of the coastline existed in the area affected, which indicated that some consideration had been given to layer 2 measures. As a consequence of the event authorities would like to extend this zone from 20 to 40m, though it is unclear if this can be achieved as will be explained later. In places like Tacloban it was evident that informal settlements were built right up to the coastline and that the enforcement of these layer 2 measures is not always possible. Though this event will undoubtedly raise awareness, newcomers from areas unaffected by the storm surge or other islands might have lower levels of awareness. Otherwise, no layer 1 measures had been constructed. However, layer 3 measures had been developed to a considerable extent, as discussed in the remaining part of this manuscript. In this sense, most of the population evacuated prior to the arrival of the storm surge as a consequence of the evacuation warnings given by authorities. Nevertheless, it is clear that the damage and large number of casualties has also greatly contributed to raising awareness about future potential for storm surges in the country.

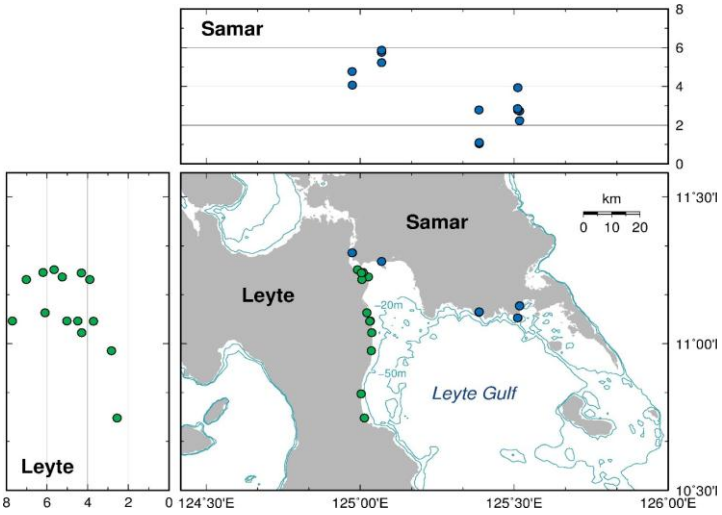

Figure 1 Surveyed locations and the distribution of storm surge heights measured by the research team during the survey on December 2013

3. Typhoon and storm surge awareness: methods and participants

Using three types of survey techniques (Structured questionnaires, focus group-interviews and non-structured interviews), an analysis of disaster awareness and preparedness was carried out amongst local residents, relief operations officials and other government officials.

Firstly, a structured questionnaire was distributed to individuals at the places surveyed where inundation levels were around 2m or higher (see Fig. 1). Each questionnaire would typically take about 10 minutes to complete, containing 16 questions about the perception of danger regarding the storm surge, evacuation, source of information (i.e., TV, radio), preparedness before the disaster, experience with previous disasters and other personal information (i.e., age, gender). During the survey the authors assisted special groups (i.e., children and the elderly) in order to ensure reliability. To attempt to capture a good sample of the society a wide variety of locations and situations were covered, from residents of refugee camps to those who had rebuilt their informal settlements and local government workers.

There were a total of 172 valid questionnaires out of 198 distributed (response rate: 86.9%). Some individuals never returned the questionnaires and some others were incomplete, and were thus excluded from the analysis. Some children (ages 10-15 or so), where also interviewed directly by the authors as part of the 10-19 year group. Due to the opportunistic nature of questionnaires only a moderate amount of effort was made to preserve a male/female balance, which explains why women were disproportionally represented in the survey (constituting 56% or respondents, according to Fig. 2, though most of those who declined to provide details regarding their gender appeared to be female). Respondents were predominantly young, with 47% being under the age of 30 (see Fig. 3), which could be considered typical in a country with a young population such as the Philippines (the median age of the country's population is 23.4 years, according to the Philippine statistics authority as of August 30, 2012). As can be expected from the age distribution many respondents were students (20%). Housewives and fishermen formed two of the other main groups of people interviewed (15% and 17%, respectively), with office workers and officials making the 4th largest sector interviewed, as part of the extensive talks conducted with local and regional government authorities. The "other" group shown in Fig. 4 includes a wide variety of occupations, including service workers, policemen, farmers, security guards, drivers, domestic workers, construction workers, self-employed, among others.

To understand the context in which the disaster took place and obtain additional insights to those obtained through the structured questionnaire three focus group interviews with 5-8 participants (a total of 20 people) were conducted, guided by a set of semi-structured questions , who were afterwards also asked to complete the structured questionnaire. The first group were seven youths of Basey, Samar that were interviewed while taking refuge at Tacloban City. The second group was composed of 8 residents of Giporlos, Eastern Samar, and the third group were 5 individuals from Tanauan, Leyte. The outline of the focus group interviews was as follows: first general questions were asked about the emotions the respondents felt during the disaster, then about the evacuation system, the events of the disaster, and the nature of the surge.

Finally, non-structured interviews were conducted in the towns of Tanauan, Palo, Tacloban and Basey. The interviewees were the Disaster Risk Reduction Management (DRRM) officers of the towns and these interviews were carried out a week after the initial visit by the team. The officers were not tasked to fill out the questionnaires, but were asked instead to explain the preparations that were carried out prior to the arrival of Typhoon Yolanda. The questions that were asked generally related to the evacuation patterns of the population, the understanding of local authorities regarding the disaster, the nature of the storm surge itself and lessons that were learnt from it. Table 1 summarizes the three types of questionnaire.

