

GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY



Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS)

A Study by the Office of Civil Defense
In collaboration with the
Department of the Interior and Local Government and the
Department of Science and Technology - Philippine Institute of
Volcanology and Seismology

2021



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF NATIONAL DEFENSE
OFFICE OF THE SECRETARY

MESSAGE



The Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS) manifests the dedication of all concerned authorities in promoting safer and resilient Filipino communities.

In line with this, I would like to express my deepest gratitude to the firm support and commitment of all participants, government agencies and stakeholders in bringing forth comprehensive action plans and strategies in response to the worst-case scenario that could result in a great devastation to both human and property in possible affected areas.

Considering the unpredictability of such destructive earthquake, the need for a continuous national and community-level engagement between leading authorities alongside community members remains. Hands-on community and agency involvement (through education on disaster awareness, preparedness, and recovery and response) can create a huge ripple of change to the projected estimation of damages and lives lost. From the careful improvement of urban structure to the adoption of modern technological development in research, a well-equipped and committed nation can prevent or lessen probable damages.

Let us all continue with our commitment to secure the welfare of our country and stand hand-in-hand with the Filipino people whom we serve.

DELFIN N. LORENZANA
Secretary, DND



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF NATIONAL DEFENSE
OFFICE OF CIVIL DEFENSE

MESSAGE



The practice of Disaster Risk Reduction and Management (DRRM) entails evidence-based and scientifically supported decision-making. As such, DRRM practitioners refer to verified information and reliable references on which every decision may be based. Researches such as the Metro Manila Earthquake Impact Reduction Study (MMEIRS) have proven to be beneficial in that respect. It too allowed for effective multi-agency and multi-disciplinary partnerships for earthquake risk reduction as it guided the harmonization of our various actions and initiatives.

Fifteen (15) years after the publication of the MMEIRS, it is a significant milestone for the Philippine government to work on the Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS) - a comprehensive review of the significant accomplishments of the action plans that we have committed across different levels of governance. Moreover, streamlining the action plans to make them more reflective of the current situation and needs not just of the Metro Manila area, but also of the affected parts of the Greater Metro Manila Area (GMMA), is one of the salient features of the study.

For their important contribution in the completion of the GMMEIRS, I would like to convey my utmost appreciation to all agencies, the public and private stakeholders, and the technical team.

Through our sustained commitment, may we strive to continuously serve our people and realize our common vision for a safer, adaptive, and disaster-resilient Filipino communities.

RICARDO B. JALAD

Undersecretary and Administrator, OCD
and Executive Director, NDRRMC



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF THE INTERIOR AND LOCAL
GOVERNMENT

MESSAGE



My heartfelt appreciation to the researchers of the Office of Civil Defense (OCD), the Department of the Interior and Local Government (DILG), and the Philippine Institute of Volcanology and Seismology (PHIVOLCS) for coming together to conduct this research on the Greater Metro Manila area's earthquake resiliency measures.

The Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS) seeks to prepare public and private institutions in the National Capital Region and its neighboring provinces should a tremor occur in the center of our country's economic activity.

By assessing and updating the earthquake resiliency strategies of relevant stakeholders, we are able to ensure that the repercussions of earthquakes and other related disasters will be significantly minimized, especially as we anticipate the dreaded Big One to rattle areas along and near the West Valley Fault.

The DILG welcomes the proactive preparedness and recovery measures that this research recommends to increase community resiliency against earthquake-related disasters such as the structural collapse, tsunamis, and landslides. In light of this, we in government must ensure that our people are provided with the necessary guardrails to keep our constituents safe, secure, and resilient against catastrophic events.

As the Vice-Chair for Disaster Preparedness of the National Disaster Risk Reduction and Management Council (NDRRMC), we at the DILG are actively seeking ways to protect Filipinos from natural and human-induced hazards and disasters. Rest assured of our commitment to foster a peaceful, safe and resilient landscape for the people living and working in the Greater Metro Manila.

May this study serve its purpose of building a strong fortress around NCR and its neighboring provinces against the perils of earthquake-related calamities. Again, thank you to OCD and PHIVOLCS for this research partnership. May we continue to safeguard the Filipino people from all types of disasters.

Mabuhay!

EDUARDO M. AÑO
Secretary, DILG



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY

MESSAGE



The idea of revisiting the Metro Manila Earthquake Impact Reduction Study is faced with increasing risks in the metropolis and nearby provinces. New communities have emerged, and more investments have been poured in what we now call the Greater Metro Manila Area (GMMA), which remains to be the main hub of our economy and governance. Foremost in our mind when the idea of the Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS) was conceptualized, is to improve our existing plans and actions, and eventually discover innovative ways so that communities, businesses, and the government will be less affected and can recover at the soonest possible time.

The impact of large-scale events to urban areas, like the GMMA, is quite extensive and this has been clearly shown by the effects of COVID-19 on our health systems, government and private sector operations and the economy. The effect of a large-magnitude earthquake centered in the area would be more devastating, especially if houses, buildings, and infrastructures are damaged, and we are not able to collectively mitigate, respond and recover effectively and timely. We need to collectively and immediately implement short to long term actions on increasing the resilience of GMMA and the whole country.

The Department of Science and Technology (DOST) and Philippine Institute of Volcanology and Seismology (PHIVOLCS) believe that, in working closely with one another and by using the results of science and technology coupled with efficient implementation of our action plans, we will have better and resilient communities.

RENATO U. SOLIDUM, Jr.
Undersecretary, DOST and
Officer-In-Charge, PHIVOLCS

Acknowledgments

The Capacity Building and Training Service (CBTS) would like to convey its appreciation to Undersecretary Ricardo B. Jalad, Administrator of the Office of Civil Defense (OCD) and Executive Director of the National Disaster Risk Reduction and Management Council (NDRRMC) for his overall leadership and unwavering support to the Service to make the GMMEIRS project a reality. Further, heartfelt acknowledgement is expressed to the Department of Science and Technology - Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS) and the Department of the Interior and Local Government (DILG) as the partners of the OCD for this undertaking. Recognition is also given to all representatives from the national government agencies, local government units and critical utilities that participated in the meetings, surveys, and workshops.

The complete acknowledgment list is found in Appendix 2.

About GMMEIRS

Among the hazards that occur in the Philippines, earthquakes serve as one of the country's major concerns. In response to the earthquake situation in the country, the Philippine government, through the Department of Science and Technology - Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS) and Metropolitan Manila Development Authority (MMDA), with support from the Japan International Cooperation Agency (JICA), conducted the Metro Manila Earthquake Impact Reduction Study (MMEIRS) in 2002 to 2004. As projected by the MMEIRS, one of the worst-scenario projections is the movement of the West Valley Fault that can generate a 7.2-magnitude earthquake that would gravely affect millions of residents in the Metro Manila Area. Since then, the Philippines has experienced several damaging earthquakes in different regions and there were new knowledge gained from each event. As DOST-PHIVOLCS implements more research on the earthquake phenomena and their impacts, new earthquake information (such as the Risk Analysis Project in 2013) is generated, which forms an essential input for a more relevant and responsive earthquake master plan.

In 2019, 15 years after the publication of the MMEIRS, the need to prioritize the preparations for a major threat that the country faces has now greatly intensified. The Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS) was proposed during the Third Inter-Agency Resiliency Team Meeting with the end-goal of making a document that would reflect the metropolis' current situation and making it relevant for a greater geographical scope, which is the Greater Metro Manila Area (GMMA). The Office of Civil Defense (OCD), with the technical support from DOST-PHIVOLCS, and the Department of Interior and Local Government (DILG) were tasked to conceptualize and develop the study. The objectives of the study are: (1) to review the action plans for earthquake risk reduction, as published in the MMEIRS in 2004; (2) to assess the accomplishments of the national government agencies (NGAs), local government units (LGUs), and critical utilities (CUs) to implement the action plans; (3) to streamline the action plans and make them more comprehensive, relevant, and reflective of the current situation and needs not just in Metro Manila but also in the affected parts of Central Luzon (i.e., Bulacan) and CALABARZON (i.e., Cavite, Laguna, and Rizal), which forms part of the Greater Metro Manila Area (GMMA); and (4) to develop recommendations for relevant earthquake risk reduction plans to be prioritized by stakeholders within the GMMA.

Chapter 2 looks at the study's related literature to provide the background on earthquake risk, and the current initiatives on earthquake risk reduction, preparedness, and response in the Philippines. The gaps on literature are also presented in the chapter.

Chapter 3 contains the review of the MMEIRS Action Plans in terms of status of implementation and accomplishment and perceived contribution to earthquake impact reduction. The status of implementation of action plans from the MMEIRS in relation to the actual reduction of the earthquake impacts was identified through the conduct of workshops and focus group discussion. The data gathered from the workshops were subjected to different methods of qualitative and quantitative data analysis to carefully scrutinize the status of implementation of the action plans.

Chapter 4 presents the categorization of action plans based on the DRRM thematic pillars and key actors. It also highlights the priority action plans per implementer. The end-product of this chapter is the identification of recommendations for earthquake risk reduction that are "tailor-fit" for LGUs, NGAs, and CUs.

Chapter 5 summarizes the results of the study while Chapter 6 enumerates recommended future studies to help translate the GMMEIRS into a strategic planning document.

Table of Contents

Messages	i
Acknowledgments.....	v
About GMMEIRS	vi
Table of Contents.....	vii
List of Figures	ix
List of Tables	x
List of Abbreviations and Acronyms	xi
Executive Summary.....	xiv
CHAPTER 1. INTRODUCTION	2
1.1 Rationale.....	2
1.2 Objectives	5
1.3 Significance of the Study	5
1.4 Study Framework.....	5
1.5 Activities Conducted	9
1.6 Methodology.....	10
1.6.1 Review of action plans	10
1.6.2 Streamlining of action plans.....	11
1.7 Scope and Limitation	12
CHAPTER 2. THE POST-MMEIRS SITUATION: A REVIEW OF RELATED LITERATURE	14
2.1 New Urban Conditions in Greater Metro Manila Area	15
2.2 Initiatives on Earthquake Risk Reduction and Management.....	19
2.3 Succeeding Earthquake Risk Assessments	24
2.4 Risk Reduction Estimates from DOST-PHIVOLCS.....	25
2.5 Experiences from Past Earthquakes and Current Practices.....	25
2.5 Information Gaps	27
CHAPTER 3. ACCOMPLISHMENT REVIEW OF MMEIRS MASTER PLAN	29
3.1 Summary of Responses and Review of Accomplishment According to Goals	29
Goal 1: Earthquake-Resilient National System	29
Goal 2: Earthquake-Resilient Urban Structures	30
Goal 3: Enhanced Emergency Risk Management.....	34
Goal 4: Increased Community Resilience.....	39

Goal 5: Reconstruction Systems	41
Goal 6: Earthquake and Tsunami Research and Development.....	43
3.2 Results of the perception survey	44
CHAPTER 4. STREAMLINING OF ACTION PLANS.....	54
4.1 Implementation strategy	55
4.1.1 Aligning the action plans based on DRRM thematic pillars	55
4.1.2 Identification of key implementers of the action plans	60
4.2 Prioritization of Action Plans	61
CHAPTER 5. SUMMARY AND CONCLUSION	67
CHAPTER 6. RECOMMENDATIONS	70
REFERENCES.....	72
APPENDICES	77
Appendix 1. Master list of GMMEIRS Action Plans	78
Appendix 2. Workshop, Meeting, and Survey Participants	91
Appendix 3. Risk Estimates for Metro Manila, CALABARZON, and Region III	96
Appendix 4. Survey Questionnaires from Workshops 1-3.....	101
Appendix 5. Workshop Results for Action Plans Accomplishment.....	107
Appendix 6. Statistical Analysis of Survey Response.....	138
Appendix 7. Highlights of Key Informant Interviews.....	140

List of Figures

Figure 1. Map of the Valley Fault System and location of the trench sites. Red lines are the traces of the West and East Valley Fault. White lines are the boundaries of local government units and black rectangles are the location of the trench sites.....	4
Figure 2. Vision, goals, and frameworks of the MMEIRS	7
Figure 3. Conceptual framework of the GMMEIRS	8
Figure 4. High density and vertical mixed-use areas along the WVF	18
Figure 5. Status of accomplishment of the six (6) goals for earthquake impact reduction	44
Figure 6. Status of accomplishment per action plan for Goal 1	44
Figure 7. Status of accomplishment per action plan for Goal 2	46
Figure 8. Status of accomplishment per action plan for Goal 3	47
Figure 9. Status of accomplishment per action plan for Goal 4	49
Figure 10. Status of accomplishment per action plan for Goal 5	50
Figure 11. Status of accomplishment per action plan for Goal 6.....	51
Figure 12. Direct and indirect action plans per goal	52
Figure 13. Approach for streamlining the GMMEIRS Action Plans	54
Figure 14. Categorization of Action Plans by Relevance into the DRRM Thematic Pillars	57
Figure 15. Relevance of the Action Plans by Contribution to DRRM Thematic Pillars	57
Figure 16. Actions Plans' Relevance (a) and Contribution (b) to Prevention and Mitigation	58
Figure 17. Actions Plans' Relevance (a) and Contribution (b) to Preparedness.....	58
Figure 18. Action Plans' Relevance (a) and Contribution (b) to Response	59
Figure 19. Action Plans' Relevance (a) and Contribution (b) to Recovery and Rehabilitation	59
Figure 20. Percentage of Key Implementers for All Action Plans.....	60
Figure 21. Key Implementers per Goal.....	60

List of Tables

Table 1. Summary of GMMEIRS activities	9
Table 2. Basis for quantifying level of accomplishment based on response	11
Table 3. Timeline of significant earthquake-relevant international frameworks, national plans, laws and issuances	15
Table 4. Population and density of Greater Metro Manila Area	16
Table 5. Earthquake Impact Estimates for Metro Manila in 2004 and 2010 and for Regions III and IV in 2010.	25
Table 6. Rating matrix used for quantifying relevance of action plans to DRRM thematic pillars	56
Table 7. Recommended priority action plans for NGAs.....	61
Table 8. Recommended priority action plans for LGUs	63
Table 9. Recommended priority action plans for CUs	64

List of Abbreviations and Acronyms

AFP	Armed Forces of the Philippines
ASEAN	Association of Southeast Asian Nations
ASEP	Association of Structural Engineers of the Philippines
BAU	Business as usual
BFP	Bureau of Fire Protection
CALABARZON	Cavite, Laguna, Batangas, Rizal, Quezon
CBRN	Chemical, biological, radiological and nuclear
CBTS	Capacity Building and Training Service
CDA	Cooperative Development Authority
CHED	Commission on Higher Education
CLUP	Comprehensive land use plan
CSAP	Core shelter assistance program
CU	Critical utility
DA	Department of Agriculture
DBM	Department of Budget and Management
DENR	Department of Environment and Natural Resources
DFA	Department of Foreign Affairs
DICT	Department of Information and Communications Technology
DILG	Department of Interior and Local Government
DOE	Department of Energy
DOF	Department of Finance
DOH	Department of Health
DOST	Department of Science and Technology
DOTr	Department of Transportation
DPWH	Department of Public Works and Highways
DRRM	Disaster risk reduction and management
DSWD	Department of Social Welfare and Development
EVF	East Valley Fault
EWS	Early warning system
FGD	Focus group discussion
GIS	Geographic information system
GMMA	Greater Metro Manila Area
GMMA-RAP	Greater Metro Manila Area Risk Analysis Project
GMMEIRS	Greater Metro Manila Earthquake Impact Reduction Study
HEMB	Health Emergency Management Bureau
HFDB	Health Facilities Development Bureau
HUDCC	Housing and Urban Development Coordinating Council
JICA	Japan International Cooperation Agency
JICA-JST	Japan International Cooperation Agency-Japan Science and Technology
LGU	Local government unit

LPG	Liquefied Petroleum Gas
LRTA	Light Rail Transit Authority
LWUA	Local Water Utilities Administration
MERALCO	Manila Electric Company
MGB	Mines and Geosciences Bureau
MMDA	Metro Manila Development Authority
MMDRRMC	Metro Manila Disaster Risk Reduction and Management Council
MMEIRS	Metro Manila Earthquake Impact Reduction Study
MWSS	Metropolitan Waterworks and Sewerage System
NAIA	Ninoy Aquino International Airport
NAMRIA	National Mapping and Resource Information Authority
NAPOCOR	National Power Corporation
NDCC	National Disaster Coordinating Council
NDRP	National Disaster Response Plan
NDRRMC	National Disaster Risk Reduction and Management Council
NDRRMP	National Disaster Risk Reduction and Management Plan
NEA	National Electrification Administration
NEDA	National Economic Development Authority
NFA	National Food Authority
NGA	National government agency
NGCP	National Grid Corporation of the Philippines
NGO	Non-governmental organization
NHA	National Housing Authority
NRT	National Resiliency Team
NRC	Nuclear Regulatory Commission,
NTC	National Telecommunications Commission
OCD	Office of Civil Defense
OIMB	Oil Industry Management Bureau
PCOO	Presidential Communications Operations Office
PDRF	Philippine Disaster Resilience Foundation Incorporated
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIHAC	Philippine International Humanitarian Assistance Cluster
PLDT	Philippine Long Distance Telephone Company
PMS	Presidential Management Staff
PNP	Philippine National Police
PNRI	Philippine Nuclear Research Institute
POPCEN	Census of population
PSA	Philippine Statistics Authority
PSCP	Public service continuity plan
RA	Republic Act
R&D	Research and development
REDAS	Rapid Earthquake Damage Assessment System
SOP	Standard operating procedure
TESDA	Technical Education and Skills Development Authority
TWG	Technical working group

UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
VFS	Valley Fault System
WVF	West Valley Fault
WVFS	West Valley Fault System

Executive Summary

The GMMEIRS covers five study objectives whose findings are summarized below:

Objective 1: Review of GMMEIRS Action Plans

In general, the MMEIRS vision, objectives and frameworks are still applicable to the GMMA context. Some action plans were modified to reflect provisions from DRRM-related laws and plans, and earthquake-related information which were not yet existent when the MMEIRS was crafted.

