
A cross-sectional descriptive study on the earthquake preparedness of selected highly vulnerable barangays in Metro Manila

Justine Mary R. Baquiran, April Faye P. Barbadillo, Maria Fonseca Camille T. Baroña, Beverly Mae C. Castillo, Charis Easter Joy G. Castro, Luis Lorenzo A. Chan, Collin Clinton E. Cheng, Mica Asher Antonie D. Ching, Elliri Aleeja V. Chio, Cheryl Yvan C. Chong, Ma. Peñafrancia L. Adversario, MD, MSPH and Jose D. Quebral, MD (Advisers)

Department of Preventive and Community Medicine, College of Medicine

Abstract

Introduction A 7.2 magnitude earthquake arising from the West Valley Fault will result in thousands of lives lost and severe damage to property and infrastructure. This study aimed to determine the disaster preparedness of barangays in Metro Manila along the West Valley Fault.

Methods This was a cross-sectional study of high risk barangays in six cities along the West Valley Fault using the Disaster Preparedness Audit. A total of 40 barangays were assessed on their levels of disaster preparedness in terms of percentage fulfilment of different criteria in the four thematic areas: 1) prevention and mitigation 2) preparedness 3) response and rehabilitation, and; 4) recovery.

Results None of the surveyed barangays could fulfil all the 27 criteria for disaster preparedness. Most were only able to satisfy 50-74% of the criteria. As per thematic area, no barangay met $\geq 75\%$ of the criteria for prevention and mitigation whereas 87.5%, 67.5% and 80% satisfied $\geq 75\%$ of the criteria for preparedness, response and recovery, respectively. In terms of overall disaster preparedness, less than half of the surveyed barangays satisfied $\geq 75\%$ of the total criteria.

Conclusion Most of the barangays surveyed are inadequately prepared to cope with disaster arising from a major earthquake generated by the West Valley Fault.

Key words: Disaster preparedness, earthquake preparedness, emergency management

In the last 10 years, more than 2.6 billion people have been affected by natural phenomena such as

earthquakes, tsunamis, landslides, floods, and extreme weather. Although the occurrence of natural disasters in Asia declined from an average of 158 in 2000-2008 to 135 in 2009, among the continents, Asia still experienced the largest share of natural disaster at 40.3%.¹

The Philippines ranked first in the top 10 countries that reported the most number of disaster events. One of the factors that increases the country's vulnerability to disasters, particularly those that are geophysical in nature, is its distinct tectonic setting. Due to numerous fault lines, the country experiences an average of 20 earthquakes per day and damaging

Correspondence:

Maria Fonseca Camille T. Baroña, Department of Preventive and Community Medicine, College of Medicine, University of the East Ramon Magsaysay Memorial Medical Center Inc., 64 Aurora Boulevard, Barangay Doña Imelda, Quezon City 1113; E-mail: fonsecabarona@gmail.com; Telephone: +639178091320

Presented in the 19th Annual Research Forum, April 11, 2017, University of the East Ramon Magsaysay Memorial Medical Center, Quezon City

earthquakes have been recorded in the past.² To set the parameters and magnitude of each earthquake, several earthquake catalogs have been developed. These catalogs revealed that the greatest concern for Metro Manila is the Valley Fault System, which runs a stretch of 90-135 km and is cited to pose the most significant threat.³ The human impact of the movement of the Valley Fault System among areas of highest regional vulnerability was determined in the 2004 Metropolitan Manila Earthquake Impact Reduction Study (MMEIRS) conducted by the Japan International Cooperation Agency (JICA) in conjunction with the Philippine Institute of Volcanology and Seismology (PHIVOLCS). The MMEIRS found that an earthquake with a magnitude of 7 or more along the West Valley fault is expected to occur and would cause collapse of 40% of total residential buildings in vulnerable areas, and result in 34,000 deaths and 114,000 injured.⁴