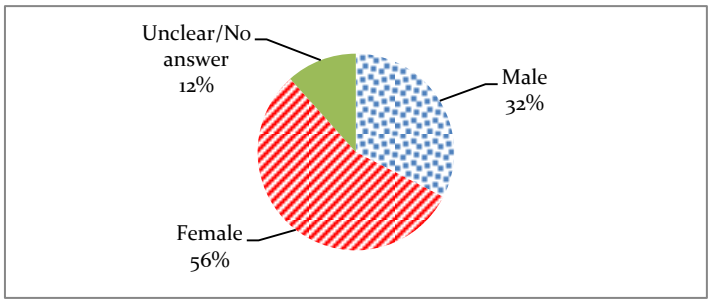

Figure 2 Gender distribution of respondents (n=172)

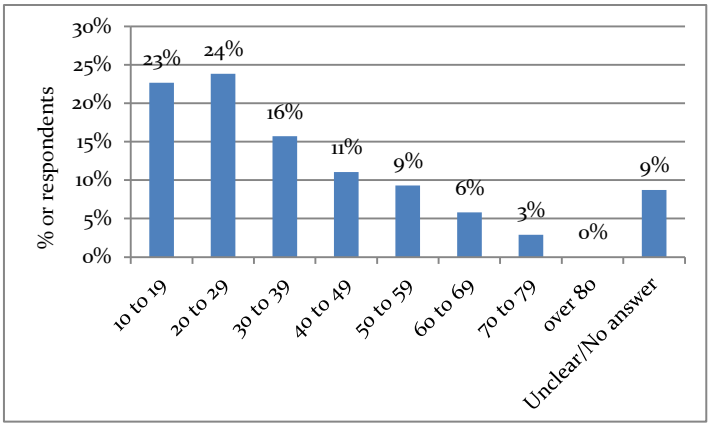

Figure 3 Age distribution of respondents (n=172)

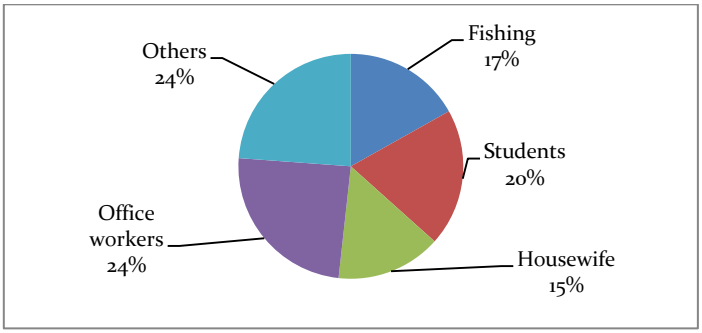

Figure 4 Occupation of respondents (n=172)

Table 1 Three types of questionnaire depending on the purpose

	Methods	Number of Participants (areas)	Period
Structured	Survey	172 survey locations (see Takagi et al., 2014)	4-12th December 2013
Focus Groups	Group Interview (5-8 participants)	20 from Tacloban City, Giporlos, Eastern Samar, and Tanauan, Leyte	4-12th December 2013
Non-structured	Interview (1:1)	Government officials in towns of Tanauan, Palo, Tacloban, and Basey and DRRM officer of the province of Leyte	19-21st December 2013

4. Results

4.1. Structured Questionnaires

4.1.1. Perception of danger

The first question of the survey simply asked correspondents if they thought that typhoon Yolanda was a disaster or not, with almost all correspondents (94%) responding affirmatively. Figure 5 (showing the answers of the second question) shows how most thought that the storm surge was a real danger for them, which can be attributed to the fact that during the field surveys most people interviewed were residents of coastal settlements (in this sense Figure 6 shows how most people thought that their house was in danger of being flooded from the sea. In a separate question regarding whether their houses had actually been flooded 61% responded affirmatively; this correlates well with the "very strongly (62%)" answers shown in Fig. 5 and with "very strongly (49%)" answers shown in Fig. 6.

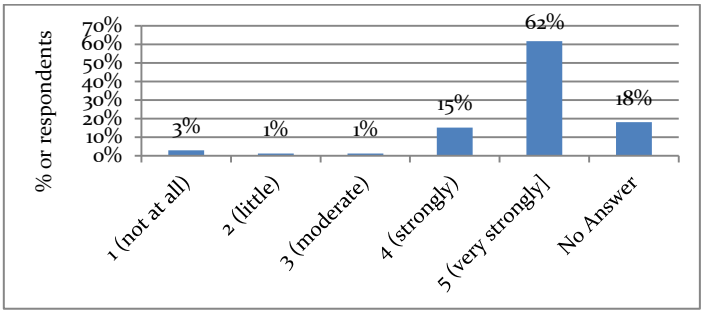

Figure 5 Distribution of the opinion of respondents regarding whether they thought the storm surge was a real danger for them (n=172)

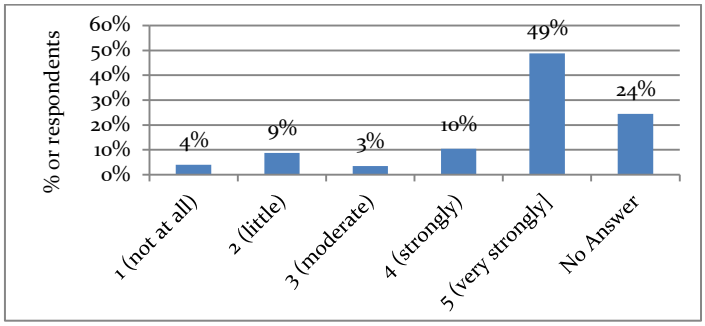

Figure 6 Distribution of the opinion of respondents regarding whether they thought that their home was in danger of being flooded from the sea. (n=172)

4.1.2. Knowledge of disaster

It is not entirely clear that respondents understood the phenomenon of the disaster before it struck. In this sense, only 47% of respondents ***said*** that they understood what a storm surge was ***and*** that the typhoon could bring with it a storm surge. It is not even clear that this 47% of people accurately understood the threat of the storm surge. Thus, respondents were asked about this extensively during the focus group interviews, as detailed later in this paper.