Objective 2: Assess the accomplishments of action plans by various actors (NGAs, LGUs and CUs)

Through a series of workshops and surveys, the totality of the accomplishment of the action plans by the NGAs, LGUs, and CUs was identified. Goal 4 (Increased Community Resilience) was found to have the highest level of accomplishment as reported by survey respondents, while the results were opposite for Goal 5 (Reconstruction Systems). Perceived impact reduction of the action plans were also assessed through workshops and surveys. Results revealed that Goal 2 (Earthquake Resilient Urban Structures) and Goal 3 (Enhanced Risk Emergency Management) have the most number of direct impact reduction action plans. Moreover, almost all of the action plans in Goal 6 (Earthquake and Tsunami Resilience Research and Development) are perceived to have direct impact reduction.

Objective 3: Streamline action plans based on the context of GMMA

The GMMEIRS action plans were categorized into the four (4) DRRM Thematic Pillars: Prevention and Mitigation, Preparedness, Response, Recovery and Rehabilitation. Two methods of categorization were done: (a) categorization by relevance, and (b) categorization by contribution.

Comparing and relating the results of the two methods of categorization, most action plans are not exclusively relevant to a single DRRM thematic pillar. Based on the scope and purpose of the action plans, most are relevant to response and preparedness, but this does not mean these are exclusively contributory to the mentioned thematic pillars. Few action plans were found to be relevant under prevention and mitigation, but most of these are exclusively contributory to the said DRRM pillar. Recovery and rehabilitation has the fewest number of relevant and contributory action plans. This may be an important consideration for future plans since recovery and rehabilitation is vital for communities' return to normalcy.

Key actors and implementers for the action plans were also identified. It was consistent for all goals that the key implementers for most action plans are NGAs. Among the trends observed is that NGAs have the largest influence over the other actors (LGUs, CUs, etc.), while LGUs are critical to executing the plans and guidelines from NGAs at the local level.

Lastly, it is important to note that these categorizations (DRRM pillar and key implementers) are highly recommended to be reviewed and validated by LGUs, NGAs and other stakeholders since this was done mostly by the study team.

Objective 4: Recommendations for priority earthquake risk reduction action plans

Utilizing the results from objectives 2 and 3, priority action plans for implementation by NGAs, LGUs and CUs were identified. The action plans identified to have direct impact reduction but have the lowest level of accomplishment were considered to be the high priority action plans. Direct action plans which have low to partial level of accomplishment were identified to be medium priority action plans. For NGAs, 12 high priority actions plans were identified which belong to Goals 2, 3, 4, and 6. For LGUs, there are 3 high priority action plans under Goals 1, 2, and 3. For CUs, 2 high priority action plans were identified under Goals 2 and 3. Same with the results form Objective 4, these findings are highly recommended to be reviewed and validated with LGUs, NGAs and CUs to better reflect the realities of their initiatives, accomplishments and other gaps in terms of overall earthquake impact reduction.

Supplementary studies that will help transform the findings into a GMMA roadmap for earthquake impact reduction are enumerated below:

- Develop an appropriate monitoring and evaluation tool to continually assess the status of implementation of the action plans.
- Explore other methods for assessing the contribution of the action plans in significantly reducing earthquake impact.
- Identify action plans that focus on other earthquake generators that may affect GMMA (e.g., earthquake and tsunami hazards from the Manila Trench)
- Assess socio-economic vulnerabilities and identification of interventions for overall risk reduction.
- Conduct a nationwide earthquake impact reduction study which shall serve as a framework for earthquake resiliency that can guide plans at various levels and sectors.

To inform future studies and plans, a proposed framework that may help translate the GMMEIRS into a strategic plan for earthquake impact reduction is included in Chapter 6.

CHAPTER 1

CHAPTER 1. INTRODUCTION

1.1 Rationale

The Philippines is one of the countries known to be at risk to disasters due to its geographic location. Specifically, it is situated along the highly seismic region called the Pacific Ring of Fire, which explains the occurrence of earthquakes, tsunamis, and volcanic eruptions (*National Disaster Risk Reduction and Management Plan: 2011-2028*; Wannewitz, Hagenlocher, & Garschagen, 2016, 134). Moreover, the country is located in the Pacific Typhoon Belt, with frequent occurrences of tropical cyclones accompanied by strong winds and heavy rains resulting to floods, landslides, and storm surges (*National Disaster Risk Reduction and Management Plan: 2011-2028*; Wannewitz et al., 2016, 134). There are also human-induced disasters brought about by political and socioeconomic factors (*National Disaster Risk Reduction and Management Plan: 2011-2028*). The worsening condition of the climate due to global warming also aggravates the occurrences of natural calamities.

Among the hazards that exist, earthquakes serve as the country's major concern. According to the Annual Report by the Department of Science and Technology-Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS) in 2017, six (6) damaging earthquakes hit the country commencing with the magnitude 6.7 earthquake in Surigao del Norte on February 10. A series of earthquakes was recorded in Mabini, Batangas Province in April 2017. A significant event in the earthquake swarms had a magnitude of 5.5 on April 4. Two (2) more strong earthquakes occurred on April 8, the first with a magnitude 5.6, succeeded by another with a magnitude 6.0. On April 12, a magnitude 6.0 earthquake occurred with epicenter near Wao, Lanao del Sur. On the 29th of the same month, a magnitude 7.2 earthquake happened offshore of Saranggani, Davao Occidental. On May 25, a magnitude 5.4 earthquake happened near the vicinity of San Marcelino, Zambales. Lastly, Ormoc City, Leyte and vicinity were shaken by a magnitude 6.5 earthquake on July 6 (DOST-PHIVOLCS Annual Report, 2017).

In response to the earthquake situation in the country, the Philippine government, with support from the Japan International Cooperation Agency (JICA), undertook the Metro Manila Earthquake Impact Reduction Study (MMEIRS). Conducted from August 2002 to March 2004, the MMEIRS serves as one of the early undertakings by the DOST-PHIVOLCS and the Metro Manila Development Authority (MMDA) in addressing the impacts of major earthquakes that can hit Metro Manila and nearby provinces. Among the main output of the MMEIRS is a comprehensive list of action plans to be undertaken to reduce the impact of worst-case earthquake scenarios.

For more than a decade since the publication of the MMEIRS in 2004, many mechanisms and approaches for managing actual and probable earthquake impacts have evolved. Notably, Republic Act (RA) 10121, otherwise known as the Philippine Disaster Risk Reduction and Management System, was enacted in 2010 and has led to the enhancement and upgrading of disaster risk reduction and management (DRRM) measures in the country. Nevertheless, the MMEIRS still serves as the main reference for most disaster managers in planning for earthquake risk reduction and management activities.

The Urban centers are highly at risk to large magnitude earthquake events. As projected by the MMEIRS, one of the worst-scenario earthquakes for Metropolitan Manila is the movement of the West Valley Fault (WVF). According to geological studies, the WVF moved four (4) times and generated strong earthquakes within the last 1400 years. The approximate return period of these earthquakes is between 400 and 600 years. The last occurrence of the WVF movement was in 1658, and no large event is known after the 17th century. Although the MMEIRS provides a list of useful action plans to address this concern, there has been no documented update on the status of implementation of these action plans.

More than putting focus in Metro Manila, it is also important to highlight that the impacts of WVF movement could also affect the regions of Central Luzon and CALABARZON.

Recognizing the prevalent threat of the WVF movement and the series of recent earthquake incidents in the country, the present administration established the National Resiliency Team (NRT). Organized under the leadership of the Presidential Management Staff (PMS), the NRT is a group of national government agencies (NGAs) that are mandated to spearhead strategic discussions for earthquake prevention, mitigation, and preparedness. On September 7, 2017, the NRT directed the Office of Civil Defense (OCD) to craft an updated MMEIRS or “Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS)”, which should focus not only in Metro Manila but also in Central Luzon and CALABARZON.

In this regard, the GMMEIRS has been prepared as a result of the efforts of the National Disaster Risk Reduction Management Council (NDRRMC) through the OCD, in collaboration with DOST-PHIVOLCS and the Department of the Interior and Local Government (DILG).

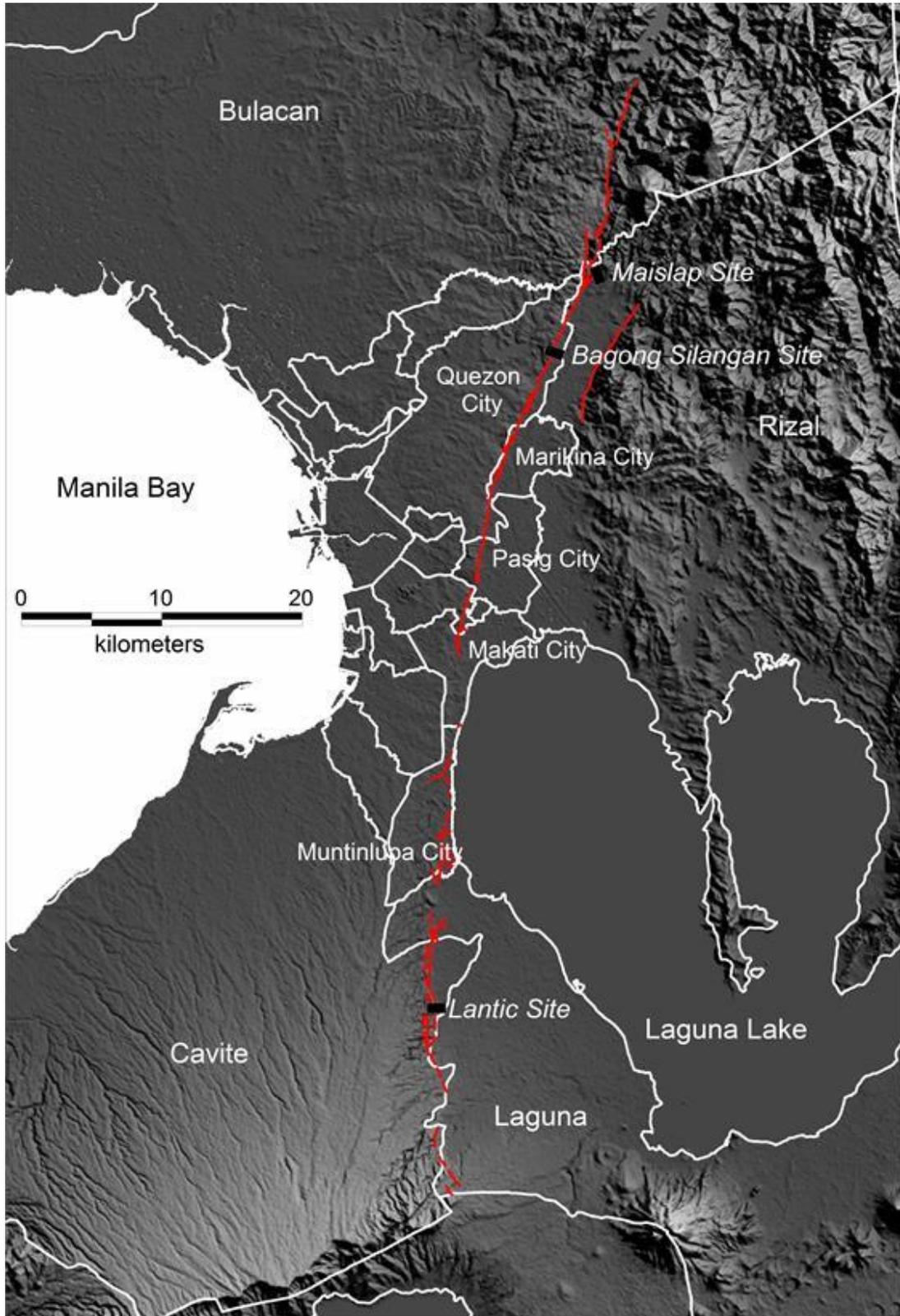


Figure 1. Map of the Valley Fault System and location of the trench sites. Red lines are the traces of the West and East Valley Fault. White lines are the boundaries of local government units and black rectangles are the location of the trench sites. (Source: DOST- PHIVOLCS)

1.2 Objectives

The GMMEIRS aims to:

1. review the action plans for earthquake risk reduction, as published in the MMEIRS in 2004;
2. assess the accomplishments of the NGAs, local government units (LGUs), and critical utilities (CUs) to implement the action plans;
3. streamline the action plans and make them more comprehensive, relevant, and reflective of the current situation and needs not just in Metro Manila, but also in the affected parts of Central Luzon (i.e., Bulacan and Pampanga) and CALABARZON (i.e., Cavite, Laguna, and Rizal), collectively known as the Greater Metro Manila Area (GMMA); and,
4. develop recommendations for relevant earthquake risk reduction plans to be prioritized by stakeholders within GMMA.

1.3 Significance of the Study

The GMMEIRS serves as one of the primary references to address the earthquake-related concerns in the Philippines. Although the MMEIRS is recognized as a landmark and a first-of-its-kind document in the Philippines, it is high time to update its provisions. The fact that it has been more than a decade ago since the MMEIRS was released, means that there is a need to come up with new measures to ensure the earthquake resiliency of localities.

Another significance of the GMMEIRS is that it made use of multi-stakeholder and multilevel coordination and collaboration with NGAs, LGUs and CUs in terms of assessing the accomplishments of the action plans from MMEIRS. Hence, the results of the GMMEIRS can provide opportunities and mechanisms for both public and private stakeholders to collaborate toward earthquake resiliency. In terms of fulfillment of mandate, the GMMEIRS is an indicator of the accomplishment of one of the objectives of the NRT. The study's findings can help shape the direction of the NRT in setting strategic goals to protect the country against earthquakes and other related hazards.

1.4 Study Framework

The main component of the study framework draws heavily on the presentation of the MMEIRS. The MMEIRS identified a disaster management plan for Metro Manila that focused on a vision to achieve "a safer Metropolitan Manila from earthquake impact" (MMEIRS, 2004, p. 7). To attain the vision, six (6) goals were identified:

1. To develop a national system resistant to earthquake impact;
2. To improve Metropolitan Manila's urban structure resistant to earthquake;
3. To enhance effective risk management system;
4. To increase community resilience;

5. To formulate reconstruction systems; and
6. To promote research and technology development for earthquake impact reduction measures.

The goals contain objectives and frameworks to represent the policies and strategies to achieve the identified goals and objectives, and action plans to specify salient activities to put into practice the policies and strategies represented in the frameworks. The vision, goals, objectives, and frameworks of the MMEIRS are summarized in Figure 2.

The study framework for the GMMEIRS (Figure 3) synthesizes how the objectives of the study were addressed. Literature review of the development of DRRM in the GMMA and in the country was done as reference for the assessment of the action plans since these DRRM-related regional and national policies and plans shape the activities and priorities in GMMA. Accomplishment of the action plans from the MMEIRS was assessed by gathering and analyzing the necessary inputs by the concerned stakeholders during the workshops and meetings. This was performed to gauge whether or not the action plans were completely, partially, or minimally carried out by the stakeholders. Once the status of implementation of the action plans was determined, the findings of the study were analyzed per goal and per framework. New high priority action plans were identified after the analysis of the status of implementation. The end-goal of the study was to formulate recommendations for the crafting of a plan for earthquake impact reduction in the GMMA based on the results of the study that are targeted specifically for NGAs, LGUs, and CUs.