Due to the threat, a list of barangays with high regional vulnerability was publicly released by the PHIVOLCS in 2015. The National Disaster Risk Reduction and Management Council (NDRMMC), the national agency governing the implementation of disaster preparation and response in the country, established a national guide through the National Disaster Risk Reduction Management Plan (NDRRMP) which outlines strategies and activities that aim to strengthen the capacity of both the national and local governments in disaster risk reduction and management. However, literature suggests that implementation of disaster preparedness plans is either discontinuous or only done during a disaster.² A direct relationship was also observed to exist between the prevalence of a natural event and disaster preparedness. The less often a natural event occurs, the less likely disaster managers prepare.⁵ Although considered the smallest political unit, the barangay is expected to be the frontline of emergency measures during disasters per the Local Government Code of 1991. Moreover, a community's mutual support systems and reliance on its own resources have been found to result in least damage and fast recovery from disasters.⁷ Survival strategies in the community level are used to cope with the impacts of disaster before outside help is available.⁸ Hence, a study on the barangay's disaster preparedness was undertaken.

This study aimed to determine the level of disaster preparedness for a major earthquake generated by the West Valley Fault among vulnerable barangays in Metro Manila. Specifically, the study aimed to determine percentage of criteria complied with in each of the four thematic areas of prevention and mitigation, preparedness, response, and recovery, determine overall compliance, and determine compliance by city. Results of the study would contribute to existing literature on disaster preparedness at the community level and to the planning of sustainable community-based disaster preparedness programs and policies.

Methods

The study employed a cross-sectional descriptive design involving highly vulnerable barangays based to their location along the West Valley Fault from a list released by PHIVOLCS. Key informants identified to be members of the Barangay Development Council (BDC) served as study respondents. The investigators conducted face-to-face interviews using the Community Profile Questionnaire and the Disaster Preparedness Audit. The study was approved by the Ethics Review Committee. Informed consent was obtained from each of the respondents.

Using the formula for estimation of a population proportion with a desired precision of 0.05 at 0.05 level of significance and 95% confidence interval, a sample size of 384 barangays was computed. Since the computed value was greater than 5% of the available population size, i.e., 42 highly vulnerable barangays, a finite population correction was used and the final required sample size was computed to be 38 barangays. The number of barangays per municipality was obtained through proportionate sampling.

Disaster preparedness was related to the community's compliance to the different criteria under the thematic areas of prevention and mitigation, preparedness, response and recovery. Level of preparedness was defined as percentage of fulfillment of the criteria under each dimension categorized as <50%, 50-74%, and ≥75%.

The instruments used were the Community Profile Questionnaire, which captured community demographics, and the Disaster Preparedness Audit

(DPA) tool condensed from the original tool of the Department of the Interior and Local Government (DILG).⁹ The DPA contained 27 criteria under the four thematic areas of disaster preparedness: preparedness, prevention and mitigation, response, and recovery. Each thematic area contained different criteria to assess disaster preparedness: 11 criteria under prevention and mitigation, 8 under preparedness, and 4 each under response and recovery. Pretesting of the tool was done in Laguna, which is also one of the highly vulnerable areas identified by PHIVOLCS.

Data from the barangays were collected through face-to-face interviews with members of the BDC. Observation and records review were also done to validate data obtained from key informants. Data were then encoded in MS Excel and processed using the Statistical Package for the Social Sciences (SPSS) version.¹³ Frequency tables were generated to show the distribution of the barangays in terms of demographic data, i.e., available facilities, services, and economic activities, and in terms of disaster preparedness. The barangays were evaluated based on percent fulfillment of the criteria under each thematic area as less than 50%, 50 to 74% and $\geq 75\%$.

Results

Majority (40%) of the respondents were barangay office staff, while the rest were disaster team leaders and coordinators, barangay captains and barangay councilors. The mean age of the respondents was 52 years; there were more male (75%) respondents, as seen in Table 1.

Table 1. Characteristics of respondents from the 40 participating barangays.

Characteristics of Respondents	Barangays No. (%)
Age (years)	
20-39	4 (10.0)
40-59	27 (65.5)
60-79	9 (22.5)
Sex	
Male	30 (75.0)
Female	10 (25.0)
Position	
Barangay Captain	8 (20.0)
Kagawad	7 (17.5)
Disaster Team Leaders and Coordinators	9 (22.5)
Barangay office staff	16 (40.0)

More than half of the barangays had a population density of 10,000 to 49,999 persons per square kilometer. The public jeepney/tricycle was the dominant mode of transportation while the main access route was the national road in most of the barangays. The most common source of drinking water was private waterworks. Less than half of the barangays had a sewerage system. Almost two-thirds of barangays had a flush toilet system but most of the barangays surveyed in Muntinlupa and Taguig City used the pail system (Table 2).