4.1.3. Experience with previous disasters

As shown in Fig. 7, most of respondents (56%) said that they had not experienced any type of damage due to coastal hazards so far in their lives. To some extent it is thus normal that many of them did not have much awareness about the potential threat of storm surges, as shown in Figs. 5 and 6, and this likely to have negatively affected disaster preparedness.

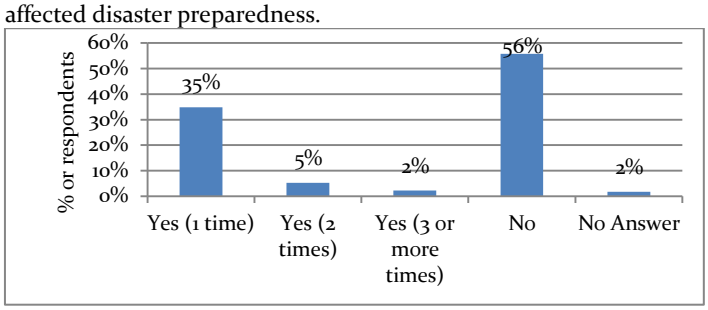

Figure. 7 Proportion of respondents who have experienced some sort of damage from a previous disaster (i.e. storm surge or tsunami) (n=172)

4.1.4. Preparedness before the disaster and source of information about the disaster

Regarding sources of information on the disaster 52% of respondents said they obtained information about the storm surge, with 69% saying that this information was at least moderately useful (see Fig. 8). Over three quarters relied on TV or radio, and to a lesser extent on the internet and other members of the family (see Fig. 9). Public officers consulted indeed described how the Organization of Civil Defence (OCD) had distributed information to local media regarding the event and that this was broadcasted to the population.

4.1.5. Evacuation

Regarding evacuation preparedness prior to the event (layer 3 measures) only 20% or respondents confirmed that they had taken part in evacuation drills at some point in their lives (13% in one evacuation drill, and 7% in 2 or more), though 58% said they knew how to evacuate (see Fig. 10). This indeed denotes that some efforts had been made by local authorities to train the population, and

that generally these had been understood by a sizeable majority of the population.

Accordingly, around 59% of respondents confirmed that they had indeed evacuated before the arrival or the typhoon and 36% said that they had not, which correlates well with information obtained during the focus group interviews. In fact, prior to the event the Organization of Civil Defence (OCD) also issued an evacuation warning, which was the reason cited by 73% of the people for evacuating (see Fig. 11). Fig. 12 shows that 66% evacuated when they saw forecasts or after receiving the evacuation warning. Around three quarters of those who evacuated did so walking (74%, see Fig. 13), Also, Fig. 14 illustrates that 69% of evacuees proceeded to evacuation shelters (34%), high buildings (8%) or other public facilities. 29% of people evacuated to their family or relatives' places, which is somehow related with evacuation patterns, and highlights the importance of family ties in the area (88% of respondents said that they evacuated together with other members of family, see Fig. 15).

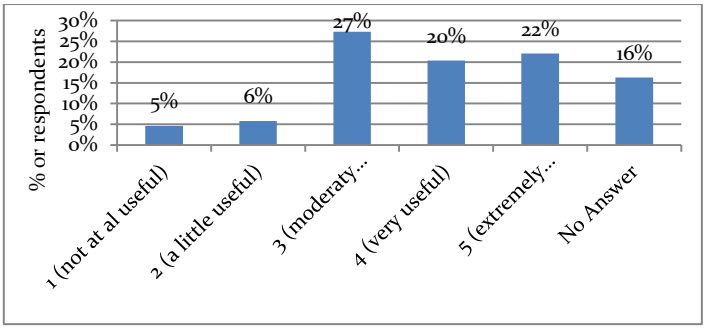

Figure 8 Distribution of respondent answer regarding whether the information they obtained on the storm surge was useful (n=90, only includes the respondents who said they had obtained some information regarding the storm surge)

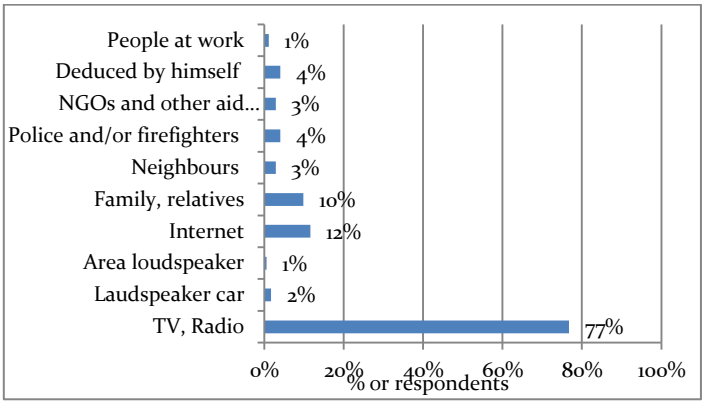

Figure 9 Source of information on storm surge and typhoon (n=90, multiple-choice allowed)