Vision	Goals	Objectives	Frameworks			
A Safer Metropolitan Manila from Earthquake Impact	To develop national system resistant to earthquake impact	To increase social and community sustainability	<ul style="list-style-type: none"> NSD-1 Protect stability of national government function NSD-2 Protect stability of socio-economic system 			
	To improve Metropolitan Manila's urban structure resistant to earthquake	To increase resistance of Metropolitan Manila's vulnerable areas	<ul style="list-style-type: none"> USI-1 Promote earthquake resistant urban development USI-2 Promote flameproof urban development USI-3 Promote spatial urban development 			
			<ul style="list-style-type: none"> USI-4 Promote earthquake-resistant buildings USI-5 Promote earthquake-resistant public facilities 			
			<ul style="list-style-type: none"> USI-6 Promote earthquake-resistant infrastructure USI-7 Promote earthquake-resistant lifeline 			
			To enhance effective risk management system	To prevent secondary effects and damages	<ul style="list-style-type: none"> RMS-1 Promote fire preparedness and mitigation including handling hazardous materials RMS-2 Take measures against tsunami 	
					To strengthen disaster management system	<ul style="list-style-type: none"> RMS-3 Enhance legal basis for disaster management RMS-4 Strengthen institutional capacity for implementing Preparedness and mitigation measures RMS-5 Strengthen inter-institutional coordination
						To improve disaster response capability
			To ensure access to critical information	<ul style="list-style-type: none"> RMS-14 Establish information and communication system RMS-15 Establish geographic information system RMS-16 Manage emergency public information 		
	To increase community resilience	To establish disaster management mechanism through enhancement of social capital		<ul style="list-style-type: none"> CRI-1 Enhance self reliant and mutual help for efficient risk management capacity CRI-2 Inculcate a disaster mitigation culture in future generations 		
	To formulate reconstruction systems	To improve community recovery capability		<ul style="list-style-type: none"> RSF-1 Supply temporary refugee housings RSF-2 Prepare emergency assistance for everyday life RSF-3 Establish debris clearance and management system RSF-4 Restore public and social services RSF-5 Establish post-disaster reconstruction system of the damaged area RSF-6 Enhance institutional aspect 		
			To promote research and technology development for earthquake impact reduction measures	To sustain research and effective transfer of technology	<ul style="list-style-type: none"> R&D-1 Promote sustained research and development on earthquake 	

Figure 2. Vision, goals, and frameworks of the MMEIRS

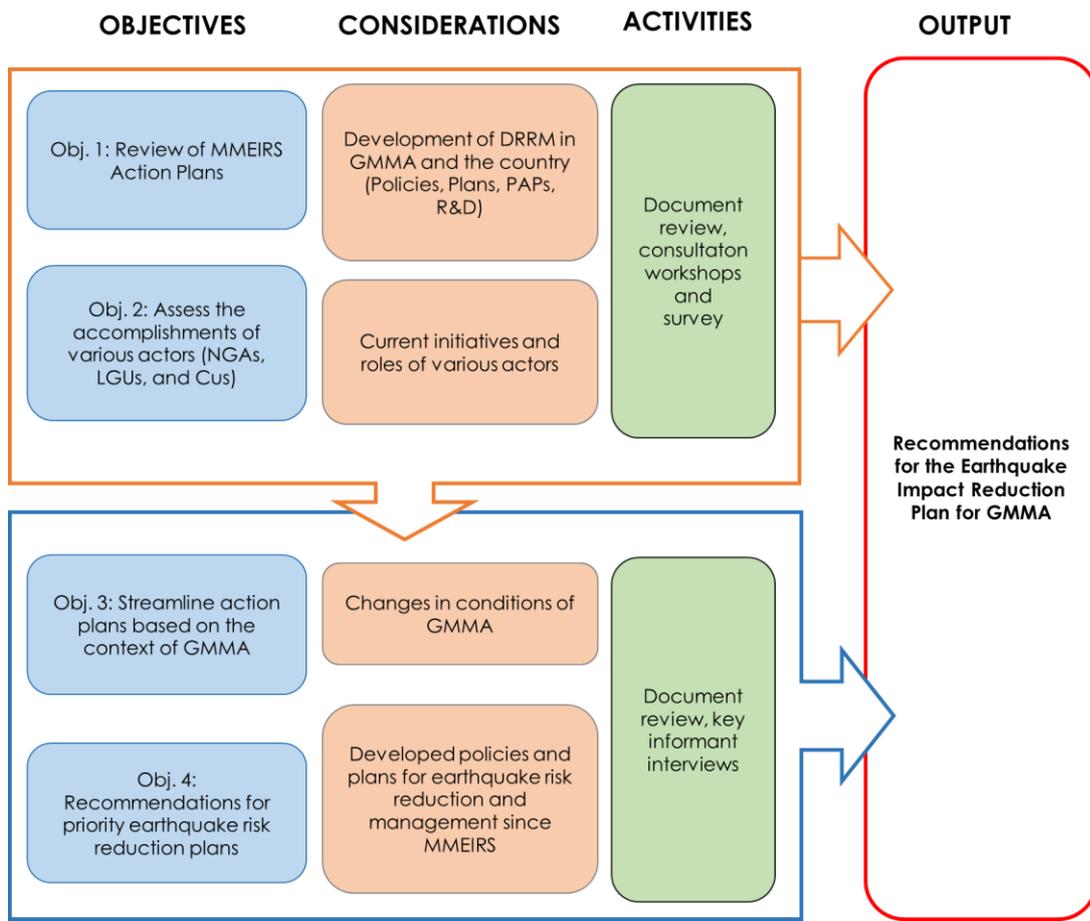


Figure 3. Conceptual framework of the GMMEIRS

1.5 Activities Conducted

The major activities include workshops, key informant interviews and review of available references including government reports, online publications, among others. The table below summarizes the activities conducted for the study, while the highlights for each of the workshops are briefly discussed in the succeeding sections.

Table 1. Summary of GMMEIRS activities

Activity & Date	Agenda/Outputs	Participants
<p>Workshop 1 23-25 May 2018 Makati Palace Hotel, Makati City</p>	<ul style="list-style-type: none"> Review and validation of the results of survey questionnaire answered by the LGUs based on the Action Plans indicated in the MMEIRS Formulation of recommendations for the development of more relevant and comprehensive Action Plans for earthquake resiliency and prioritization 	<p>Representatives from the following LGUs: Bulacan, Caloocan City, Las Piñas City, Makati City, Malabon City, Mandaluyong City, Navotas City, Province of Pampanga, Parañaque City, Pasay City Pasig City, Pateros, Quezon City, Rizal, San Juan City, Taguig City, Valenzuela City</p>
<p>Workshop 2 14-16 January 2019 Madison 101 Hotel + Towers, Quezon City</p>	<ul style="list-style-type: none"> Review and validation of the results of the survey questionnaire based on the Action Plans in the MMEIRS answered by the NGAs Formulation of recommendations for the updating of Action Plans for these to be more comprehensive and relevant 	<p>Representatives from the following NGAs: BFP, CHED, DA, DBM, DENR-MGB, DFA, DICT, DILG, DOE DOTr, DPWH, DSWD, HUDCC MMDA, MWSS, NAMRIA, NEDA, NHA, OCD, PCOO, PNP, TESDA</p>
<p>Workshop 3 20-22 March 2019 Madison 101 Hotel + Towers, Quezon City</p>	<ul style="list-style-type: none"> Checking the validity of the updates on what has been done on the action points Determination of action plans prioritization Determination of direct or indirect Action Plans 	<p>Representatives from the following critical lifelines and utility sectors: CDA, DOH HEMB, DOH HFDB, DOST PNRI, Globe Telecom, LRTA, LWUA, Meralco NAPOCOR, NEA, NFA, NGCP NTC, PLDT</p>
<p>Series of key informant interviews November to December 2019</p>	<ul style="list-style-type: none"> Validation of survey results Gathering of experts' opinion on the framework for streamlining of GMMEIRS action plans Identification of future directions for prioritization of earthquake risk reduction plan 	<p>CDP Manila Observatory PDRF DOST-PHIVOLCS Quezon City DRRMO</p>

Three major workshops were conducted from 2018 to 2019 which are aimed at gathering updates on the accomplishments of action plans in the MMEIRS, particularly from the following actors: **LGUs, NGAs, and critical lifelines and utility (CU) providers**. Before the workshops, data gathering tools designed by facilitators and survey questionnaire were prepared by the study team (refer to Appendix 4).

- For the **1st workshop** involving LGUs from Metro Manila, Central Luzon, and CALABARZON, the activities were intended to derive estimated earthquake impact reduction. Participants were grouped into three (3) and each group was assigned to review and validate action plans per goal (as organized in the MMEIRS report). Discussions focused on the review of action plans relevant to LGUs specifically their accomplishment status.
- In the **2nd workshop** involving NGAs, outputs from Workshop 1 were validated. Prioritization levels of the actions plans in terms of earthquake preparedness were also discussed. Identification of the pre- and post-earthquake action plans was done by labelling which are “direct” and “indirect”. **Direct impact** action plans refer to those applicable before the earthquake event strikes such as awareness and preparedness activities, reduction of elements at risk, and other measures to lower number of affected population, casualties, cost of damage, etc. **Indirect impact** action plans include management of disaster, building forward better, recovery and rehabilitation, response mechanisms, contingency and the backup system, service continuity plans, post-disaster needs assessment, reconstruction plans, etc. For this workshop, the survey was administered using Google Forms (see Appendix 4).
- In the **last workshop (CU Workshop)**, participants answered a survey questionnaire consisting of three parts: validation of action plans, prioritization of action plans, and identification of “direct” and “indirect” action plans.

1.6 Methodology

This section summarizes the procedure on how data gathered thru the previously mentioned activities were used to complete the study. Elaboration of the analysis methodology for each of the study objectives are discussed in the initial portion of relevant chapters.

1.6.1 Review of action plans

A survey questionnaire was utilized to review the action plans in MMEIRS based on their level of **accomplishment, prioritization and contribution to risk and impact reduction**. The MMEIRS master plan goals-objectives-action plan framework was used as basis for the questionnaire distributed to the LGUs, NGAs, and critical lifelines utility sectors. It was assumed that earthquake impact is reduced if the action plans are implemented by the agency; if not, risks and vulnerabilities are increased.

The questionnaire was divided in three parts, wherein most denote the restated action plans. The first part consisted of categorical questions which capture the action plans’ level of accomplishment. To derive the level of accomplishment of action plans, the participants were tasked to answer whether or not they have done the particular action plan by answering “Yes”, “No”, “N/A”, “Partial”. Thus, the number of “Yes” and “Partial” responses determined compliance with the action plans suggesting greater earthquake impact reduction. Below are the weights assigned for the answers to quantify the level of accomplishment.

Table 2. Basis for quantifying level of accomplishment based on response

Response	Value	Operational Definition
Yes	3	Action plan is implemented, high earthquake impact reduction
Partial	2	Action plan is partially implemented, moderate earthquake impact reduction
No	1	Action plan is not implemented, no earthquake impact reduction
N/A	0	Action plan is not applicable, considered as no earthquake impact reduction

The second part of the questionnaire was on the prioritization of the action plan where they answered “high”, “moderate”, and “low”. The third part determined contribution to earthquake risk and impact reduction and pre- and post-earthquake action plans by answering “direct” and “indirect”.

Descriptive statistics was used to measure the categorical questions, and thematic analysis was used to identify common themes in the open-ended questions. Specifically, these are the methods used:

1. **Triangulation:** Used as a method to resolve limitations regarding sample representation.
2. **Weighted mean:** Used as a resolution to combine the quantitative responses of all the participants according to goals.
3. **Equal interval classification:** Used to determine the action plan prioritization for study recommendations.
4. **Thematic analysis:** The participants’ qualitative answers were consolidated to provide further analysis to the quantitative data. These tend to determine the means of verification and the explanation why there is low or high implementation level.
5. **Descriptive statistics:** The number and the percentage of the responses (yes, no, partial, and N/A) were taken. These are grouped according to goals and action plans.
6. **Inferential Statistics:** In an attempt to further strengthen analysis, ANOVA and Regression are used to analyze the data. However, results were insignificant (see Appendix 6).

The questionnaires were sent to participants prior to the workshop to provide ample time for their feedback. It should be noted that the questionnaires are different for each of the groups of participants. In the first workshop, only the categorical yes–no questions were given to the participants. In the second workshop, prioritization was added. Then, in the third workshop, the questions were tailor-fitted to the agencies and the categorical “direct” and “indirect” was added (see Annex 5).

1.6.2 Streamlining of action plans

The MMEIRS is a framework of action which is first-of-its kind in the Philippines. Since the MMEIRS masterplan frameworks are still applicable in the context of GMMA, these were retained with some modifications. Through the follow-up key informant interviews, feedbacks of experts and key resource persons were utilized in identifying directions for streamlining the action plans to fit the GMMA context. Below are some major considerations for streamlining of action plans, while the elaboration on the approach is discussed in Chapter 4:

- Updated urban context of the GMMA
- Ongoing and completed programs, projects and activities (PPAs) of national government on earthquake resiliency
- DRRM-related policies and plans in the country since MMEIRS

- Current practices on disaster risk reduction and management, focusing on earthquake, specifically the 7.2 WVF magnitude earthquake

1.7 Scope and Limitation

The GMMEIRS only covers Metro Manila and its nearby provinces which are assessed to have high projected damage to Magnitude 7.2 earthquake caused by the West Valley Fault Movement—Bulacan, Pampanga, Cavite, Laguna, and Rizal. It is acknowledged that there are many other earthquake generators in the Philippines, with their own worst-case scenarios for each locality. However, other than the mentioned areas, the study does not include discussions about these other earthquake generators and localities.

Another limitation is the duration of the study. Unlike the two (2)-year completion for the MMEIRS, only nine (9) months were allotted for GMMEIRS. The initial phase of entire study was conducted from January to June 2019, with preliminary two (2)-day workshop on May 24-25, 2018, and an extension from October to December of 2019. Because of this time limitations, the team was restricted to available open data which are mostly web-based, and those provided during workshops and interviews. Most importantly, the study does not intend to provide an updated projection of earthquake effects and impacts to GMMA. Moreover, thorough data gathering required to perform complete analysis of earthquake impact estimates and risk reduction measures is one of limitations for this study since more time and resources are necessary for these.

Biases are also noted as among the study's limitations. Although the GMMEIRS employed surveys, workshops, and interviews as methodologies, the inputs are based mainly on the views of the representatives from NGAs, LGUs, and CUs. The data gathered on accomplishment of action plans are based on the participants' and representatives' knowledge and awareness, thus greatly influencing the results for this aspect of the study.

The GMMEIRS is also hindered by information consistency due to the different set of participants who attended the workshops and responded to the surveys. Also, not all the invited NGAs, LGUs, and CUs participated in the data collection methodologies, so adjustments were made in the consolidation and analysis. More details are to be explained in the results section of this study.

CHAPTER 2

CHAPTER 2. THE POST-MMEIRS SITUATION: A REVIEW OF RELATED LITERATURE

The geographic position and geotectonic setting of the Philippines expose the country to volcanic eruptions and earthquakes, floods, landslides, tsunamis, cyclones, and annual monsoons (Center for Environmental Geomatics-Manila Observatory, 2005; Padagdag, 2018; Senate Economic Planning Office, 2017). In the latest report from The World Risk Index, the Philippines ranked third among the 172 countries with the highest disaster risk, next to Vanuatu and Tonga, respectively (Radtke, Mann, Weller, Kirch, & Prütz, 2018).

Earthquake is one of the most serious natural disasters that the country experiences (Shaw, Srinivas, & Sharma, 2009). Additionally, according to the risk index of natural disasters in the Philippines for 2019, when sorted by type of disaster, earthquake has the second highest score with 9.5, next to tropical cyclone with a 9.6 out of a maximum of 10 points (Statista Research Department, 2019). The other three disasters depicted in the risk index are drought, flood, and tsunami with scores of 4, 7.2, and 9.3, respectively (Statista Research Department, 2019).

When MMEIRS was released, both the public and private sectors started to comply with the required mainstreaming of disaster management in their policies, plans, programs and operations. In terms of legislations, the Philippine Disaster Risk Reduction and Management Act of 2010 (RA 10121) and Climate Change Act of 2009 (RA 9729) set the foundation for institutionalizing disaster management framework and strategies in the country. Thus, necessary institutional structures and resources were readily available for DRRM. At the global level, the Philippines became a member of international agreements on disaster risk reduction such as the Hyogo Framework (2005-2015) and Sendai Framework (2015-2030) (Domingo & Olaguera, 2017).

Significant improvements for easy understanding of earthquakes have been attained too since MMEIRS. The DOST-PHIVOLCS has continuously been updating risk information on geologic hazards, including earthquakes. Several collaborations among NGAs and research institutions (both nationally and internationally) resulted to the conduct of studies on earthquake risk assessment. Some outputs from these collaborations include vast technological platforms to increase public awareness, disseminate information on earthquake risks, and even recommend actions for preparedness and response.