More than two-thirds of respondent barangays in every city had a fire station but less than half had a police station. At least 70% of the barangays had a senior citizens center, livelihood training, alternative learning, and health and nutrition programs. All barangays had access to landline and cellphone service. Public hospitals were found in only four of the barangays surveyed and less than half had private hospitals. Private clinics, drug stores and public health centers were present in at least 80% of barangays (Table 2).

The major economic activities of community members varied across the barangays. Although professional work and services were most common followed by trade, it occurred in less than half of the selected barangays in each municipality. Trade was most predominant among the barangays in Marikina, Makati and Quezon City; fishing and services for Muntinlupa; trade and manufacturing for Pasig. Almost all barangays had organizations which could be mobilized for volunteer work (Table 2).

Among the 11 criteria under prevention and mitigation, compliance was at least 75% in information and communications, clean-up and dredging of canals, waste segregation, inventory of sources of pollution and presence of a clinic. Compliance was moderate in the presence of a maintenance area, collaboration with other agencies, and identification of local and foreign agencies for support and response operations. None of the barangays met the requirement for a management team with two members per 300 people (Table 3).

In the area of preparedness, all barangays surveyed had a LDRRM plan and communication protocols with the municipal government. The other criteria with at least 80% compliance were community-based disaster risk management and LDRRM plan based on Hazard Vulnerability and

Earthquake preparedness of selected highly vulnerable barangays in Metro Manila

Table 2. Socio-demographic characteristics of 40 barangays surveyed.

Socio-demographic Characteristics	Total Barangays No. (%)
Population density	
<10,000	4 (10.0)
10,000 - 49,999	23 (57.5)
50,000 - 99,999	9 (22.5)
≥100,000	4 (10.)
Transportation	
Private car/jeepney	7 (15.0)
Public jeepney/tricycle	29 (72.5)
Others (e.g. <i>padyak</i> , pedicab)	4 (10.0)
Main access route	
National road	38 (95.0)
Seasonal road	1 (2.5)
Alley	1 (2.5)
Drinking water	
Private waterworks	32 (80.0)
Purchased	8 (20.0)
Sewerage system	14 (35.0)
Toilet facility	
Flush toilet	23 (57.5)
Pail system	17 (42.5)
Services	
Fire station	28 (70.0)
Police station	19 (47.5)
Senior citizens center	29 (72.5)
Livelihood training program	35 (87.5)
Alternative learning system	31 (77.5)
Health and nutrition program	37 (92.5)
Infrastructure and communication	
Landline	40 (100.0)
Cellphone service	40 (100.0)
Public hospital	4 (10.0)
Private hospital	13 (32.5)
Private clinic	35 (87.5)
Drug stores	38 (95.0)
Public health centers	37 (92.5)
Economic activities of residents	
Professional work	14 (35.0)
Trade	7 (17.5)
Fishing	3 (7.5)
Manufacturing	1 (2.5)
Services	10 (25.0)
OFW	2 (5.0)
Space rental	1 (2.5)
Economic activities in the community	
None	2 (5.0)
Farming	4 (10.0)
Fishing	7 (17.5)
Manufacturing	10 (25.0)
Trade	26 (65.0)
Service	14 (35.0)
Organizations for volunteer work	39 (97.5)

Table 3. Percentage distribution of disaster preparedness per thematic areas among 40 selected barangays.