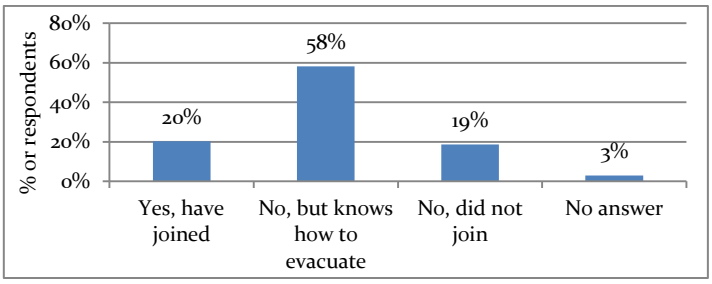

Figure 10 Proportion of respondents who have taken part in evacuation drills (n=172)

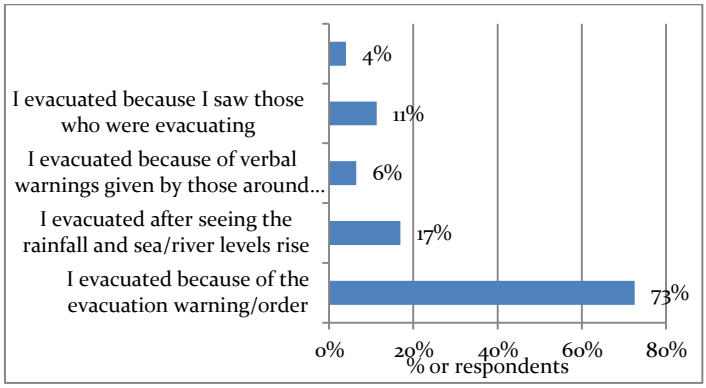

Figure 11 Reasons cited by respondents for evacuating (note that multiple answers were allowed in this question) (n=124)

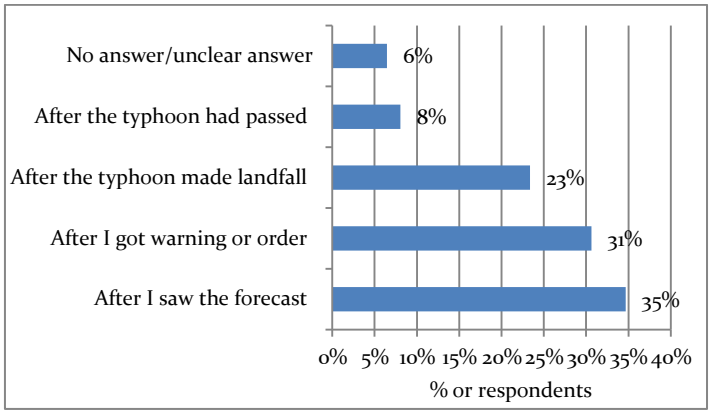

Figure 12 Evacuation timing of respondents (n=124)

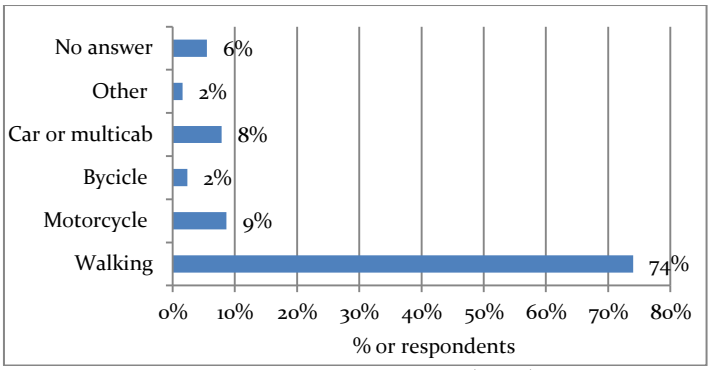

Figure 13 Evacuation method (n=124)

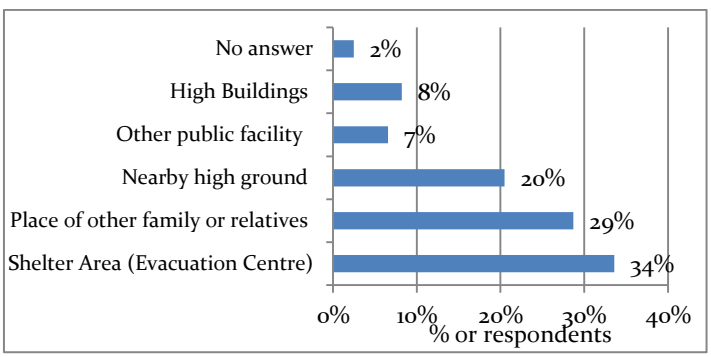

Figure 14 Evacuation destination of respondents (n=124)