There have been extensive changes in urban conditions of Metro Manila and its surrounding areas. Among these are the increase in population and structural density of the area, outpour of investments on infrastructure, both initiated by the government and private business sectors, and advancements in urban information and communications technology, specifically on wayfinding, transportation, and living space rentals.

The country also experienced episodes of earthquakes, even destructive ones, since the release of MMEIRS. Evidently, there have been lessons learned from these past earthquake events that led to the crafting of models for best practices on disaster management. These models serve as useful inputs to analyze possible updates to the strategies in the MMEIRS, thus inputs to the GMMEIRS. These changes since MMEIRS shall be the focus of this chapter to present the existing urban conditions, current practices on earthquake risk management, preparedness and response.

Table 3. Timeline of significant earthquake-relevant international frameworks, national plans, laws and issuances

Year	Policies, plans, projects, technology
1972	National Building Code (after 1968 Casiguran Earthquake & 1970 Baler Earthquake)
1978	PD 1566: An Act Strengthening the Philippine Disaster Control, Capability and Establishing the National Program on Community Disaster Preparedness
1992	Revised Edition of the National Structural Code (after 1992 Luzon Earthquake)
2002	Rapid Earthquake Damage Assessment System
2004	Metro Manila Earthquake Impact Reduction Study
2005	Hyogo Framework
2010	RA 10121: Philippine Disaster Risk Reduction and Management Act of 2010
2011	Oplan Metro Yakal
2013	Greater Metro Manila Area Risk Analysis Project
2015	Oplan Metro Yakal Plus
2015	Sendai Framework
2016	DOST-PHIVOLCS FaultFinder
2017	Philippine Earthquake Model Atlas
2019	Harmonized National Contingency Plan for the Magnitude 7.2 Earthquake
2019	Earthquake Resiliency Program Management Office
2019	GeoRiskPH Integrated System and HazardHunterPH

2.1 New Urban Conditions in Greater Metro Manila Area

Since MMEIRS was circulated, urban conditions in Metro Manila have changed - - from the population, transportation networks, urban corridors and nodes, and the type of economic activities, to name a few. Urban development has sprawled in the originally bedroom communities of Bulacan, Pampanga, Cavite, Laguna and Rizal, thus making them part of Mega Manila, sometimes called the Greater Metro Manila Area or the areas transected by the East Valley Fault and West Valley Fault (collectively the Valley Fault System [VFS]). In the context of this study, the GMMA include NCR, and the provinces of Pampanga, Bulacan, Rizal, Cavite and Laguna which are traversed by the West Valley Fault. The GMMA contains the economic powerhouse of the country characterized by a mix of major urban centers, gateways such as airports and seaports, and special economic zones.

Table 4. Population and density of Greater Metro Manila Area (Source: PSA 2015 Census)

City/Municipality	Population	Land Area (square kilometers)	Population Density (persons per sq km)	Population Growth Rate (2010-2015)
National Capital Region (NCR)	12,877,253	619.54	20,785	1.58
Pampanga	2,609,744	2064.59	1,264	1.68*
Bulacan	3,292,071	2,783.69	1,183	2.28
Cavite	3,678,301	1,526.28	2,410	3.37
Laguna	3,035,081	1,928.23	1,574	2.47
Rizal	2,884,227	1,182.65	2,439	2.88
GMMA Total	28,376,677	10,105	2,808	N/A

*excludes Angeles City with a population growth rate of 4.52 for 2010 to 2015.

The National Capital Region or Metro Manila has the highest population density in GMMA as it houses the major urban centers. Daytime population of NCR reaches 15 million. The increase in daytime population mostly comes from provinces of Bulacan, Rizal, Cavite and Laguna who mostly work in the central business districts (CBDs) of Metro Manila. There are about six (6) central business districts within Metro Manila that attract residential and commuter population because of the aggregation of employment opportunities and commercial activities in these areas.

The provinces of Bulacan and Pampanga in Region III now cover most of the special economic zones, industrial zones, and new residential and mixed-use commercial complexes. In general, Region III is envisioned to be the planned expansion of Metro Manila, as evidenced by the multitude of key projects such as the Clark Green City (which contains the Clark International Airport), the anticipated New Manila International Airport in Bulacan, and the redevelopment of the Clark-Malolos railway to connect to Manila stations.

Region IV-A provinces which are generally more densely populated than Region III, is evidently the bedroom community of Metro Manila. Dense residential developments, industrial zones, and commercial complex are present in Cavite, Laguna and Rizal. A key infrastructure project is the Philippine National Railways (PNR) line redevelopment traversing the Province of Laguna. The Sangley Airport in Cavite is also being developed as an alternative airport in the south, to augment operations in Ninoy Aquino International Airport (NAIA).

Since the release of MMEIRS in 2004, below are the major urban developments that are perceived to significantly change the urban conditions to which the assessments in MMEIRS were based:

Build! Build! Build!

The “Build, Build, Build” agenda of the government is seen to boost infrastructure development and usher in the envisioned “Golden Age of Infrastructure” of the country in the medium-term by intensifying investments on public infrastructure whilst addressing implementation bottlenecks, ensuring the readiness of infrastructure programs and projects (PAPs) in the pipeline, and enhancing the absorptive capacities of implementing agencies in project preparation, development, and implementation. A total of 4,490 infrastructure PAPs on transportation, water resources, energy, social, information and communications technology (ICT), and other public infrastructure were identified in this agenda (NEDA, 2018). For GMMA, relevant projects include the North-South Commuter Rail Project, MRT 7, Metro Manila Skyway Project, and Metro Manila Subway System which are described

in the succeeding section. What is important to consider in this program is its role in expediting infrastructure developments in GMMA. Projects included in this agenda, specifically those expected to serve high populations, and located in high-risk areas should be carefully studied and integrated in risks assessments, and preparedness plans.

New Clark City

Originally the Clark Green City, the New Clark City is a master planned urban district in Capas, Tarlac, with an area of approximately 9,450 hectares (23,400 acres) that will accommodate up to 1.2 million people. It is managed by the Bases Conversion and Development Authority (BCDA). It is envisioned as a planned metropolis to help ease the congestion in Metro Manila. It is also expected to house key economic infrastructure, logistics hub, government offices, and attract population from the densely occupied NCR. It currently contains the Clark International Airport and is served by the Subic-Clark-Tarlac Expressway. The North-South-Commuter Railway, specifically the Clark to Tutuban Segment will connect New Clark City to Metro Manila. This development is relevant to GMMEIRS since this will basically be an extension of Metro Manila, but a planned version of it.

Redevelopment of North-South Commuter Railway

The development of the Clark-Calamba Railway which is divided into two segments, is one of the key components of the Roadmap for Transport Infrastructure Development for the Greater Capital Region” (referred to as Transport Roadmap 1), which was approved by the Aquino administration in June 2014 and subsequently validated by the Duterte administration under the “Build, Build, Build Program. In Roadmap 1, three major interrelated urban issues affecting the Greater Capital Region (GCR) were identified, namely: (1) Traffic congestion; (2) Hazard risks – flood, landslide, earthquake; and (3) Affordable housing. This is an ongoing program, with DOTr as lead agency. Preliminary plans have been crafted, and land consolidation for areas surrounding the stations is also ongoing (CONCEP & JICA, 2018).

MRT 7

Implemented by DOTr, this is a 23-kilometer elevated railway line with 14 stations from San Jose Del Monte, Bulacan to MRT 3 North Avenue in Quezon City. The new line will carry approximately 28,000 passengers an hour in each direction, which can be extended to roughly 36,000 passengers an hour with further upgrades. It is estimated to initially serve approximately 350,000 passengers a day, which will increase to 800,000 passengers a day upon completion of the upgrades. The new railway line will make it easy for the residents of Quezon City, Caloocan City, Bulacan, and neighboring areas to commute to the metropolis much faster than on road. It is also expected to decrease travel time by 2.5 hours from the current 3.5 hours on road. Construction of stations is ongoing which currently causes heavy traffic from Quezon City to San Jose del Monte, Bulacan (ppp.gov.ph). Noteworthy is the location of the line’s depot and first station from San Jose del Monte, Bulacan, specifically in Ciudad Real, which is also where the West Valley Fault starts.

Metro Manila Subway Project

This project is the first underground transport system in the Philippines – a 36km-long subway in Metro Manila which will connect to major rail lines of PNR Clark, PNR Calamba, and the Common Station (in North EDSA). The subway’s proposed stations will be located in Mindanao Avenue, Tandang Sora, North Avenue, Quezon Avenue, East Avenue, Anonas, Katipunan, Ortigas North, Ortigas South, Kalayaan Avenue, Bonifacio Global City, Cayetano Boulevard, the Food Terminal Inc. complex and NAIA. The expected completion of the subway is in 2025. The DOTr expects that the subway will initially serve some 370,000 riders a day (Camus, 2019).

Metro Manila Skyway Project

This skyway project will connect South Luzon Expressway (SLEX) at Alabang to Balintawak in Quezon City before North Luzon Expressway (NLEX) through Central Metro Manila Area by using predominantly median of Quirino, G. Araneta and A. Bonifacio road networks. Among the key benefits of the project is the improvement of accessibility, mobility, and connectivity in and out of the metropolis via eight (8) strategically located interchanges: at Buendia, Pres. Quirino Avenue, Plaza Dilao and Nagtahan, Aurora Boulevard, E. Rodriguez Avenue, Quezon Avenue, Sgt. Rivera and Balintawak with a total of 14 Toll Plazas. The project will enhance the economic interaction of CALABARZON, Mega Manila, and central Luzon to contribute over 60% of the country's Gross Domestic Product (GDP). It will also provide an alternate route to decongest EDSA and the major thoroughfares around its vicinity (ppp.gov.ph).

Laguna Lakeshore Expressway Dike Project

This project aims to mitigate flooding in coastal communities along Laguna Lake. It will also ease traffic congestion by providing an alternate route to and from Laguna. The Laguna Lakeshore Expressway Dike will provide a high standard highway and dike with proposed alignment that runs 500 meters away but following the shoreline of the Laguna Lake (PPP Center, 2014).

Vertical mixed use developments in Metro Manila and surrounding areas

There has been an increase in high-rise buildings in Metro Manila, especially mixed-use buildings, condominiums, and even parking buildings. Due to the limited space, new constructions tend to increase their floor-area ratio to maximize land area. Areas where most of these “skyscrapers” are found are in major urban centers and central business districts such as in Ortigas, Ayala, Cubao-Araneta, and Bonifacio Global City to name a few. There is also a boom in high-density compact residential condominiums even in surrounding provinces of Laguna, Cavite and Bulacan since these are considered bedroom communities of Metro Manila. These buildings, especially residential condominiums, contain large populations which should be incorporated in the scenario for the Magnitude 7.2 earthquake.

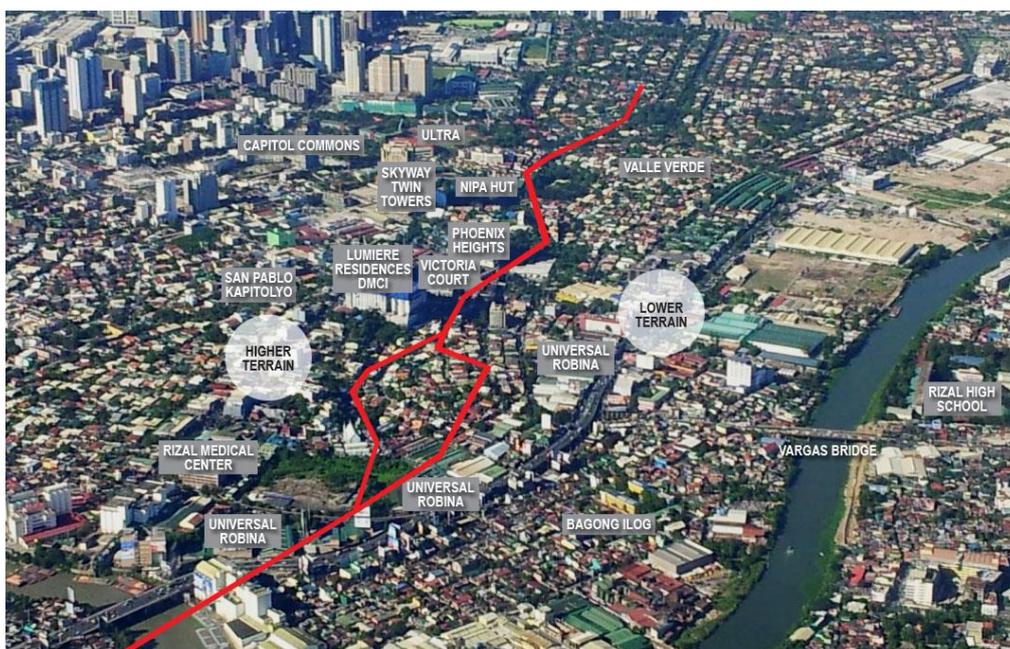


Figure 4. High density and vertical mixed-use areas along the WWF

Source: <http://pasigcitynatin.weebly.com/>

Improvement and redevelopment of major gateways (Clark International Airport, New Manila International Airport, Sangley Airport)

As part of the commitment of government (specifically DOTr) to provide better transportation, major gateways such as ports are being improved and new ones being established which include the Clark International Airport, New Manila International Airport in Bulacan, and Sangley Airport in Cavite. These are meant to augment the operations of the already congested Ninoy Aquino International Airport in Pasay. Since these are major gateways to GMMA, the potential capacities of this airport to withstand the 7.2 magnitude earthquake, as well as to aid in preparedness and response operations should be included in the updated risks assessments and contingency plans.

Angat Dam and Dyke Strengthening Project

The strengthening of the Angat Dam and Dyke would ensure the stability of these infrastructures to withstand possible risks from seismic activity that may originate from the West Valley Fault. As of 30 June 2019, construction and flood protection works have been completed; five (5) out of seven (7) dam instrumentation contract packages were already completed (MWSS, nd)

2.2 Initiatives on Earthquake Risk Reduction and Management

This section discusses the plans, programs, and activities for earthquake risk reduction, preparedness, and response in the country since the release of MMEIRS in 2004. It focuses on the initiatives within the Greater Metro Manila Area. The plans, programs and practices are organized based on its relevance to disaster management phases focusing on risk reduction, preparedness and response.

When it comes to disaster response strategies, the Philippines has come a long way as a country highly vulnerable to natural disasters (Center for Excellence in Disaster Management & Humanitarian Assistance, 2018; Senate Economic Planning Office, 2017). Response toward disaster reduction has progressively developed and has extensively grown with every disaster that the country has encountered. Disaster management program covers disaster preparedness, organization and training, construction of disaster reduction facilities, disaster response and rehabilitation, public information, and research and development (Orallo, 2011).

Prevention and Mitigation

This section focuses on plans, programs and practices on analyzing the earthquake characteristics including risk and vulnerability assessments, improvement of infrastructure, and, public education and awareness.

Initiatives focusing on **earthquake risk and vulnerability assessment** include the following:

Greater Metro Manila Area Risk Analysis Project (GMMA-RAP, 2013) with the NDRRMC, Geoscience Australia, and DOST-PHIVOLCS. The GMMA RAP provides a comprehensive study on earthquake risks, and projected effects and impacts in GMMA for both magnitude 6.5 and 7.2 earthquakes. This report summarized the activities and outputs of Component 5, which focused on the development of earthquake hazard modeling and risk analysis for GMMA. Highlights of the GMMA RAP are discussed in this section.

Rapid Earthquake Damage Assessment System (REDAS) is a software developed by DOST-PHIVOLCS in 2002. It was originally meant for earthquake hazard and impact assessment, but through the years, it included multi-hazard maps. Presently, REDAS can simulate earthquake hazards such as ground shaking, liquefaction, landslides and tsunamis, and also reflect hydro-meteorological hazard data such as floods, storm surge and rain-induced landslides. In the past decade, DOST-PHIVOLCS persistently conducted workshops to capacitate target users (civil defense officials, disaster managers, local government officials, planners and rescue groups, to name a few) of the software. The nationwide workshops are continuously being conducted to promote and equip users with a tool to better understand earthquake hazards and risk, and identify local needs, mechanisms for prevention, mitigation and preparedness, and data needed for making prompt decisions for rescue and relief operations. Overall, REDAS aims to function as a decision support tool for disaster managers, and also to aid in mainstreaming DRR in the local development planning process (PHIVOLCS, REDAS Activities, 2018; Bautista et al., 2011)

Existing initiatives on **earthquake information tools, public education and awareness** are briefly described below:

Hazard Hunter is an application that can be used to generate indicative hazard assessment reports on a user's specified location. It is helpful as a reference of property owners, buyers, land developers, planners, and other stakeholders who need immediate hazard information and assessment. It aims to increase people's awareness of natural hazards and advocates the implementation of plans to prepare for and mitigate the effects of hazards. HazardHunterPH was first released on July 16, 2019.