Thematic Areas	Total Barangays No. (%)
Prevention and Mitigation	
Management team with 2 members per 300 people	
Relief	0
Health and Medical	0
Security/Peace and Order	0
Evacuation Center	
Clinic	30 (75.0)
Information and communication area	38 (95.0)
Maintenance area	29 (72.5)
Practicing waste segregation	34 (85.0)
Nearby open dumpsites, polluted rivers, factories, piggery, poultry or other sources of pollution are listed	23 (79.3)
Clean-ups and dredging of canals	37 (92.5)
With identified and established local and foreign agencies for financial and "in kind" support and response operation	24 (60.0)
With established collaborative efforts with NGAs, NGOs, PSOs, CSOs or other partners	26 (65.0)
Preparedness	
LDRRM plan on prevention/mitigation, preparedness, response, recovery/rehabilitation	40 (100.0)
LDRRM plan based on Hazard Vulnerability and Capacity Assessment	33 (82.5)
Established RDANA (Rapid Damage Assessment Needs Analysis) plan	30 (75.0)
Community-based Disaster Risk Management (CBDRM) practiced	39 (97.5)
Established communication protocols between municipal to barangay level	40 (100.0)
Established communication protocols between barangay level to municipal level	40 (100.0)
Disaster resilient architecture and engineering incorporated to infrastructures	21 (52.5)
Architecture of buildings modified to adapt to multiple hazards	20 (50.0)
Response	
Established evacuation centers	5 (12.5)
Identified open ground/area to serve as an encampment for tent and other mobile temporary shelter (in cases there are no established evacuation center facility)	34 (85.0)
People to monitor water sources during a disaster	32 (80.0)
Environmental watchers deployed during a disaster	36 (90.0)
Recovery	
Accessible health facilities (i.e. health center, public/ private hospitals/ clinics)	35 (87.5)
Vulnerable groups (i.e. sick, elderly, disabled, women and children) prioritized in terms of health needs	43 (85.0)
Clean and adequate supply of drinking water ensured after a disaster	26 (65.0)
Regular clean-up drives	38 (95.0)

Earthquake preparedness of selected highly vulnerable barangays in Metro Manila

Table 4. Percentage distribution of 40 barangays according to level of preparedness for each thematic area.

Dimensions	Level of Preparedness		
	<50% No. (%)	50-74% No. (%)	≥75% No. (%)
Prevention and mitigation	11 (27.5)	29 (72.5)	0
Preparedness	0	5 (12.5)	35 (87.5)
Response	4 (10.0)	9 (22.5)	27 (67.5)
Recovery	2 (5.0)	6 (15.0)	32 (80.0)
Overall	2 (5.0)	23 (57.5)	15 (32.5)

Table 5. Frequency distribution of barangays according to level of preparedness per city.

Dimension	City					
	Makati (n=4)	Marikina (n=4)	Muntinlupa (n=7)	Pasig (n=2)	Quezon City (n=11)	Taguig (n=12)
Prevention and mitigation						
<50%	0	0	0	0	3	8
50-74%	4	4	7	2	8	4
≥75%	0	0	0	0	0	0
Preparedness						
<50%	0	0	0	0	0	0
50-74%	0	0	0	0	2	3
≥75%	4	4	7	2	9	9
Response						
<50%	0	0	0	0	1	3
50-74%	0	2	3	0	1	3
≥75%	4	2	4	2	9	6
Recovery						
<50%	0	0	0	0	0	2
50-74%	1	0	0	0	2	3
≥75%	3	4	7	2	9	7
Overall						
<50%	0	0	0	0	0	2
50-74%	2	1	4	0	7	9
≥75%	2	3	3	2	4	1

Capacity Assessment. Only 52.5% and 50% reported incorporation of disaster resilient architecture and engineering to infrastructures and modification of structures, respectively (Table 3).

In the area of response, there was 80 to 90% compliance with environmental watchers during disaster, open grounds or areas for evacuation identified and people assigned to monitor water sources. Only five barangays had established evacuation centers (Table 3). Under the last thematic area, which is recovery, there was 85 to 95% compliance with regular clean up drives, identified health facilities that could be accessed, and

prioritization of vulnerable groups. A lower proportion reported availability of clean and adequate drinking water source after a disaster (Table 3).