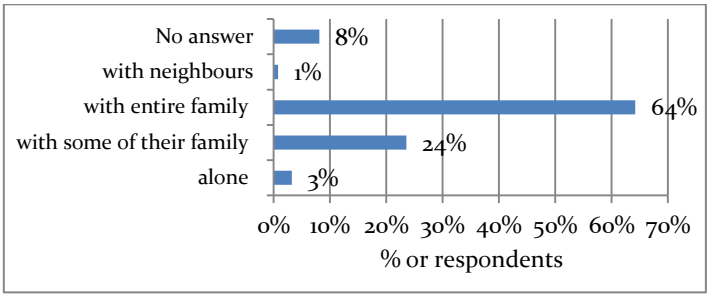

Figure 15 Evacuation group patterns (n=124)

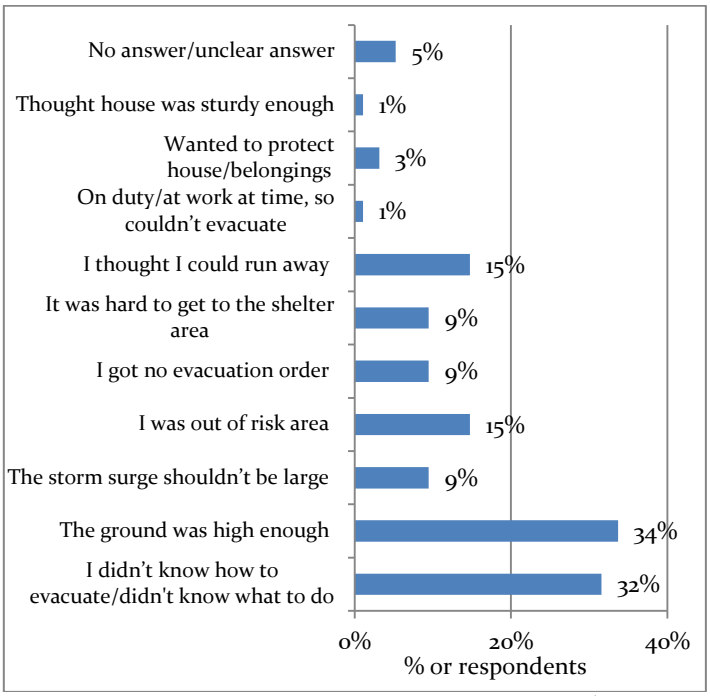

Figure 16 Reasons cited by respondents for not evacuating (note that multiple answers were allowed in this question)

The reasons cited for not evacuating are more complex, as shown in Fig. 16. Essentially, the reasons given by those who stayed in their homes were that they did not know how to evacuate or what to do (32% of those who did not evacuate), or that they were in safe or high enough area (49%). Other reasons given included difficulty in getting to evacuation area, not receiving evacuation order, or underestimating the danger posed by the storm (thinking that the storm would not be so high or that they could run away easily. Nevertheless, 94% of respondents agreed that if they faced a similar situation once again they would indeed evacuate.

4.2. Focus group interviews

Focus group interviews were conducted at the same time as the questionnaire survey in order to provide insights as to how to interpret the data from structured questionnaires and to obtain qualitative information for a more detailed picture of the disaster. The focus group interviews took place with three different groups of people who completed the structured questionnaires. All interviewees concurred that they had felt fear during the disaster and likened the situation to an "end-of-the-world" scenario. Everybody described the situation as eerie because they could not see anything and yet could feel the strength of the typhoon. They also felt panic because they were not sure where to go or what to do, leading to feelings of accepting death.

Many respondents said that they did not possess an accurate picture of the event, despite the fact that 77% of respondents of the structured questionnaire strongly or very strongly believed that the storm surge was a real danger for them (see Fig. 5). The results thus show some level of confusion. Later interviews with public officials emphasized that people had been warned of the flooding, though they did not seem to conceptualize the phenomenon itself correctly. In this sense, many people expressed the view that it would have been better for authorities and media to describe it as a "tsunami or tidal wave", which would have given people a better feeling of the danger involved.

4.2.1. Tanauan, Leyte

The group was composed of 5 residents of Tanauan, Leyte. They told the authors that evacuation warnings were sent to the barangay (the term used to denote "village", which is the smallest administrative unit in the Philippines) a day prior to Haiyan's landfall. However, this proved inefficient because they had not taken part in any evacuation drills, disaster preparedness trainings or other capacity building activities. Also, they did not understand the nature of the storm surge. The typhoon hit early morning at around 7:30 AM. The flood due to the storm surge was said to be more than the height of a normal person. There were 5 waves with one-minute intervals in between them. The last wave was the strongest. When the waves hit, it created a whirlpool effect that made it impossible for those trapped in it to swim through and resorted to clinging to trees to save their lives. The waves had very fast velocity and the water level held for about 30-40 minutes. Afterwards the inundation receded very quickly and in about 5 minutes was completely gone. They have also noted that the water reached the church, the designated evacuation center, where about 200 people fled. Those caught fleeing during the event were engulfed by the waves.

4.2.2. Tacloban City, Leyte

The group (composed of seven youths from Basey that took refuge in Tacloban City after the disaster) did not have any clear understanding of the phenomena of storm surges prior to the typhoon. They simply knew that a super typhoon was coming. They did have knowledge on how and where to evacuate because they had evacuation drills prior to the event. However, they noted that not all of the people evacuated or had an idea of the evacuation system. They stated that there were people who evacuated to a plaza that was directly in front of the coast, which was hit by waves around 15ft high (approximately 5m) and perished. They also noted that if people were warned that a storm surge is like a "tidal wave" then many more people would have evacuated earlier.