All information used for the calculation of hazard assessment is based on the most recent updates provided by the corresponding mandated government agencies through the GeoRiskPH Integrated System. Details on archived data or additional information about the hazards may be accessed from DOST-PHIVOLCS for seismic and volcanic hazards, and DOST-PAGASA and DENR-MGB for hydro-meteorological/climatological hazards.

HazardHunterPH is a product of the Geospatial Information Management and Analysis Project for Hazards and Risk Assessment in the Philippines (GeoRiskPH), a multi-agency initiative led by DOST-PHIVOLCS and participated by DOST-PAGASA, DOST-ASTI, DENR-MGB, DENR-NAMRIA, DND-OCD, and DepEd (GeoRiskPH, n.d.). GeoRiskPH was developed to help address the lack of consolidated information that is vital for effective climate and disaster risk assessment; it "systematizes data from various sources into one platform and provides essential tools for disaster risk management" (PMS, 2020). GeoRiskPH acknowledges the valuable contribution of the Geological Survey of Japan (GSJ) for training the team in developing HazardHunterPH (GeoRiskPH, n.d.). DOST-developed technologies including GeoRisk, were approved by the President and the Cabinet with a recommendation from DOST for all agencies to update and share with them available hazard information to enhance the system (Parrocha, 2019)

Fault Finder

A web and mobile application capable of doing proximity searches to active faults which can be useful for land-use planning, risk assessment, disaster risk reduction plan, and awareness. It is a product of the collaboration between DOST-PHIVOLCS and the GSJ, National Institute of Advanced Industrial Science and Technology (AIST), Japan. FaultFinder was released on July 27, 2016 (DOST-PHIVOLCS).

Philippine Earthquake Model Atlas

Developed by DOST-PHIVOLCS, this atlas is a handbook of probabilistic seismic hazard maps that will aid engineers in designing earthquake resilient buildings and structures. It can also be used as a tool for land use and urban planning, and disaster risk management plans of LGUs, government agencies, and other stakeholders. The PEM Atlas aims to promote and enhance the existing National Structural Code of the Philippines (NSCP), a referral code of the National Building Code (NBC). This will serve as basis for designing earthquake resilient structures like residential and commercial buildings, critical facilities such as dams, bridges, and hospitals, and hazardous installations such as nuclear, biological, and chemical facilities (PIA, 2018).

Disaster Information for Nationwide Awareness Project (Project DINA)

Project DINA is an initiative of the OCD to complete its commitment to promote public awareness on disaster preparedness. It contains a system of information materials on DRRM, specifically *to do's* before, during and after earthquakes, tsunamis, tropical cyclones, landslides, floods, volcanic eruptions and fires (OCD, n.d.).

Lastly, a project covering **disaster and climate risk management, which is not exclusive to but includes earthquake risk management**, is the **GMMA READY Project**. It is a joint initiative of OCD, NDRRMC, Collective Strengthening on Community Awareness on Natural Disasters (CSCAND) Agencies (composed of DOST-PHIVOLCS, PAGASA, MGB and NAMRIA), MMDA, HLURB, UNDP, and Australian Aid. The project aims to decrease the vulnerability of the Greater Metro Manila Area (GMMA) to natural hazards and increase its resilience, by strengthening the institutional capacities of the local government units, concerned national government agencies, academic institutions and civil society organizations to manage disaster and climate change risks. It has five expected outputs: (1) disaster/climate risk vulnerability assessment; (2) development and implementation of disaster/climate risk mitigation actions; (3) mainstreaming of disaster/climate risk management (DRM/CRM) in operations of both public and private sector, and (4) development plans and regulatory processes; and, (5) establishment of DRM/CRM knowledge management system/community of practice (GFDRR, n.d.). One of its activities is the creation of the **Valley Fault System Atlas** (released in 2014), a handbook that includes large-scale maps of the Greater Metro Manila Area (GMMA) showing locations transected by the VFS. The VFS Atlas was created by DOST PHIVOLCS (PHIVOLCS, OCD, & NDRRMC, The Valley Fault System in Greater Metro Manila Area, 2014).

In terms of **earthquake risk reduction thru infrastructure improvements**, efforts and measures have been made by DPWH to increase the “earthquake resiliency” of public infrastructures.

Earthquake Recording Instrumentation for Buildings

The National Structural Code (NSC) and National Building Code (NBC) have provisions on earthquake recording instrumentation. In line with this, DPWH released the most recent guidelines and implementing rules of earthquake recording instrumentation through NBCDO Memorandum Circular 1 Series of 2015 (NBCDO MC 1 S2015). This Memorandum Circular is applicable to all buildings in the country located in Seismic Zone 4 (except in Palawan and Tawi-Tawi). It also sets specific guidelines for all buildings within 200km radius from Type A faults as specified in the NSC. The said requirements are necessary prior to issuance of Certificate of Occupancy and Building Permits. The guidelines requires all government buildings higher than 50 meters to have 3 accelerographs, one accelerograph for provincial/city/municipal buildings, hospitals with 50 bed capacity or more and schools with 20 classrooms or more which are not exceeding 3 storeys. The guidelines also set requirements for private buildings.

Seismic Design Specifications

DPWH released updated design specifications incorporating and strengthening the integration of seismic resistance of structures. This includes the following:

- *DPWH LRFD Bridge Seismic Design Specifications, 2013*
This is an output of the Project “Study on Improvement of Bridges through Disaster Mitigating Measures for Large-Scale Earthquakes” by the Government of the Republic of the Philippines and the Government of Japan. The project was done to improve the durability and safety of bridges under large-scale earthquake in the Philippines. The DPWH LRFD Bridge Seismic Design Specification was meant to improve and update the seismic design guidelines based on technological advancements on earthquake design and construction. It incorporates Japan’s experience in the design of bridges for large-scale earthquakes. The 2013 version has undergone revisions, the latest of which was released in 2019 (DPWH).
- *DPWH Highway Bridge Seismic Isolation Design Specification, 2019*
Compared to the 2013 Bridge Seismic Design Specifications (BSDS), the Highway Bridge Seismic Isolation Design Specification of 2019 provides supplemental specifications towards a more detailed guideline on the application of seismic isolation method for new bridges, specifically the treatment of the verification and design of seismic isolation bearings (DPWH, 2019)
- *DPWH Seismic Retrofitting Manual for Highway Bridges, 2019*
This is an updated version of the DPWH 1993 Seismic Retrofit Guidelines to cover the requirements of the DPWH 2013 BSDS in terms of the seismic performance level and the seismic hazard requirements. Procedures of the Federal Highway Administration (FHWA)’s 2006 “Seismic Retrofitting Manual for Highway Structures: Part 1-Bridges” were adopted including the retrofit procedures, rating, evaluation and retrofit method (DPWH, 2019).

Structural Audit of government buildings

In 2018, DPWH finished the structural audit of government buildings and bridges along national roads in Metro Manila as part of its safety measures in preparation for a major earthquake. DPWH deployed teams to assess more than 4,900 government structures in Metro Manila, majority of which are public schools and hospitals. From this audit, they assessed the need to retrofit 25 bridges and three flyovers (Bondoc, 2018).

Earthquake Resiliency Program Management Office (ER-PMO)

DPWH established the ER-PMO which adopts an integrated department approach to address earthquake resiliency problems. The office was created thru Department Order 75 Series of 2019. It is directly under the Office of the DPWH Secretary. Among the responsibilities of the ERPMO are the following:

- formulate and operationalize the DPWH Earthquake Resiliency and Response Plan
- develop and institutionalize the Earthquake Contingency and Continuity Plan
- fast track implementation of urgently needed interventions to ensure resilient infrastructures
- undertake vulnerability and risk assessment of all critical infrastructures

To assist the DPWH ER-PMO, several agencies were identified to serve as support agencies – the NEDA, DOF, DBM, DILG, DSWD, NDRRMC, DOST-PHIVOLCS, DENR-MGB (Unite, 2019).

The DPWH is determined to improve connectivity in Metro Manila through the **Metro Manila Logistics Improvement project** which targets to add 12 bridges crossing Pasig River, Marikina River and Manggahan Floodway. The department also has the **Metro Manila Priority Bridges Seismic Improvement Project Phase I** which includes retrofitting of Guadalupe Bridge and Lambingan Bridge to ensure safety of 365,000 and 30,257 motorists who use the respective bridges daily.

Other earthquake resilience measures of DPWH are:

- Retrofitting of 10 flyovers along EDSA and other major thoroughfares in Metro Manila
- Retrofitting of bridges (C5 – Katipunan/Aurora Boulevard Flyover, C-5/Pasig Boulevard Flyover, C.P. Garcia Bridge, Insular Bilibid Prison Bridge, Cupang Bridge, Lower Buli Bridge, Alabang – Bayanan Bridge) which were completed in 2018.

Preparedness and Response

MMDA's Oplan Metro Yakal (2011) and its integrated earthquake contingency plan **Oplan Metro Yakal Plus (2015)** were developed from the findings of the MMEIRS. Also referred to as Metro Manila Earthquake Contingency Plan, the Oplan Metro Yakal Plus, an enhanced version of the Oplan Metro Yakal and uses data from the updated West Valley Fault System Atlas, is an integrated contingency plan for earthquake and related geological hazards. It is an operational plan that anticipates what could happen if a 7.2-magnitude earthquake strikes along the WVF, including associated threats of landslides, rupture, liquefaction, or tsunami. It also outlines the response measures that will be carried out prior to and immediately after a hazard strikes, as well as the roles and responsibilities of members and partners of the Metro Manila Disaster Risk Reduction and Management Council (MMDRRMC).

The **Harmonized National Contingency Plan for the Magnitude 7.2 Earthquake** was formulated by the NDRRMC. It is a working plan designed to address the response requirements resulting from the anticipated occurrence of the 7.2-magnitude earthquake caused by the movement of the WVF (Padagdag, 2018). The scenario may yield a PHIVOLCS earthquake intensity scale of VIII, which will affect not only Metro Manila, but also the nearby regions of Central Luzon and CALABARZON.

In 2018, the NDRRMC, OCD, and Department of Social Welfare and Development (DSWD) published the **National Disaster Response Plan: Earthquake and Tsunami** as the national government's action plan in providing response assistance for managing earthquakes and tsunamis. The plan aims to ensure the timely, effective, and coordinated response of the national government by providing support assistance to disaster-affected areas. The National Disaster Response Plan (NDRP) outlines key planning aspects such as timelines, lead agencies, outcomes, and activities according to four (4) thematic areas.

Government agencies and even the private sector are also aggressive in the conduct of earthquake drills to condition the public on the correct disposition and actions during an earthquake. Relevant measures include the quarterly Nationwide Simultaneous Earthquake Drill (NSED), and MMDA's Metro Manila Shake Drill.

Overall, the government has progressed in raising the people's awareness on the adverse impact of disasters on the population and the economy by integrating natural hazard risks in its plans, strengthening institutions, and implementing projects like EWS, improving weather forecasting, and strengthening disaster response (Commission on Audit, 2013).

2.3 Succeeding Earthquake Risk Assessments

The GMMA is particularly vulnerable to the devastating effects of earthquakes, as it is surrounded by a complex system of faults and trenches such as the Valley Fault System (VFS), Philippine Fault, Lubang Fault, Manila Trench, and Casiguran Fault (MMEIRS, 2004). Among these geological features, the VFS, which contains two major segments known as the WVF and the East Valley Fault (EVF), traverses GMMA and is considered to potentially cause the largest impact to the area, should it generate a major earthquake.

Highlights from Greater Metro Manila Area Risk Analysis Project

One of the comprehensive studies to update the assessments in MMEIRS is the Greater Metro Manila Area Risk Analysis Project (GMMA-RAP). Highlights of GMMA-RAP in terms of projected estimates on loss and damages for the magnitude 7.2 earthquake are the following:

Building damages

In terms of physical damage, the high number of “collapse” in terms of floor area is projected to be in Barangay Mayamot in **Antipolo City**, Barangay Rosario in **Pasig City** and Barangay BF Homes in **Paranaque** which may be due to the large land area of these barangays. For projected “complete damage with no collapse”, high values are projected to be in Barangay Cupang, also in Antipolo City, Barangays San Andres and San Isidro in Cainta, Barangay San Jose in Rodriguez, Barangay Manggahan in Pasig City, Barangay Santa Ana in Taytay and in Metro Manila, Barangays Bel-Air and San Lorenzo in Makati City, Barangays Alabang and Cupang in Muntinlupa, Barangay Bagumbayan in Quezon City and Barangay Fort Bonifacio in Taguig City. The high values may again be attributable to big land areas, predominant era of construction and presence of many high rise structures resulting in total large floor areas.

Casualties

The highest numbers of fatalities are found in the same barangays where “collapse” and “complete damage with no collapse” categories are projected, which include Barangays Cupang and Mayamot in Antipolo City, Barangays San Andres and San Isidro in Cainta and Barangay Rosario in Pasig City. Batasan Hills in Quezon City consistently appeared from fatalities to injuries categories although it is not prominent in the damage list. A possible explanation could be its high population count. Barangays Cupang and Mayamot in Antipolo City are consistently within injuries to fatalities list, possibly due to its barangay land area size. Again, when normalized accordingly, the high values for these big barangays dissipated. Meanwhile, what surfaced are peaks for small-sized barangays notably pronounced in the high-density area of old like in the City of Manila.

Economic loss

The barangays which registered high economic loss were: San Lorenzo and Bel-Air both in Makati City, San Antonio in Pasig City, Bagumbayan in Quezon City and Fort Bonifacio in Taguig City. The aforementioned two barangays in Makati only figured prominently under the “complete damage with no collapse” category. Both had predominant pre-1972 era of construction. When normalized, the two barangays still retained their prominence in normalized economic loss category. The Pasig City barangay of San Antonio, only emerged prominently in the slightly damage category. Despite this, it showed high as among the top five in the economic loss. It is possible that some buildings in this barangay also suffered severe damage other than just “slight damage”. When normalized, the barangay again appeared prominent. The two remaining barangays, Bagumbayan in Quezon City and

Barangay Fort Bonifacio in Taguig City, initially showed in the “complete damage with no collapse” category. Just like the other barangays, the two barangays show up even in normalized map version. The above-mentioned barangays which sustained the highest economic losses were not among the barangays which registered the highest number of collapsed category. A major factor could be the possible high replacement costs for these highly urbanized barangays rather than the count of total floor area damaged.

2.4 Risk Reduction Estimates from DOST-PHIVOLCS

The MMEIRS in 2004 and the current numbers crunched by the DOST-PHIVOLCS using the REDAS exhibit the changes in impact between the two timeframes. The succeeding table shows the current risk estimated according to the DOST-PHIVOLCS (2019). Comparatively, data from the Philippine Statistics Authority (PSA) 2010 population and those from MMEIRS estimates in 2004, a decline was noted in the total number of deaths: from 33,500 to 30,205, or from 0.33 to 0.25% of the total population in Metro Manila only. As this may be an indication of actual reduction of impact, the statistics cannot be affirmed yet. Because of the differences in census reference, methodologies, indicators used during the estimation, it is unlikely that these changes directly refer to a reduced earthquake impact.

Table 5. Earthquake Impact Estimates for Metro Manila in 2004 and 2010 and for Regions III and IV in 2010. Source: DOST-PHIVOLCS (May 2019)

	Structural Damage	Building Collapse	Economic Loss (in million PhP)	Injuries	Fatalities
Metro Manila (based on 2004 MMEIRS data)				113,600	33,500 (0.33%)
Metro Manila (based on 2010 PSA data)	1,741,514 buildings	50,124 buildings	882,530	535,766	30,205 (0.25%)
Region III (based on 2010 PSA data)	792,936 buildings	6,123 buildings	213,980	68,388	3,033
Region IV-A (based on 2010 PSA data)	1,509,598 buildings	21,068 Buildings	560,130	202,267	10,053

2.5 Experiences from Past Earthquakes and Current Practices

Considerable work has been and is currently being done in the Philippines to understand the physics of earthquakes. Earthquakes are studied, measured, mapped, monitored, and analyzed (Gray, 2016; MMEIRS, 2004; University of Edinburgh, 2009). However, there is no available tool or system yet that

can predict the next earthquake event (Bullen, 2017). It certainly cannot be prevented, but the damages in future earthquake risk can be reduced. In an article by the United States Geological Survey (2006), earthquake risks such as death, injury, and economic loss can be reduced by (1) better planning, construction, and mitigation practices before earthquakes happen, and (2) providing critical and timely information to improve response after they occur. Another study recommended that some strategies for reducing structural vulnerabilities are to incorporate earthquake-resilient features in new constructions, retrofit existing structures, and transfer risk through insurance (Sphere India and EFICOR, 2010). Furthermore, it was concluded that reducing earthquake damage requires a thorough approach and managing earthquake risk, which means analyzing the risk and finding efficient ways to reduce that risk (United Nations Office for Disaster Risk Reduction, n.d.).