Overall, a third of the barangays surveyed met more than 75% of 27 criteria on disaster preparedness, more than half of barangays fulfilled 50-74%, and two barangays, both in Taguig met less than half of the criteria. None of the barangays fulfilled 75% of the criteria for prevention and mitigation and 11 barangays had less than 50% compliance. The percentages of barangays that satisfied at least 75% of criteria were 88% in preparedness, 80% in recovery and 68% in response (Table 4). At the level of the

city or municipality, Pasig and Marikina had the highest percentage of barangays which were most prepared. At least 57% of barangays from all cities satisfied at least 75% of criteria for preparedness, response and recovery. More than half of the barangays in Makati, Muntinlupa, Quezon City and Taguig were considered as moderately prepared (Table 5).

Discussion

In this study, four thematic areas of overall disaster preparedness were evaluated. Prevention and mitigation entail reduction of vulnerabilities and hazards, and enhancement of the community's capacity, while preparedness refers to the creation of disaster plans and systems, incorporation of disaster-resilient designs, and modification of architectural buildings to adapt to hazards. Response includes provision of basic needs whereas recovery involves restoration or continuity of community activities post-disaster.

Despite the national initiative of formulating disaster risk reduction strategies through an LDRRM plan in every barangay, gaps were found in mainstreaming the plan in respective LGUs. The study found gaps in the implementation of disaster preparedness plans as shown by less than 75% percent fulfillment of the disaster preparedness criteria by most barangays (57.5%). This corroborates research on community-based disaster preparedness which revealed that despite the potential of increasing the capacity and disaster resilience of communities, limited practice of community-based disaster preparedness is observed.¹⁰

In this study, several gaps in the implementation of disaster preparedness plans were found. In the area of prevention and mitigation, management team for relief, health and medical, security/peace and order, with two members per 300 population, identification and establishment of local and foreign agencies for support and response operation, and collaborative efforts with non-governmental and civic society organizations were the principal criteria that were primarily unmet. The absence of having a management team of two members per 300 population may be attributed to the lack of available and trained personnel. The absence of public health centers in three barangays and public hospitals in 36 barangays contributed to the inability to meet the

proposed health management team to population ratio of 2:300 since there may be no public health personnel to train. In the same way, the lack of police stations in 21 of 40 barangays resulted in the scarcity of officers to lead the security/peace and order team. Barangays form their disaster management team from members of their own community and when deficient in number of personnel, the ratio of two management team members to 300 population would be unmet. In addition, the high population density of some barangays could have been a factor in meeting the required ratio.

However, the number of trained personnel may not necessarily be the most important factor in disaster preparedness. In a study on a terrorist gas attack in Tokyo, it was reported that despite the insufficient number of the management team, the disaster response was considered a success.¹¹ Efficiency and capability of response teams offset the lack of manpower. In a report by Tayag and Insauriga on the response in the 1990 Luzon earthquake, it was also found that although rescue teams were present, capability in disaster response was more emphasized.¹²

Another gap found was identification and establishment of local and foreign agencies for external support. Apart from creating a LDRRM plan, the BDC should also report other funding sources and support aside from LGUs. Forty percent (40%) of barangays reported absence of other local or foreign funding sources while the remainder identified local groups such as homeowners' associations, Rotary Clubs and fraternities. Political dynamics was identified to play a role in having external support in times of disaster. Typically, a government favors spending in areas that are politically aligned with the party in power. Moreover, a government that lacks external support can also exhibit a ratchet effect, where the government intentionally neglects to support a population to draw attention and then steal humanitarian aid during a disaster as international organizations are more likely to tolerate theft in times of disaster as they are more focused on providing needed aid.¹³ Another reason for the absence of external support is the perceived capability of the barangays with high economic status to support themselves.

In the area of preparedness, incorporation of disaster resilient architectures and engineering in infrastructures and modification of architectural buildings to adapt to multiple hazards were a

challenge reported in nearly half of the barangays surveyed. Numerous structures had been built before the 1991 National Building Code of the Philippines. Although there is an existing law, its implementation remains a challenge. A Filipino architect and urban planner, Palafox stated that the country is still lacking in the provision of resilient and sustainable infrastructures.¹⁴ For instance, in the aftermath of the Bohol and Cebu earthquake in 2015, most buildings were discovered to be structurally unfit to withstand a high intensity earthquake. The deficit resulted from use of cheap substandard materials, shortcuts in labor procedures and irregular processes in acquiring building permits. Modification of buildings was reported to be difficult as it required funds and involved a lengthy and tedious process of securing permits.