4.2.3. Giporlos, Eastern Samar

The group was composed of middle-aged residents of Giporlos, Eastern Samar. They indicated that prior to Haiyan's landfall only 20% of the residents of their Barangay evacuated to safer areas. The evacuation order came from the Barangay and Municipal Halls. Though they obtained information on storm surges through the interne they did not understand the nature of this information well. Regarding the number of people who understood the event one of them noted that "10% of the residents is already a generous number". Generally speaking prior to the event their understanding of a storm surge is that it was just strong waves from the sea. The typhoon made landfall in the morning, and it was their first time to experience such an event. They experienced 3 waves, with 10-second intervals between each wave, with the last being the strongest. They also described that they could not see the waves because of the near zero visibility during the event.

4.3 Non-structured Interviews

Non-structured interviews were conducted a week after the initial field work carried out by the team. The informants were the Disaster Risk Reduction Management Officers (DRRMO) of various towns in Leyte Province. The main objective was to gather information that would be able to put into chronological order the events prior and during the typhoon, as well as to understand whether the officials had a clear picture about the nature of storm surges.

The various officials stated that information regarding Haiyan started to be received from November 4. Part of the initial information they were sent was the predicted wind speed of the Typhoon from the Philippine Atmospheric, Geophysical, and Astronomical Services Association (PAGASA).

The following day the towns started to set-up rescue teams, evacuation centres and warnings were sent to coastal barangays.

Storm surge warnings were given on November 6, though the officials generally did not expect it to be as big as stated (several expressed that they could not believe such high levels of water could be possible) and generally it seems that the actual phenomena was not well understood. In this sense their knowledge of what could happen was limited to strong waves, which were a usual occurrence during typhoons in the past. Also on this date the City DRRM Council in Tacloban was convened to initiate disaster preparation strategies. Preventive evacuation to the Tacloban City Convention Center was carried out in the afternoon of that day. Emergency stockpiles started to be prepared in various towns and communities.

From November 7 evacuation activities began to be carried out and residents were told to evacuate, with several officials stating how they circulated around the municipality to implement a forced evacuation. However, many residents on the coastal Barangays did not evacuate because they did not understand correctly the nature of storm surges. The weather in Tacloban was hot and humid with no rain in sight.

In the early morning of November 8 at around 3 AM to 5 AM the weather was still very calm, prompting some of the evacuees to return to their houses. At around 5:00 to 6:00 AM strong winds were felt. The shoreline at Tacloban and other localities started to recede at around 06:00, in Tacloban the water retreated to up to 100 m from the coast. At around 6:30 AM, the storm surge hit, manifesting itself quickly, "in less than the time to drink a cup of coffee." The episode lasted 30-40 minutes and consisted of 3 waves, with the third being the strongest. By 7:00 AM it had subsided.

A number of interesting insights into disaster preparedness were also gained by talking to DRRM officials, who noted how plans for the city of Tacloban considered flooding but did not take into consideration hazards along the coastline. Essentially, DRM plans had focused on flooding as the primary hazard, and various settlement had extensive flood hazard maps as well as flood markers, but had not given any consideration to the possibility of coastal hazards. Also, it appeared that 3 months prior to the typhoon several barangays were in the midst of improving disaster preparedness, with officials undergoing training and development planning to incorporate DRRM into their policies. Immediately after the training was finished typhoon Haiyan formed.

4. Resilience and Sustainability Implications

After every major disaster the damage to coastal areas generally leaves an important imprint in the minds of those who experienced it. Major examples of this can be found in other signify recent events, such as the 2004 Indian Ocean Tsunami or the 2011 tsunami in Japan. These two events highlight the link of disaster prevention to development and showcase how a high disaster-aware developed country such as Japan can establish a multi-layer countermeasure system against disasters, which can help reduce the overall damage [1]. However, developing countries often do not place as much emphasis on disaster mitigation in their development policies and clearly show lower levels of resilience to events such as typhoons and tsunamis [1]. The results of the present survey highlight the need to mainstream measures to improve disaster resilience into the general development agenda of countries such as the Philippines. Resilience is generally considered to have 3 components: agents (the people and organisations involved, including local authorities), institutions (referring to the sets of rules that guide human behaviour) and systems infrastructure. Though developing countries often lack the resources to construct layer 1 "hard measures", spatial planning and evacuation systems do not necessarily require large investments and can prove highly effective against coastal disasters [1]. If adequately constructed, certain government buildings and other robust structures can survive even tsunamis of considerable height, and the building of such Evacuation Buildings should take place in all areas at risk by coastal hazards [11]

It is thus clearly important for local authorities to establish effective layer 2 measures, were the inhabitants of an area do not "forget" past events and the construction of housing in areas that are at high risk is prevented. This can be established through adequate regulations and zoning control that prevents development in potentially hazardous areas. In this sense the Department of Environment and Natural Resources intended to delimitate a 20m to 40m "no build zones" along the coasts in the different areas of the Eastern Visayas region [13], though during the authors' field survey in the area one year after the disaster it was clear that this was not being enforced and that many houses were being rebuilt right next to the coastline. This is a clear failure of the agent and institutional component of resilience, failing to improve resilience to future events.

Despite the comparative lack of resources of a country like the Philippines, some efforts had clearly been made on the side of the authorities. Prior to the arrival of Haiyan both Leyte and Eastern Samar had disaster mitigation and prevention strategies in place. An early warning system was employed, which made use of hazard maps and flood drills. The provinces also had communication centres tasked with relaying information to the various municipalities. These are all important elements of community preparedness [14]. Despite these preparations the province was hit badly because they had been preparing mainly for flooding from upland and river areas. The disaster brought by typhoon Haiyan was due to a storm surge – a coastal hazard.