To better explore earthquake risk management in the Philippines, this section shall provide a brief review of some earthquake experiences since MMEIRS, and how NGAs, LGUs, private sector, communities, among others prepared and responded to these. From these past experiences, lessons learned and best practices shall be extracted. It should also be noted that these are based on information available to the team and may be updated when other references are available.

Past earthquakes in the Philippines

This section tackles the past strongest earthquakes after MMEIRS, with an attempt to focus on affected urban areas to gather ideas of lessons learned which are relevant to the context of GMMA.

Magnitude 6.9 earthquake in Central Visayas (February 6, 2012)

A strong earthquake with epicenter approximately 5km northwest of Tayasan, Negros Oriental which was generated by NE-trending blind thrust along the eastern region of Negros Island. Various towns in Negros Oriental felt the strongest ground shaking at PEIS VII to VIII. Unusual sea waves and local tsunamis were also reported in Negros Oriental and Cebu (DOST-PHIVOLCS, 2015). It affected 63,899 families. A total of 51 people died, 62 still missing and 112 were injured. It caused a total damage of ₱383-million on infrastructures (NDRRMC, 2012).

Magnitude 7.6 earthquake near Guiuan, Eastern Samar (August 31, 2012)

A major earthquake with a magnitude of 7.6 happened near Guiuan, Eastern Samar on August 31, 2012 resulting to PEIS V to VII in various parts of Visayas and Mindanao (DOST-PHIVOLCS, 2012). The quake caused damage on homes, bridges, and other infrastructures. There were also power interruptions in the affected areas. The total cost of damage was Php133.6 million (NDRRMC, 2012).

Magnitude 7.2 earthquake in Bohol (October 15, 2013)

The quake affected most of Central Visayas, particularly Bohol and Cebu. It was felt in the whole area of Visayas and reached as far as Masbate Island in the north and Cotabato in Southern Mindanao. The earthquake was generated by the North Bohol Fault (NBF). At least 3900 aftershocks were reported (DOST-PHIVOLCS, 2013). According to the NDRRMC, a total of 222 people died, 8 were missing and 976 others were injured. An estimated 73,000 structures were damaged with more than 14,500 destroyed totally (Sabornido, 2018).

2017 Batangas Series of Earthquakes

In April 2017, a series of earthquakes with epicenter in Batangas occurred. On April 4, a magnitude 5.5 earthquake happened 7km NE of Tingloy, Batangas at a shallow depth of 7km. This was followed by two (2) earthquakes in Mabini on April 8. Series of earthquakes that lasted until August 2017 also followed with total recorded earthquakes of 3,958 between magnitudes 1.7 to 4.7 (DOST-PHIVOLCS, 2017) . The series of earthquakes affected around 6,500 families, resulted to six (6) injuries, more than 3,000 damaged houses (NDRRMC, 2017).

Magnitude 6.1 earthquake in Castillejos, Zambales (April 22, 2019)

This earthquake shook the provinces of Zambales, Pampanga and its surrounding areas. The epicenter was located 18 kilometers northeast of Castillejos, Zambales. A total of 924 aftershocks were recorded as of 29 April 2019. The strongest ground shaking was felt in Brgy. Nabuclod, Floridablanca, Pampanga with PEIS VIII (DOST-PHIVOLCS, 2019). A total of sixteen (16) deaths, eighty-six (86) injuries and fourteen (14) missing persons were reported in Region III. An instance that provided a “preview” of the possible effects of the Big One is the collapse of the 4-story Chuzon Supermarket in Porac, Pampanga. Twelve persons were trapped in the collapsed structure, resulting to 4 deaths and 8 injuries. DPWH assessed that, the building collapsed not just because of the earthquake’s intensity, but also due to: violations of the building code, lack of proper seismic analysis prior to construction, and absence of structural reinforcements per building plan.

Magnitude 6.3, 6.6, 6.1 and 6.5 in Tulumun, Cotabato (October 2019)

A series of earthquakes in Cotabato were recorded in 2019 which affected the provinces of Cotabato, Davao del Sur, Maguindanao, Sarangani, South Cotabato and Sultan Kudarat, as well as cities such as Davao City and General Santos City. The magnitude 6.5 earthquake concentrated at the central portion of Makilala and eastern portion of Kidapawan City, Cotabato where PEIS Intensity VIII was observed (DOST-PHIVOLCS, 2019). A total of 53,362 families/260,492 persons were affected in 322 barangays, resulting to 24 deaths and 55 injuries. Most of these casualties are in the rural areas of Davao del Sur and North Cotabato. There were power and water supply interruptions. Power supply was immediately restored in most of the affected areas. To augment water supply, the local water service provider and the Philippine Red Cross helped in rationing water (NDRRMC, 2019, Nov.11).

2.5 Information Gaps

In a study by Shaw et al. (2010), policy points and recommendations were suggested for the 16 cities and one (1) municipality of Metro Manila to encourage community resiliency in terms of physical, social, economic, institutional, and natural aspects. However, resilience was evaluated only against climate-related natural hazards, such as typhoons, flooding, drought, etc., but not against earthquakes. Aside from that, the study did not cover some affected areas of Central Luzon (i.e., Bulacan) and CALABARZON (i.e., Cavite, Laguna, Rizal, and Quezon) in the event that a magnitude 7.2, WWF earthquake hits the country.

Orallo (2011) concluded in her report that it is very important to revisit the priority plan of action of the MMEIRS Report. Because the study was conducted a few years back, various parts of Metro Manila have undergone rapid urban development since then, adding a significant number of structures to the totals indicated in the report. The author added that should an earthquake occur, there is a possibility that actual casualties and damages will be higher than the estimates in the study.

CHAPTER 3

CHAPTER 3. ACCOMPLISHMENT REVIEW OF MMEIRS MASTER PLAN

The results are presented and discussed with reference to the objective of the study, which is to assess the accomplishments of the action plans implemented. This chapter is divided into two sections. The first section presents a review of the six (6) goals and its frameworks, together with information from relevant references and workshops which gives a generic background of the accomplishment per framework. This allows for another angle of explanation to further clarify the results of the survey which is discussed in the second section.

3.1 Summary of Responses and Review of Accomplishment According to Goals

Goal 1: Earthquake-Resilient National System

In case the WVF moves, it is projected that major affairs of society (economic activities, basic services, communication systems, and public health) may be crippled, since the country's main government (including administrative, legislative, and judiciary functions), economic, financial, and information centers are all located within the GMMA. If the country's national systems were to collapse, the cascading effect that would ensue could lead to chaos and destruction of unparalleled proportions, and would profoundly affect the entire nation. The physical, economic, and social losses that will be generated by the catastrophe could be quite significant; therefore, it is paramount to secure the resilience of the country's national systems. NGAs, together with the LGUs and critical infrastructures, are often interdependent; therefore, the system is more vulnerable to crises as a whole. The improvement and maintenance of national systems should be at the core of disaster risk reduction, especially in earthquake impact reduction. The need for greater coordination of all agencies and critical facilities is important for an effective disaster preparedness and response. Appropriate policies, plans, and strategies that target hazards in specific areas have to be crafted and implemented at all levels of the government to ensure the resistance of our national systems. Updating of regulations to ensure resiliency of national systems should be given more attention.

Executive Order 52 institutionalized the two-pronged strategy toward an earthquake-resilient GMMA (PMS, 2019). The first strategy focuses on the enhancement of the resiliency by (1) reducing population density and dispersing economic activity, (2) establishing an integrated regional government center to enhance government and business service continuity, and (3) reinforcing building standards. These strategies primarily support the goal to develop an earthquake-resilient national system.

NSD 1: Protect stability of national government functions

This framework emphasizes the importance of maintaining national functions in the event of an emergency. To achieve this, it is deemed important to safeguard the official residence and principal workplace of the President of the Philippines in Manila and the office of the Vice President in Quezon City, the Senate in Pasay City, which is on a reclaimed land on Manila Bay, and the House of Representatives in Quezon City, which is near the WVF. One of the main action plans for this framework includes the development and enhancement of continuity plan at the national, regional, and local levels. Other pertinent action plans are the development and practice of emergency and evacuation drills, and the conduct of infrastructure check and maintenance to ensure structural integrity of the government facilities.

A number of government agencies have been identified to have vital functions in ensuring the continuity of national functions through the NRT. Most NGAs identified the importance of a public service continuity plan (PSCP) and a disaster mitigation plan. However, most of these plans are drafted, proposed, and awaiting approval, or in its initial versions. Moreover, the Department of Energy (DOE) issued an Energy Resiliency Policy (Department Circular No. 2018-01-001) on January 17, 2018, which mainstreams energy resiliency in all plans and programs of the energy sector. This includes updating of existing contingency plans in the power and oil sectors, the public service continuity plan, and business continuity plans of the private sector.

In terms of conducting emergency drills, the national agencies participate in the nationwide simultaneous Earthquake Drill that is held annually. Additionally, agencies conduct trainings to its staff to provide skills for emergency response. Other agencies attend seminars, meetings, or briefings inside or outside their offices to improve their response capabilities. For instance, the DSWD is one of the agencies that develop and train a disaster response team. The MMDA and OCD spearhead the conduct of a national emergency simulation exercise participated by different offices. The LGUs do not necessarily take actions on ensuring the stability of national government functions but are rather more focused on the development of the skills of its local staff to continue local functions.

According to this framework, government agencies should also ensure the stability of their buildings for continued operations in times of emergency. Some agencies have identified the availability of emergency equipment, such as fire extinguishers, and the presence of evacuation routes. An important means of verification that has been identified for this plan is the adherence of these government-owned buildings with the National Building Code. However, almost all agencies do not have a regular structural inspection of their buildings to ensure their stability against a strong earthquake.

NSD 2: Protect the stability of socioeconomic system

In the MMEIRS, it is estimated that 47% of the houses in Metro Manila will be damaged or burnt, and about three (3) million people will become refugees or homeless. These damages have been identified to have negative consequences on the stability of socioeconomic functions. This framework looks at the stability of the technological equipment that is used to run socioeconomic functions. This also suggests the decentralization of business operations from the capital and strengthening the emergency services capability to minimize impact in the country's economy.

In terms of decentralizing operations, national agencies, the DPWH, DSWD, and Commission on Higher Education (CHED), among others, have their regional offices for continuation of their functions. For the stabilization of prices of goods, the Department of Agriculture (DA) specifically complies with the Price Act of 1992 and 2013, together with the reports and documentation from the Agribusiness and Marketing Assistance Service of the department. Moreover, foreign aid is also expected to be effectively managed under this framework. The Philippine International Humanitarian Assistance Cluster (PIHAC) serves as the primary body in handling incoming foreign aid.

Goal 2: Earthquake-Resilient Urban Structures

Protection of urban structures against catastrophic earthquakes is a key issue in highly urbanized countries such as the Philippines. The MMEIRS illustrates the extreme vulnerability of urban structures including buildings and infrastructures like roads, railways, port facilities, and lifelines, such as power, telecommunications, and water supply. Based on the damage estimation, some 40% of the total residential buildings in Metro Manila will be affected in the event the WVF moves.

The second strategy of the two-pronged strategy under Executive Order 52 (PMS, 2019) highlights risk reduction in the GMMA through the following:

- Ensuring the resilience of public structures.
- Ensuring the availability of different modes of transport such as land, air, and sea access so that GMMA will not be isolated.
- Ensuring the availability of basic necessities such as water, food, power, and shelter.
- Establishing command and control centers nationwide.
- Establishing a full-time Presidential Management Office.

USI 1: Promote earthquake-resistant urban development

Metro Manila and GMMA are urban areas with more urban development projects. It is important to look at the earthquake resiliency of the structures in these areas. The primary measure that can ensure an earthquake-resistant urban development is the strengthening or retrofitting of every residential building among others.

The DOST-PHIVOLCS, Association of Structural Engineers of the Philippines (ASEP), and Japan International Cooperation Agency-Japan Science and Technology (JICA-JST) developed a “How safe is my house” tool to assess the safety of homes. The DILG disseminates this tool in various households. The MMDA is also mandated to assess public safety in coordination with the DOST-PHIVOLCS, DPWH, and LGUs. The National Building Code sets guidelines in strengthening homes from the impacts of earthquake hazards. To ensure that the design and building of homes are earthquake- and fire-resistant, the Housing and Urban Development Coordinating Council (HUDCC) integrates climate change adaptation and disaster risk reduction to the local shelter plan and Comprehensive Land Use Plan (CLUP).

Moreover, another action plan calls for the setting and implementing of standards for road width and proportion of open spaces. MMDA takes part in urban renewal, zoning, and land use planning and shelter services in collaboration with the LGUs and HUDCC. To consider urban redevelopment of former informal settlement areas, the National Economic and Development Authority (NEDA) provides the guidelines to higher level CLUPs, i.e., provincial development and physical framework plans, which already consider climate change adaptation and disaster risk reduction. At the LGU level, almost all LGUs redesign or improve CLUPs into earthquake risk-sensitive plans. It is also noted that there is an ongoing enhancement of the National Disaster Risk Reduction and Management Plan (NDRRMP).

USI 2: Promote flameproof urban development

Fire is another threat viewed as a consequential hazard to earthquake. The MMEIRS estimated fire outbreaks that are caused by liquefied petroleum gas (LPG) and excessive power lines from informal settlement areas. It is, therefore, important to highlight the actions for preventing fire outbreaks, spread of fire, and promotion of flameproof urban development.

One of the action plans in this framework is to secure the possible sources of fire such as LPG tanks, gasoline refilling stations, oil depot, bottled gasoline-vending stores, illegal power connections, and other hazardous materials. In the workshop with NGAs and DOE, the Oil Industry Management Bureau (OIMB) set safety standards for LPG tanks and fuels. Safety standards and security are also being implemented in the power systems, like curbing of power pilferage and illegal connections in the franchise areas of distribution utilities. The Bureau of Fire Protection (BFP) sets guidelines for strengthening buildings against fire hazards and conducts inspections. During the FGD session, it was revealed that BFP also conducts annual inspection to ensure that the guidelines on fire prevention are met.

USI 3: Promote spatial urban development

It is recognized that areas near the WVF and coastal areas will be the area of high evacuation difficulty. This framework primarily emphasizes the need for open spaces for evacuation in the event of a devastating earthquake. Buildings and offices should set a proportion of open space (relative to population) for mass earthquake evacuation. Most NGAs have open spaces according to the results from the second workshop with the NGAs (see Appendix 5). As per Batas Pambansa 220, offices are required to provide a certain percentage for an open area.

Additionally, introduction of firebreak network elements (such as parks and other open spaces, roads, and pedestrian alleys) in urban plans could promote spatial urban development. It was also disclosed that memoranda/directives from the National Building Code Development Office of DPWH set information for building construction.

USI 4: Promote earthquake-resistant buildings

During the workshops, there were no identified actions to develop and introduce affordable seismic retrofitting technologies and methods for building owners and developers. There were also no explicit information identified for conducting research and development for alternative, affordable, lightweight, and nonflammable construction materials. On the other hand, there are efforts to educate and train human resources for building (structural) engineering. Capacity building programs through seminars and workshops for technical employees are conducted by agencies such as the HUDCC and MMDA.

USI 4: Promote earthquake-resistant buildings and USI 5: Promoting earthquake-resistant public facilities

Compared with residential buildings, public buildings are expected to be more stable and resistant to earthquake damages as it is assumed that they follow the structural code set by the DPWH. Building seismic diagnosis results for 80 public buildings showed that 45% of the buildings have basic or suspicious structural problems. On the other hand, 55% of the buildings were sound. Building damage estimation results against the worst-case scenario for public facilities indicate that 8-10% of the buildings would collapse or would be heavily damaged, while 20-25% would be partly damaged. Public buildings serve as the center facilities in the event of a disaster (MMEIRS, 2004). These buildings will have to continue the vital functions of providing emergency services to various agencies. Hence, their structural strengthening is especially important.

In promoting earthquake-resistant public facilities, it is highlighted that the seismic performance of public buildings be evaluated. The DPWH ensures this by conducting vulnerability assessments in their infrastructures and facilities. As of this writing, the Metropolitan Waterworks and Sewerage System (MWSS) is processing the structural assessment of the MWSS Arroceros Building.

Moreover, in retrofitting public buildings with low seismic-performance rating, the Department of Health (DOH) has limited the retrofitting only to DOH hospitals that underwent assessment, although a program for retrofitting is in place, according to the agency. The DPWH has ongoing retrofitting of structures/projects being implemented; whereas NEDA is in the process of retrofitting the NEDA Pasig Building, as reported in the workshop.