Apart from issues on the safety of infrastructures, barangays also reported resistance and lack of cooperation from families whose houses lie on or within 500 meters from the fault line. This was attributed to unrealistic optimism bias, where people believe they are at less risk of experiencing a disaster compared to others. Moreover, people do not perform actions despite having the motivation when effects of hazards are perceived as fundamentally unbeatable, when they perceive themselves having low efficacy, or are not entirely disposed to cope with the situation. A sense of fatalism or belief that the disaster may be too catastrophic that preparedness may be inefficient can also influence the lack of preparedness.¹⁵

The findings also revealed that establishment of evacuation centers was the second criteria least met. Although the DILG's DPA tool includes assessment on existence of evacuation centers in barangays, the NDRRMP clearly states that safe and timely mobilization of affected community members is the LGU's principal role during disaster. Addressing shelter needs is a task assigned to the Department of Social Welfare and Development (DSWD) with the LGUs serving as partner agencies. This may explain the low percentage of surveyed barangays reporting presence of evacuation centers in their communities. Despite the lack of evacuation centers, temporary shelters exist and the top three were schools, basketball courts and streets. The use of temporary shelters is commonly observed in developing countries due to lack of resources. Unfortunately, ventilation, space, cultural and social issues and integration of sanitation and hygiene that are all critical to disaster

recovery are not usually considered in these temporary shelters.¹⁶

Aside from shelter, it is expected that after a disaster, utility services such as water supply could be disrupted. Access to clean and adequate supply of drinking water after a disaster was reported by the barangays to be a challenge. This was observed to result from total reliance on private waterworks. Despite awareness on the need for alternative water source, increased dependence on private water companies and supply from evacuation centers was reported.

Although gaps exist in the implementation of disaster management plans, there were criteria which nearly all barangays satisfied. These include the presence of LDRRM plan, practice of CBRDM, establishment of communication protocols, assignment of environmental watchers, and prioritization of vulnerable groups particularly the elderly, sick, disabled, pregnant, and children. The NRRMC mandates barangays to create a LDRRM plan to which all surveyed barangays complied. Practice of CBRDM was also observed. Community participation, on the other hand, was reflected by the high percentage of barangays with existing community groups and organizations tapped for volunteer work and service. All barangays surveyed reported existence of established communication protocols between the municipal and barangay level. Presidential Decree No. 1 mandates the Office of the Civil Defense to establish standard procedures on the communication system in municipal and barangay disaster risk reduction and management councils.¹⁷

Among the thematic areas in disaster preparedness, criteria under prevention and mitigation were identified as the most difficult to meet. Prevention and mitigation entail resources, particularly, manpower for the proportional distribution of disaster management team and support from external sources were found lacking in most barangays. On the other hand, preparedness was the thematic area where more than 75% of the criteria were met by most barangays.

Despite being aware that they are at high risk for a large-scale earthquake, not a single barangay was able to meet all the 27 criteria of disaster preparedness. Majority were only able to fulfill at least half of the criteria. The study likewise revealed that the key challenge in disaster preparedness at the barangay level lies in the implementation of local disaster preparedness plans. The creation of a disaster

plan is not the final step in preparing for a disaster. Implementation and community integration are key to the success of disaster preparedness. Although considered the smallest political unit, the barangay plays a crucial role in disaster response. Survival strategies at the barangay level are used to cope with impacts of disaster before outside help is available. Therefore, its role in mitigating the impact of disaster is crucial. Even though a legal framework through the NDRRM plan exists, the lack of financial and human capacity still undermines disaster preparedness efforts thereby resulting to failure in the achievement of its goals.

More local studies on disaster preparedness should be undertaken. Study designs that can provide evidence of association or causation between factors such as community characteristics and level of disaster preparedness are recommended. Qualitative studies like focus group discussions should also be employed to be able to generate a rich discussion on key issues identified in this study.