At the country institutional level, the Philippine Atmospheric, Geophysical, and Astronomical Services Association (PAGASA) also provided regular updates on the storm. As early as November 5, information on the disaster was disseminated to the different Barangays, radio stations and TV stations. Radio and local TV explained that the water might be 5 to 7m height starting from November 6th (an estimation regarding the inundation height came to the OCD from the National Disaster Risk Reduction Management Council (NDRRMC) around 2 days before the event). From the results of semi-structured and non-structured interviews in this study it seems that most people took notice of these warnings (see also [15]). In this sense, recent past events such as the damages incurred during Typhoon Washi (Sendong) and Typhoon Bopha (Pablo) that hit Mindanao in 2011 and 2012 respectively might have raised people's awareness about typhoon risks in that area. However, there were clearly a number of misinterpretations and lack of understanding about the nature of a storm surge. As mentioned in Section 4.3.5, one of the public officials also highlighted that some of the misinterpretation of the phenomenon were due to the information given by PAGASA being too technical. They explained the phenomena of storm surges to people by saying

that it is a *"dagko nga balod"* which in the vernacular means "very big waves." People initially thought that their houses could withstand strong waves, and this discouraged them from evacuating. In fact, the photographic and witness evidence showed how the storm surge in many places was rather more similar to a tsunami wave, and this phenomenon was corroborated by computer simulations [16]

Officials from the Office of Civil Defence (OCD), the implementing agency of the Disaster Risk Reduction and Management (DRRM) Act of the Philippines, explained to the authors how preparatory meetings starting November 4, 5 days prior to the Typhoon's landfall on November 8. This information was received by various local authorities, as evidenced by the interviews carried out by the authors with DRRMO officials. During the final meeting on the day before the typhoon the secretaries (the title given to cabinet ministers in the Philippines) of the Department of the Interior and Local Government (DILG) and the Department of National Defence (DND) came to the region to make an assessment of the resources available, and stayed for 1-2 weeks after the disaster. The Secretary of DND is the chairman of the NDRRMC and the secretary of DILG is one of the co-vice chairs (in charge of preparedness) of the NDRRMC.

Regarding evacuation, there is a law that considers this process, with two stages contemplated: first an evacuation advice and afterwards a mandatory evacuation. The Organization of Civil Defence (OCD) advised people to evacuate, and most did so by themselves, so a forced evacuation was not necessary in most cases, and there were no reports of mandatory evacuations that were received by the OCD, although the authors did encounter reports that officials of certain communities did enforce evacuation a day prior to the arrival of the typhoon. For the case of Tacloban city the typhoon arrived Friday, but pre-evacuation took place on November 6 (Wednesday). The major of the city instructed residents to evacuate and officials came to the different barangays to give instructions. Some of the residents who did not evacuate prior to the typhoon evacuated from their houses to neighbouring houses that were stronger, as explained previously.

The OCD also expressed how a number of lessons have been learnt from this typhoon, with such lessons being crucial for the sustainable development of the country as a whole given the large number of typhoons that affect it on an annual basis. Preparations by national and local governments should be carried out before the event. They have identified some weaknesses, such as the dissemination of information, and that this information should be internalized by the public (see also [15]). Prevention and mitigation are thus a key part to reduce the impact of disasters. Through education people should learn how to prepare for the disaster by themselves, in order to better cope with natural disasters. Some key buildings were also not designed to resist such a disaster, and for instance the OCD's own main building was damaged (the roof was destroyed and electrical installations damaged due to the heavy rain) so they had moved to new temporary office at the time of the author's first post-disaster survey. In this sense, various requests are being made to the national government for funds to build official buildings (schools, hospitals, etc) to a higher standard. For instance, prior to the event the building code of the Philippines stated that the roofs of schools and hospitals should be designed to withstand 250km/hr winds in Wind Zone 1 Areas such as Leyte and Eastern Samar. After the event there has been a debate about whether to increase this or to treat Haiyan as a special case [17].

5. Summary and Conclusions

One of the key problems identified during the focus group interviews was how people were not able to clearly conceptualize the concept of storm surge during the event. Even local authorities, who had been warned about the possibility of 7 or 8m high waves, were not aware that these waves would manifest themselves as a flood, and it was clear that local hazard maps underestimated the potential hazards due to a storm surge. Many expressed how it would have been better for the central government and media to describe the event as "tsunami-like" waves. Thus, one of the key lessons of this disaster is that it is not only important to warn population about the danger of an incoming storm surge, but also to accurately depict the nature of a storm surge. In this case, a lack of awareness about the incoming threat appeared to have somehow undermined preparedness efforts on the side of the authorities. Although the authors collected evidence that these efforts were indeed extensive, it is important that in the future all the population is warned that it is imperative to take shelter before the event. It appears that many residents, even those that had received information about the storm surge, "under-estimated" the event and thought that they could evacuate at a later stage or during the event [13]. Thus, the lack of accurate dissemination of information when faced with a low frequency natural disaster event could seriously compromise a coastal community and put its long-term sustainable development into question.

However, for an effective disaster management strategy to be effective it must rely on several layers of protection. In this sense, it is important that more emphasis is placed in the future on layer 2 measures by making sure that residents do not build their houses too close to the sea, and important buildings (refuge centres, schools, hospitals) are placed on high ground. Disaster Management authorities would like to move in this direction and to also upgrade the design code so that buildings can cope with higher strength winds, in line with a general philosophy of "Building Back Better".