USI 6: Promote earthquake-resistant urban infrastructures

Retrofitting of infrastructure, such as roads, buildings, train systems, railways, airports, and seaports, plays an important role for ensuring that emergency activities would run smoothly. Hence, assessment

of seismic performance of bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems is a vital action.

Various agencies are involved in the structural assessment and retrofitting of urban infrastructures. DPWH leads the inventory, assessment and inspection of structural integrity of roads and bridges nationwide. In Metro Manila, MMDA also conducts inspection of bridges, flyovers, and tunnels in collaboration with DPWH, LGUs and related agencies. Inspection of commuter rail systems is under the DOTr such as the LRT Line 1 which underwent a third-party inspection to ensure that the structural integrity of the facility could withstand catastrophic shaking during an earthquake and shall not compromise the safety of its personnel, passengers, and facilities.

Retrofitting of bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems and development of transport facility reconstruction plan are being conducted in accordance with the different agencies' contingency plans. It is the same with the establishment of a backup system and site for airport control center, air traffic tower, and approach leader.

USI 7: Promote earthquake-resistant lifeline

Lifelines consisting of water, sewage, gas, electricity, and telecommunications have become indispensable to the everyday living of people. The impact of the disaster may be worsened by a shortage or lack of these lifeline utilities. In the MMEIRS damage estimation, the damage for water network would reach 4,000 points in the worst case, and the damaged length for electricity and telecommunications would reach 31 km and 97 km, respectively. It is, therefore, necessary for lifeline companies to make these lifelines earthquake-resistant to reduce the estimated damage.

In relation to managing lifeline utilities, some agencies reported to have GIS database in their offices. Agencies such as the DPWH and DOE have geotagged information on critical infrastructures. The Mines and Geosciences Bureau (MGB) and National Mapping and Resource Information Authority (NAMRIA) have a wide range of geospatial information on hazards and exposure data. The Philippine Geoportal presents geospatial information online, but may be limited since there are life nodes that are not available or uploaded.

During the workshops, no explicit information was gathered on: actions related to the development of earthquake emergency operation team and support system for lifeline; development of lifeline earthquake emergency operation manuals; development of lifeline facility reconstruction plan; and, conduct of regular emergency operation exercise for lifeline.

Moreover, in terms of introducing and using earthquake-resistant water distribution pipes, the MWSS mentioned that it is included in their Concessionaires Business Plan and partially being implemented in main water lines located in critical areas. However, they identified that full implementation in all water transmission lines is not financially feasible. In terms of electrical infrastructure, the Manila Electric Company (MERALCO) emphasized that overhead and underground conductors are already earthquake-resistant based on technical specification.

In communications, the MMDA has the Metrobase, Metro Manila Crisis Monitoring and Management Center, and a communication set in four sectors for monitoring and communication. PLDT-SMART Communications, Inc. highlighted that the network infrastructure delivering telecommunication services is designed to function with no single point of failure that will affect the entire network, and that the regions/clusters will operate at full or reduced service levels depending on the extent of disaster per area, as the elements that support the service is decentralized. There are centralized monitoring and control that oversee both the overall operations and the individual regions/clusters.

Goal 3: Enhanced Emergency Risk Management

According to the MMEIRS, the actual losses by a VFS earthquake will vary depending on the “level of preparedness and effectiveness of the risk management and emergency response systems”. The third goal of the MMEIRS, therefore, calls for an enhancement of an effective risk management system. To achieve this, impact reduction efforts should include the prevention of secondary effects and damages of earthquake such as fire outbreaks and tsunamis; strengthening of disaster management system at the national, regional, and local government levels; improvement of disaster response capacities; and ensuring access to critical information for adequate responses and inventory of essential information.

RMS 1: Promote fire preparedness and mitigation including handling hazardous materials

According to the MMEIRS, it is estimated that many informal settlements may suffer fire outbreaks due to houses made from flammable materials such as wood. Aside from that, it is recognized that there exist hazardous facilities and materials in places. Such hazardous materials include kerosene, gasoline, petroleum, LPG, chemical substances, etc. To mitigate fire damage, it is emphasized that enhancing firefighting response is not enough, but preparedness and mitigation measures must also be strengthened. The MMEIRS noted that these areas have to take many preparedness and mitigation measures against fire.

Some agencies conduct trainings, seminars, and drills for emergency teams in the barangays. For instance, the BFP has enhancement of skills, whereas the MMDA performs operation trainings and lectures. According to the agencies, capacity-building on firefighting is a concern of the LGUs and the BFP. In terms of regulating flammable materials and substances, there are existing regulations and permits issued by the DOE through the OIMB, whereas according to the Department of Environment and Natural Resources, relocating facilities with hazardous materials is based on the Philippine Environmental Impact Statement System as regulated by the Department of Environment and Natural Resources–Environmental Management Bureau (DENR-EMB).

RMS 2: Take measures against tsunami

The focus of GMMEIRS is the impact of 7.2 magnitude earthquake to be generated by the movement of the West Valley Fault, which is inland and not tsunamigenic. Hence, the thorough assessment of the action plans within this framework is limited. Nevertheless, the prioritization of research on tsunami is included in Goal 6.

RMS 3: Enhance legal basis for disaster management

The MMEIRS saw the need for developing a framework for disaster risk management in Metro Manila. It mentioned that this framework should include a holistic approach to disaster management and its relation to planning and development. Additionally, this framework suggested that at the local level, a city/municipal ordinance is needed to strengthen the legal framework and institutionalize disaster mitigation programs.

RA 10121 strengthens the Philippine’s DRRM system, provides a national DRRM framework, and institutionalizes the national DRRM plan. One important point raised during the FGD emphasized that, while there are contingency plans at the LGU level, the challenge remains whether these contingencies will be effective enough in providing risk reduction in the event of a disaster.

Moreover, at the national agency level, some NGAs mentioned that they have in-house DRRM personnel (e.g., OCD, Armed Forces of the Philippines [AFP], Light Rail Transit Authority [LRTA]) and technical staff (e.g., MGB) to perform DRRM activities. However, in terms of sectoral development plan, most sectors currently do not have one, or if available, these are currently being updated (see Appendix 5). In the power sector, the National Electrification Administration (NEA) reported that they have an electric cooperative plan. For the water sector, continuous preparation of water supply/sanitation studies for various municipalities nationwide (particularly Manila Bay Supreme Court Mandamus on Sanitation areas) are being conducted according to the Local Water Utilities Administration (LWUA).

RMS 4: Strengthen institutional capacity for implementing preparedness and mitigate measures

This framework calls for strengthening local disaster management councils. The MMEIRS noted that no substantive changes have been made since the establishment of local disaster management councils, despite legal changes affecting local government authorities and responsibilities, and changes in the government's organizational structure. The framework emphasized the importance of reorganization and revitalization of disaster coordinating councils. Various local ordinances in line with this are developed at the local level by the LGU and the MMDA.

According to the agencies present in the workshop, these action plans are assigned to the function of the OCD and LGUs. Trainings are conducted by the regional offices of the OCD and the Capacity Building and Training Service (CBTS).

RMS 5: Strengthen inter-institutional coordination

The MMEIRS' report detailed the need for improving the current mechanisms for inter-institutional coordination on disaster. In 2004, it has been assessed by the study that most groups within institutions that oversee disaster mitigation have no formal meetings or programs for pre-disaster preparedness and mitigation. Therefore, effective response, relief, and recovery operations are restricted in the level of inter-institutional coordination. Part of the recommendations of the MMEIRS is to update the action plans of institutions so that these will pave the way for increased coordination between institutions, stronger decision-making process, and effective lateral communication and mutual aid in both pre- and post-disaster scenarios.

After the MMEIRS was conducted, there have been many changes in the structure and protocols of disaster mitigation. It is evident that over the years, the Philippine government has given higher priority in DRRM through the formulation of the bodies that oversee disaster risk reduction across the country. This is evident in the Oplan Metro Yakal Plus which provides the structure for interoperability through its Incident Command System. Moreover, activities mentioned in the workshop's data gathering include the conduct of national simultaneous earthquake drills, tabletop exercises, and the Metro Manila shake drill.

RMS 6: Strengthen institutional disaster response capability

The need to upgrade capacity training and resources has been identified as one of the top priorities in DRRM. Each level of government should further enhance DRRM capabilities. As assessed by the MMEIRS, the guidelines and assistance provided by the government to LGUs, NGAs, and CUs are outdated and not substantial. Ideally, the said guideline should at least involve emergency planning, training procedures, and identification and procurement of needed resources. Presently, there have been leaps of changes among government and nongovernment institutions.

In the first workshop, it was revealed that most of the LGUs have complied with the action plans. According to the summary of workshops, development of standard relief and response resources based on national guidelines has been highly implemented by the LGUs. The NGAs, on the other hand, have identified the actions as not applicable to their mandates.

RMS 7: Develop operation systems and procedures

This particular framework is a supplement to strengthening inter-institutional disaster response capacity, as effective communication and coordination among institutions are crucial for DRRM. Disaster response requires inter-institutional mutual aid to save more lives and property. In 2004, MMEIRS identified that most of Metro Manila's Disaster Coordination Councils have no standard operating procedures (SOPs) to serve as a guide for post-disaster scenarios. Ideally, the SOP should detail specific protocols for critical response and relief functions. Moreover, in 2004, it was an issue that municipalities lack fully functional disaster operations centers to serve as focal points for inter-agency coordination, information gathering, analysis, and dissemination.

There have been many efforts and activities to develop an operation system and procedures for response and contingency to the 7.2-magnitude earthquake. Some agencies affirmed that there are already set of protocols that can be found in their respective offices' DRRM manuals. As also mentioned, there are a number of established practices for the conduct of different emergency simulation drill and exercises. The *Harmonized Contingency Plan for the Magnitude 7.2 Earthquake* also serves as guide for contingency measures in the event of the disaster.

RMS 8: Enhance capability of fire suppression and hazardous material

There are secondary post-earthquake hazards, one of which is a potential fire outbreak, which has been identified as high risk because the GMMA is densely occupied with infrastructures. The proximity of the buildings in the central business and residential areas raises the possibility of a huge fire outbreak. According to an earthquake scenario illustrated in the MMEIRS, about 1,700 hectares of land will potentially burn down and 19,300 people will be killed (MMEIRS, 2004). The study pointed out that fire service capacity in Metro Manila cannot handle fire suppression. Furthermore, there is a need to significantly reduce hazardous materials (plastic and paper scattered around Metro Manila) that can ignite and cause fire outbreak.

The results of the workshop indicated that many offices are in the process of updating their DRRM manuals. In terms of communications protocol, some agencies identified that they use devices such as radio systems. The Department of Information and Communications Technology (DICT) mentioned that they have established backup communications and mirror stations.

RMS 9: Secure evacuation route and evacuation sites

Building collapse and fire outbreak due to the 7.2-magnitude earthquake will leave as many as 3.15 million people in Metro Manila alone homeless, according to damage estimation (MMEIRS, 2004). Therefore, an evacuation plan to provide a temporary but secure shelter for this huge number of possible evacuees should be designed ahead. As this plan serves to prepare and guide evacuees to their temporary shelters safely and efficiently, inclusion of strategies on evacuation routes and methods of disseminating this plan to the public is equally important.

LGUs are mandated to create and carry out such evacuation plans based on the number of estimated evacuees and existing land use in their territories; whereas, the MMDA is tasked to review all plans and make the necessary coordination to ensure that these plans are consistent across all LGUs, comprehensive, and conform to standards set by the national government.

Additionally, according to the MMEIRS, LGUs, especially those with limited open spaces, should identify and designate their evacuation sites in coordination with their neighboring LGUs. Evacuation routes should also be identified, taking into consideration the extent of post-earthquake fires, distribution of hazardous facilities, degree of safety of bridges, accessibility to the evacuation sites, etc., because roads would be destroyed and bridges would collapse, rendering them impassable. This limitation would pose greater challenge for organized rescues and firefighting activities within affected areas.

Appropriate means of disseminating the evacuation plan to the general public, such as setting up clear signs of emergency evacuation sites and routes, and access to up-to-date information, should also be stipulated in the plan. Moreover, to ensure efficient implementation of the evacuation plan, LGUs must establish a scheme or protocol for mobilizing resources to fund the entire evacuation system.

The results of the first workshop indicated that, almost all LGUs have prepared their evacuation plans and sites, and established their schemes for mobilizing resources for evacuation in accordance to the *Oplan Metro Yakal Plus*, which is the contingency plan of the MMDRRMC. On the contrary, most NGAs recognize that these action plans are not applicable because these are not their mandates. Moreover, majority of the CUs have established their schemes for mobilizing resources for evacuation (see Appendix 5).

RMS 10: Secure water, food, and other necessities

In the event of disasters such as earthquakes, people are driven not only out of their homes but also out of the normal life situation. Companies supplying basic commodities and services to people may not return to their usual operations immediately because their establishments may have been affected by collapsed buildings, damaged roads, destroyed water supply pipes, or disrupted electricity supply. Whether or not people are in evacuation areas, delivery system of essential goods (such as water, food, clothing, and medicines) should be well-planned and secured to ensure sufficiency of supply and stockpile, and to maintain normal prices of the commodities in such emergency situations (MMEIRS, 2004). With this in mind, LGUs must be able to estimate the number of affected people, along with their needs per day so that adequate supply for all may be prepared and provided for a certain period of time.

The MMEIRS emphasized that, for large-scale water sources, measures should be in place to regularly check the integrity of their structures and be retrofitted if necessary. To ensure quick recovery of damaged water supply pipes, stockpiling of pipe materials must be done. Furthermore, alternatives for water supply system other than Angat Dam must be developed.

Results indicate that the LGUs have been responsive when it comes to establishing emergency supply system of water, food, and other necessities such as clothing and medicine (refer to Appendix 5). NGAs, on the other hand, mostly mentioned that most action plans in this framework are not applicable to their offices' mandates.

According to the MWSS, a water supply distribution system will be developed once delivery points are identified, but the data will be coming from the DILG. For large-scale water resource, the MWSS enumerated the following constructions:

1. Ongoing: Cardona treatment plant to extract water from the Laguna Lake
2. Detailed Engineering and Design phase: Kaliwa Dam in General Nakar, Quezon
3. Ongoing: Sumag Diversion Facility, General Nakar, Quezon
4. Feasibility study of Ipo Dam 3 in Norzagaray, Bulacan

Moreover, the NEDA specified that funds for the preparation of the Philippine Water Supply and Sanitation Master Plan have already been provided. The National Food Authority (NFA) also reported that a buffer stock for relief operations is already in place.

RMS 11: Enhance emergency health and medical response system

Metro Manila has scant resources and fragmented systems of emergency medical responses to potential consequences after an earthquake (MMEIRS, 2004). Taking this into consideration, it was deemed necessary for LGUs to formulate networks of mutual cooperation among LGUs in GMMA and surrounding provinces, which would strengthen their emergency response capacities in order to support each other and to come up with a multilayered response structure from community level to national and international levels with the technical support of DOH and MMDA.

Major action plans for this framework include: (1) enhancing emergency response capacities of DRRM organizations and (2) improving government hospital capacities. The results of the workshops pointed out that most of the LGUs have responded yes to both major action plans, with 89% and 58%, respectively (refer to Appendix 5). Most of the NGAs see these actions not applicable for their offices. Concerning other necessary action plans in this framework, CUs gave varied responses (refer to Appendix 5). Although not clear, they indicated that technical assistance and provision for enhancement are already in place.

RMS 12: Establish emergency transportation system

The MMEIRS revealed that Metro Manila has no recognized emergency transportation system.. Primary and secondary emergency road networks within GMMA should be identified and established to facilitate timely and efficient delivery of basic goods and services, and primary emergency responses such as rescue, medical relief, and firefighting activities. Moreover, ensuring the efficient use of the road network and clearing of debris and damaged infrastructures along these roads should also be prioritized. Also, transportation via land, sea, and air will be operated to maintain the accessibility of GMMA to its surrounding regions, which is likely to be separated because of damaged bridges and collapsed buildings, and to accommodate people and commodities that will be coming from other domestic and international areas.

According to the workshop results, the MMDA is establishing metro-wide emergency road network, stating that these are based on their contingency plan. The DPWH undertakes arrangements for emergency road-clearing based on their contingency plan. The Department of Transportation (DOTr) indicated that they can carry out transport assistance between Subic-Clark and Metro Manila north region. Action plans under this framework are being implemented by the DPWH and MMDA, as they mentioned that these are part of their contingency plan (DPWH) and of the *Oplan Metro Yakal Plus* (MMDA). Additionally, the DOTr will direct its attached agencies (Civil Aviation Authority of the Philippines and Manila International Airport Authority) to establish such emergency protocols for security purposes in the Ninoy Aquino International Airport (NAIA). In terms of retrofitting Manila port to earthquake- and tsunami-resistant construction, NEDA explained that this might be included in the Manila Bay Sustainable Development Master Plan.