Further policies that would prescribe mobilization and engagement of community officials and members should be in place since community actions are observed to be influenced largely by existing policies and laws. Disaster preparedness plans should be adoptable, feasible, and tailored to the needs, strengths, and weaknesses of communities. This can be achieved through continuous dialogue with community members. Disaster planning should be continuous, collaborative, data-driven, and most importantly, useful for end-user communities as these translate to effective and more sustainable disaster preparedness plans. Lastly, as partners of the barangay, the government and its agencies should establish and strengthen monitoring and reporting mechanisms to be able to assess implementation of LDRRM plans and address any existing gaps.

References

1. Total Disaster Risk Management - Good Practices 1st ed. Kobe: Asian Disaster Reduction; 2005.
2. Annan K, To?pfer K. Global Environment Outlook 3 (GEO-3). 1st ed. London: Earthscan; 2002.
3. Philippine Institute of Volcanology and Seismology, Geoscience Australia. Enhancing Risk Analysis Capacities for Flood, Tropical Cyclone Severe Wind and Earthquake for the Greater Metro Manila Area. Republic of the Philippines and the Commonwealth of Australia (Geoscience Australia). Available from: http://ndrrmc.gov.ph/attachments/article/1509/component_5_eartquake_risk_analysis_technical%20report_-_final_draft_by_ga_and_phivolcs.pdf.
4. Japan International Cooperation Agency, Metro Manila Development Authority, Philippine Institute of Volcanology and Seismology. Earthquake Impact Reduction Study for Metropolitan Manila, Republic of the Philippines 2004. Final Report, Volume 1. [Retrieved Sept 16, 2016].
5. Ismail-Zadeh A, Takeuchi K. Preventive disaster management of extreme natural events. *Natural Hazards* 2007; 42(3): 459-67. Available from: <http://www.mitp.ru/~aismail/papers/NHprevdis2007.pdf>.
6. Solo T, Godinat M, Velasco O. <http://siteresources.worldbank.org/INTLACREGTO/PHAZMAN/Resources/ArticlefromTOLIV.pdf> World Bank Group Archives 2003. Available from: <http://siteresources.worldbank.org/INTLACREGTO/PHAZMAN/Resources/ArticlefromTOLIV.pdf>. [Retrieved May 20, 2016].
7. Victoria L. Community-Based Approaches to Disaster Mitigation. Asian Disaster Preparedness Center 2002. Available from: <http://www.adpc.net/v2007/IKM/ONLINE%20DOCUMENTS/downloads/ADUMP/CBDM.pdf>.
8. GMA News. LIST: Barangays in Metro Manila, nearby provinces near earthquake fault 2015. Available from: <http://www.gmanetwork.com/news/scitech/science/489334/list-barangays-in-metro-manila-nearby-provinces-near-earthquake-fault/story/>.
9. Dizon A, Battad G, Antonio Jr. A, Barcelon J, Caday L, Garcia J, et al. The Development of a Condensed Disaster Preparedness Audit Tool Through Statistical and Thematic Analysis for Rapid Assessment of Barangays [Undergraduate]. Ateneo de Manila University; 2014.
10. Allen K. Community-based disaster preparedness and climate adaptation: local capacity-building in the Philippines. *Disasters* 2006; 30(1): 81-101.
11. Cohen C, Werker E. The political economy of 'natural' disasters. *Journal of Conflict Resolution* 2008; 52(6): 795-819.
12. Palafox, Jr. F. Architecture, planning and design: Recommendations toward a more resilient Philippines. *The Manila Times* 2013; Available from: <http://www.manilatimes.net/architecture-planning-and-design-recommendations-toward-a-more-resilient-philippines/63130/>. [Retrieved May 20, 2016].
13. Gow K, Paton D. *The Phoenix of Natural Disasters* 1st ed. New York: Nova Science Publishers; 2008.
14. Bashawri A, Garrity S, Moodley K. An overview of the design of disaster re-lief shelters. *Procedia Economics and Finance* 2014; 18: 924-31. Available from: https://www.researchgate.net/profile/Abdulrahman_Bashawri/publication/273454228_An_Overview_of_the_Design_of_Disaster_Relief_Shelters/links/5502c5d50cf2d60c0e6471d0/An-Overview-of-the-Design-of-Disaster-Relief-Shelters.pdf.
15. Office of Civil Defense. *OCD Operation Manual for Response* 2016.