The Philippines appears to have been steadily improving its disaster preparedness and emergency response capabilities. However, this event indicates that much remains to be done and that the resilience of coastal communities should improve so that rebuilding can be more effective after such "super-typhoon" events. Although some degree of damage should always be expected from such events, it is imperative that the loss of life is minimized and that key infrastructure remains in operation to facilitate the relief progress and reconstruction.

Acknowledgements

The authors would like to acknowledge the contribution of the other team members and the NHK team that accompanied the survey group: T. Ooyama, R. Nakamura, K. Kumagai, J. Gremio, E. Shimakawa, N. Mizugai, H. Kitajima, T. Okado. Also, several Department of Public Works and Highways (DPWH), Office of Civil Defence (OCD), Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA) and other Philippines disaster management officials provided invaluable information to the authors. Finally, funds for the field survey were mainly provided by Strategic Research Foundation Grant-aided Project for Private Universities from the Ministry of Education (obtained by Waseda University), and partly by the Global Programme on Sustainability Science Global Leadership Initiative (GPSS-GLI, The University of Tokyo) and a research grant from Tokyo Institute of Technology.

References

[1] Esteban, M. Tsimopoulou, V., Mikami, T., Yun, N. Y., Suppasri, A. and Shibayama,T. (2013) "Recent Tsunami Events and Preparedness: Development of Tsunami Awareness in Indonesia, Chile and Japan", International Journal of Disaster Risk Reduction, Vol. 5, pp. 84-97.

[2] Hoshino, S., Esteban., M., Shibayama, T., Mikami, T. and Takabatake, T. (2012) Climate Change and Coastal Defences in Tokyo Bay. Proc. of 32nd Int. Conf. on Coastal Engineering (ICCE 2012), Santander, Spain.

[3] Mikami, T., Shibayama, T. and Esteban, M., (2012a) Analysis of Inundation Disaster and Mitigation in Waterfront Area Based on Field Survey of Storm Surge in New York City Caused by 2012 Hurricane

Sandy, Journal of Japan Society of Civil Engineers, Ser. B3 (Ocean Engineering), Vol. 69, No. 2, pp. I_982-I_987.
[4] NDRRMC (2014) Effects of Typhoon "YOLANDA" (HAIYAN), SitRep No. 104, 19 Jan 2014
[5] TIME (2013) The Typhoon's Toll, TIME Magazine, Vol.182, No.22.
[6]National Water Plan of the Netherlands, http://english.verkeerenwaterstaat.nl/english/Images/NWP%20english_tcm249-274704.pdf. Accessed 10 August 2012
[7] Tsimopoulou, V., Vrijling, J.K., Kok, M., Jonkman, S.N., Stijnen, J.W., (2013) Economic implications of multi-layer safety projects for flood protection, Proc. ESREL conference, Amsterdam
[8]Takagi, H., Esteban, M., Shibayama, T., Mikami, T., Matsumaru, R., De Leon, M, Thao, N.D., (2014) Track Analysis, Simulation and Field Survey of the 2013 Typhoon Haiyan Storm Surge. Journal of Flood Risk Management (submitted)
[9] Kubota, H., and J. C. L. Chan (2009), Interdecadal variability of tropical cyclone landfall in the Philippines from 1902 to 2005, Geophys. Res. Lett., 36, L12802, doi:10.1029/2009GL038108.
[10] Brand, S., Blelloch, J. W. (1973) Changes in the Characteristics of Typhoons Crossing the Philippines. J. Appl. Meteor., 12, 104–109.
[11] Shibayama, T., Esteban, M., Nistor, I., Takagi, H., Danh Thao, N., Matsumaru, R., Mikami, T., Aranguiz, R., Jayaratne, R. and Ohira, K. (2013) Classification of Tsunami and Evacuation Areas. Journal of Natural Hazards, 67 (2), 365-386
[12]Friend, R. and MacClone, K. (2013) Climate Resilience Framework, Putting Resilience into Practice. Institute for Social and Environmental Transition.
[13] Department of Environment and Natural Resources Region VIII (2014) DENR Delineates 20 and 40 meters easement of coast lines affected by Typhoon Yolanda. Department of Environment and Natural Resources Region VIII, Palo, Leyte, Philippines
[14] Paton, D. and Johnston, D. (2001) Disasters and Communities: Vulnerability, Resilience and Preparedness. Disaster Preverntion and Management, 10, 270-277.
[15] Leelawat, N, Mateo, C. M. R., Gaspay, S. M., Suppasri, A., Imamura, F. (2013) Filipinos "Views on the Disaster Information for the 2013 Super Typhoon Haiyan in the Philippines", International Journal of Sustainable Future for Human Security, J-SustaiN. Vol. 2 No. 2 pp. 61-73.
[16] Bricker, J. and Roeber, V. (2015) Mechanisms of Damage During Typhoon Haiyan: Storm Surge, Waves and "Tsunami-Like" Surf Beat. Proc. Of 36th IAHR World Congress, 28 June-3 July, The Hague, Netherlands.
[17]Del Castillo, Butch (2013) Wind Zones and the Building Code. Business Mirror, Manila, Philippines. Accessed 17 January 2014 http://businessmirror.com.ph/index.php/en/news/opinion/23014-wind-zones-and-the-building-code