RMS 13: Establish search and rescue system

Establishing a search and rescue system after a disaster is a vital component in disaster risk reduction to enhance a community's capability to reduce casualties. This may be accomplished by providing a community with basic fire services such as the procurement of the necessary equipment, and helping

them develop a search and rescue system including regular trainings and drills. However, based on the MMEIRS, our national, regional, and city/municipal governments neither has well-organized search and rescue structure nor recognizes its necessity. To help achieve this action plan, the MMEIRS suggested the development and enhancement of search and rescue system in communities, and the establishment of a system to accept international emergency aid.

According to the results of the workshops, all LGUs have developed and enhanced their search and rescue systems. However, most NGAs have not done so because it is not within their mandate. When it comes to the establishment of a system to accept international emergency aid, almost all LGUs mentioned that they do so. For the NGAs, only the Philippine National Police (PNP), DOTr, and DSWD have explicitly mentioned that they accept international emergency aid as part of their policy guidelines and as part of their contingency plan. The Department of Finance noted that the escalation of requests for assistance needs to be developed from local to national and international levels.

RMS 14: Establish information and communication system

The data from the workshops also demonstrate that LGUs and CUs have accomplished the action plans for this framework (refer to Appendix 5). Whereas some NGAs noted that these action plans are rather partially implemented or not applicable as these are not covered by their mandates.

RMS 15: Establish geographic information system

According to the MMEIRS, Metro Manila has an existing GIS database that is useful for crafting a comprehensive disaster management plan that will cover response and command system in case of a disaster. However, it was revealed that this database is obsolete and a GIS that will cover the areas under GMMA should be created. For many of the participating NGAs, establishing a GIS is not within their mandate, as reported in the workshop. However, the LGUs mentioned that it is integral for them to have an existing database on disaster. In the event of a disaster, an established communication system is essential among the networks of cities in the country. Therefore, it was recommended that a GIS in every LGU should be established as well as a trained staff on recording, utilizing, and communicating the GIS. LGUs and NGAs may make use of the GeoRiskPH system and its applications which is an existing initiative by DOST-PHIVOLCS.

RMS 16: Manage emergency public information

It is the responsibility of the government to provide complete and accurate information to the public regarding disasters. To achieve this, the government must establish appropriate policies and protocols for cooperation with the media and create an atmosphere conducive to media participation in all phases of disaster management. This framework focuses on the adoption and implementation of a guide that will assist local governments in managing information concerning disasters. It also includes the establishment of partnerships with the media for awareness-raising and emergency public information. According to the results of the workshop with the NGAs, agencies like the AFP have public information offices that partner with media for DRRM-related information. Moreover, the OCD, DOST-PAGASA and DOST-PHIVOLCS also have existing emergency public information systems.

Goal 4: Increased Community Resilience

Community members are the first to be affected by a disaster and are considered as first responders. In an event of a major earthquake, communities will not be immediately given public assistance due to accessibility concerns. Therefore, this goal aims to enhance community disaster management

capacities. According to the MMEIRS, communities should develop self-reliance and disaster awareness to invoke community preparations and knowledge on evacuation, rescue activities, and immediate response to various emergencies after an earthquake.

CRI 1: Enhance self-reliance and mutual help for efficient risk management capacity

This framework emphasizes the need for the capacity of local communities to respond to the immediate impacts of an earthquake. The MMEIRS estimated that within the first 72 hours after a 7.2-magnitude earthquake hits Metro Manila, public help may not reach most of the devastated area. During this time, self-reliance and mutual help actions are found to be the most effective ways to save lives and properties.

In case of large earthquakes, it is important to maximize preparedness and disaster response capacity of the community beforehand. The results of the workshop with the LGUs showed that almost all LGUs help in enhancing and developing the communities' knowledge about earthquake hazards and vulnerabilities (see Appendix 5). Additionally, almost all LGUs help in community participation for community governance in disaster risk reduction and climate change adaptation, and in mainstreaming disaster preparedness in school curricula. On the other hand, most NGAs do not do so because it is not within their mandates. OCD, DOST-PHIVOLCS, DILG, and MMDA conduct community-based DRRM trainings and seminars that focus on knowledge development and enhancement about earthquake hazards and vulnerabilities. To increase community participation for community governance in disaster risk reduction and climate change adaptation, DSWD has climate change adaptation programs throughout its regional offices. In regard to mainstreaming programs that emphasize disaster preparedness in school curricula, MGB participates in crafting modules to understand geohazard and disaster risk. MMDA conducts community-based disaster preparedness training for schools and colleges. OCD has mainstreaming programs but conducts it through the Department of Education. DOST-PHIVOLCS has been continuously training elementary and high school science teachers and DRRM focal persons of DepEd on the basics about earthquake, its hazards and how to prepare for these. DOST-PHIVOLCS has developed teaching and learning guides and information materials for the various stake holders.

CRI 2: Inculcate a disaster mitigation culture in future generations

This framework focuses on the importance of a preparedness measure that transcends to the future generations. It is, therefore, emphasized that mitigation culture should be inculcated to the young population. Included in this framework is teaching the schooling population with earthquake preparedness and mitigation measures and incorporating these lessons in the curriculum of schools and universities.

As reported in the results of the workshops, most NGAs and LGUs develop and enhance their evacuation plans. The MMDA mentioned that they identify measures to improve their evacuation plans through their drill assessments while the OCD develops and enhances evacuation plans through workshops organized by its regional offices.

The results of the workshops also highlighted that most LGUs conduct capacity development and capability enhancement of school emergency personnel which includes participation of parent-teacher associations in school emergency planning activities. At a macro-level, the MMDA and OCD are among the agencies that are most involved in the conduct of periodic earthquake evacuation exercises in schools.

Vital to this framework is DOST-PHIVOLCS' services in promoting earthquake awareness and preparedness nationwide by providing reliable technical information that are translated to key

messages understandable to the general public and accessible through various media. To further boost disaster awareness and preparedness in the country, the OCD conducts the national simultaneous earthquake drill in collaboration with the MMDRRMC and various national and local agencies. The drills seek to intensify local communities' earthquake preparedness and to increase the commitment of LGUs in building safe communities. The MMDA also conducts earthquake drills called the Metro Manila shake drill, which aims to strengthen the preparedness among citizens in case a major earthquake strikes Metro Manila.

Goal 5: Reconstruction Systems

To facilitate recovery and maximize the effectiveness of the reconstruction process of the metropolis, preparation for recovery and construction policies, strategies, and procedures, and their acceptance by NGAs are critically important. Projected infrastructural damage from the MMEIRS states that, about 175,600 houses will totally collapse, 348,000 will partially collapse, and 97,800 will burn down in the event of a 7.2-magnitude earthquake. These damages are caused by various vulnerabilities within the city. Given these figures, efficient post-disaster recovery and reconstruction should be developed to minimize vulnerabilities.

RSF 1: Supply temporary refugee housings

After the occurrence of a destructive earthquake, the need for short-term housing is immediate and urgent. Based on the MMEIRS, it is estimated that 40% of houses will be damaged in the event of a 7.2-magnitude earthquake. This framework was included in the MMEIRS to address the need for government to formulate a temporary housing plan that would supply temporary shelter and public services after an earthquake.

The results of the workshops showed that most of the LGUs have designed a temporary refugee housing plan in case a disaster badly affects their areas. On the other hand, the NHA has a Memorandum Circular No. 2465 or the Implementing Guidelines for the Provision of Shelter Response to Calamities and Disasters, which defines the guidelines by which NHA shall assist its communities and project beneficiaries in times of calamities. HUDCC also adheres to the aforementioned memorandum circular. In addition, the *Oplan Metro Yakal Plus* details the protocols and procedures that would take place in the event of a 7.2-magnitude earthquake.

RSF 2: Prepare emergency assistance for everyday life

After a disaster, people will be faced with losses and/or damage to their assets and properties. Based on the MMEIRS, the number of people that would be affected by the 7.2-magnitude earthquake is estimated to reach more than three (3) million. This framework was included in the MMEIRS to help the government prepare measures for financial and mental relief of people affected by the earthquake scenario.

Most LGUs have basic policies for emergency assistance for everyday life, as they have identified in the workshops conducted. However, there are only few NGAs who have policies (see Appendix 5). The DOH has health programs on violence and injury prevention, and provision of health services at all levels. Furthermore, the DSWD follows necessary protection guidelines for the emergency response clusters that it handles, which include the Camp Coordination and Camp Management cluster, Internally Displaced Persons Protection cluster, and Food and Non-Food Items cluster.

RSF 3: Establish debris clearance and management system

According to the MMEIRS, the total debris (including both buildings and infrastructures) is estimated to weigh some 50 million tons. This framework was included in the MMEIRS to determine the suitable method of treatment and the dumping sites for debris for the smooth recovery and reconstruction of the urban area and infrastructure.

From the workshops, it was gathered that most LGUs already have debris clearance plans. Because this action plan is targeted specifically to LGUs, only the DPWH has a debris clearance plan for selected priority national and local roads. It was noted that the MMDA's task is to augment the LGUs and was already included in the *Oplan Metro Yakal Plus*.

RSF 4: Restore public and social services

After a disaster, maintaining law and order will prove to be difficult. This framework was intended to guide the government in the formulation of appropriate policies for post-disaster peace-and-order-keeping activities for Metro Manila.

Most LGUs have basic policies for post-disaster peace-and-order-keeping activities. Most NGAs do not have policies according to the workshop results (see Appendix 4). This framework is identified to be specifically targeted toward PNP, the country's armed, civilian national police.

RSF 5: Establish post-disaster reconstruction system of the damaged area

It was estimated in the MMEIRS that 175,600 houses would totally collapse, 348,000 would partially collapse, and 97,800 would burn down. Attention should be given to post-disaster recovery and reconstruction to restore normal life and activities. For prompt recovery and reconstruction, this framework was included in the MMEIRS as pre-disaster arrangements to cope with post-disaster situations.

Regarding the formulation of basic reconstruction policies for living, housing, employment, and economic activities, the DSWD provides cash-for-work programs and the core shelter assistance program (CSAP). CSAP is one of the interventions made by DSWD for disaster response and rehabilitation, which aims to provide environment-friendly, structurally sound shelter units to victims of disasters or those living in hazardous areas. HUDCC, the Philippine government's umbrella institution for housing and development offices, has adopted the post-disaster shelter policy framework and the national policy resettlement framework for informal settlers living in hazardous locations or those displaced by disasters and calamities. The DA derives its basic reconstruction policies from reports (on rice, corn and vegetables, and livestock distribution) submitted by its regional offices. When it comes to finances and credits, the DA synchronizes all its policies and programs with the Agricultural Credit and Policy Council and Philippine Crop Insurance Corporation. This is to sustain the flow of credit to agriculture and fisheries, and to provide insurance protection to farmers against both crop and non-crop losses arising from natural calamities.

RSF 6: Enhance institutional aspect

This framework was included in the MMEIRS to help the government formulate and prepare recovery plans and procedures that would ease post-disaster human and physical recovery and rehabilitation. To successfully carry out this framework, policies, partnerships, and organizational structures that guide and facilitate recovery must already be in place before the disaster.

The results from the workshops ascertained that the OCD has established pre-disaster policies and institutional arrangements for post-disaster reconstruction and mitigation through its Rehabilitation and Recovery Management Service and in coordination with NEDA. Whereas, the DSWD expressed that a climate change adaptation and mitigation program, which focuses on alleviating the long-term

impacts of climate change, is already in place. The department also has preparedness guidelines, and recovery and rehabilitation programs.

Goal 6: Earthquake and Tsunami Research and Development

For the promotion of earthquake impact reduction measures, a thorough analysis of present conditions and future projects is critical. Research and technology development system in the Philippines can be enhanced along areas of earthquake science, earthquake engineering, and geosciences. Assessment of current strategies and continuous monitoring of seismic activities of the WVF are important to have sustainable earthquake impact reduction strategies. The MMEIRS provided a framework that identified priority areas for further research, which are listed as follows:

1. Monitor the activity of the VFS;
2. Integrate ground information as a unique and comprehensive database;
3. Expand basic inventory on buildings and population for a detailed damage estimation purpose; and,
4. Promote a detailed study on comprehensive earthquake disaster estimation.

R&D 1: Promote sustained research and development on earthquake

As the GMMEIRS targets to develop an earthquake-resistant national system, to improve urban structure, and to enhance effective risk management system, it is also vital to conduct scientific research and studies on earthquake science and related earthquake engineering fields. This framework includes the evaluation of the activity of the VFS by DOST-PHIVOLCS and research institutions, promotion of a comprehensive census survey, and promotion of a detailed study on comprehensive earthquake disaster estimation by NDCC (now NDRRMC).

It is recognized that DOST-PHIVOLCS has the primary mandate of conducting seismological studies in the country. The MMEIRS in 2004 was developed to estimate the damage impacts and to recommend action plans to address these impacts. The GMMA-RAP in 2013 produced assessment reports and maps in response to the threats faced by the Metropolitan Manila.

The workshop results showed that most of the LGUs conduct evaluations of the VFS' activity. However, this result should be validated to elaborate evaluations done by LGUs. Some NGAs also have indirect participation in these research initiatives and risk estimations. For instance, the MMDA, DOE, and DPWH reported that they have inventories of buildings and infrastructures which can be used for damage estimations. Damage assessments have been estimated by other agencies such as the DA and OCD. The DA and DPWH have pre- and post-disaster risk assessment reports that they distribute to the public

Additionally, tsunami hazard is also being monitored by the DOST-PHIVOLCS. The MMDA also subscribes to a tsunami EWS in coordination with the DOST-PHIVOLCS. It was recorded in the workshop results that the LGUs adjacent to Manila Bay also have identified evacuation routes and guidelines for tsunami emergency. On the other hand, most NGAs do not conduct tsunami evacuation exercises because it is not part of their contingency plans. In fact, PNP, DILG, AFP, and MMDA are the only agencies that mentioned having evacuation plans in case of a tsunami.

3.2 Results of the perception survey

The results of the study were discussed in detail in the previous section. This section provides a discussion of the main findings from the survey. Included in this section are discussions on which goals and action plans were identified to have the highest and lowest levels of accomplishments, and means of verification that would explain their status. The discussion of the level of accomplishment of action plans is disaggregated for LGUs, NGAs, and CUs to further scrutinize the updates on the action plans from the MMEIRS.

Figure 5 summarizes the Action Plan level of accomplishment for each goal. Increased community resiliency (Goal 4) has the highest level of accomplishment among the three (3) groups of participants and the lowest level of accomplishment is Earthquake Resilient Urban Structures (Goal 2). Explanations for the results are discussed in detail for each goal in the subsequent sections.

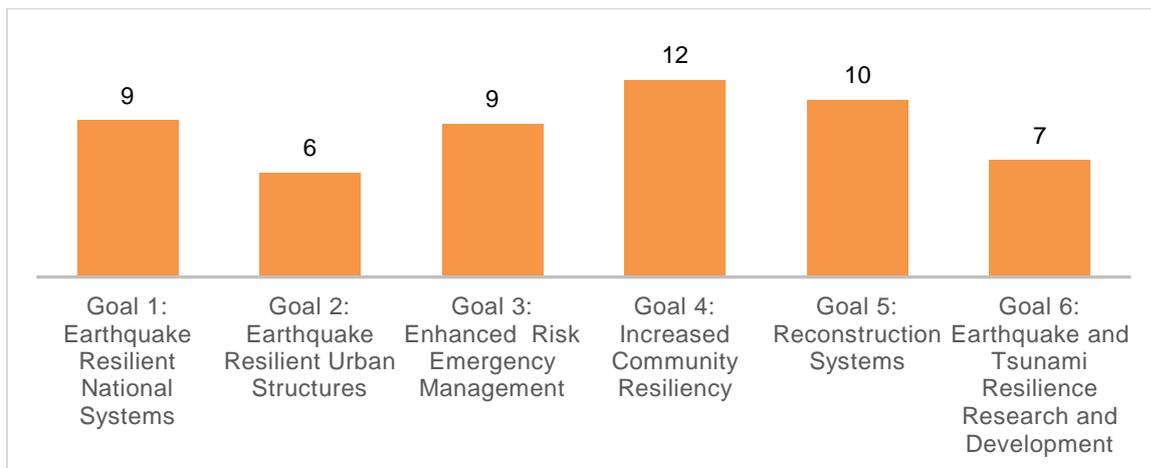


Figure 5. Status of accomplishment of the six (6) goals for earthquake impact reduction

Goal 1: Earthquake-Resilient National Systems

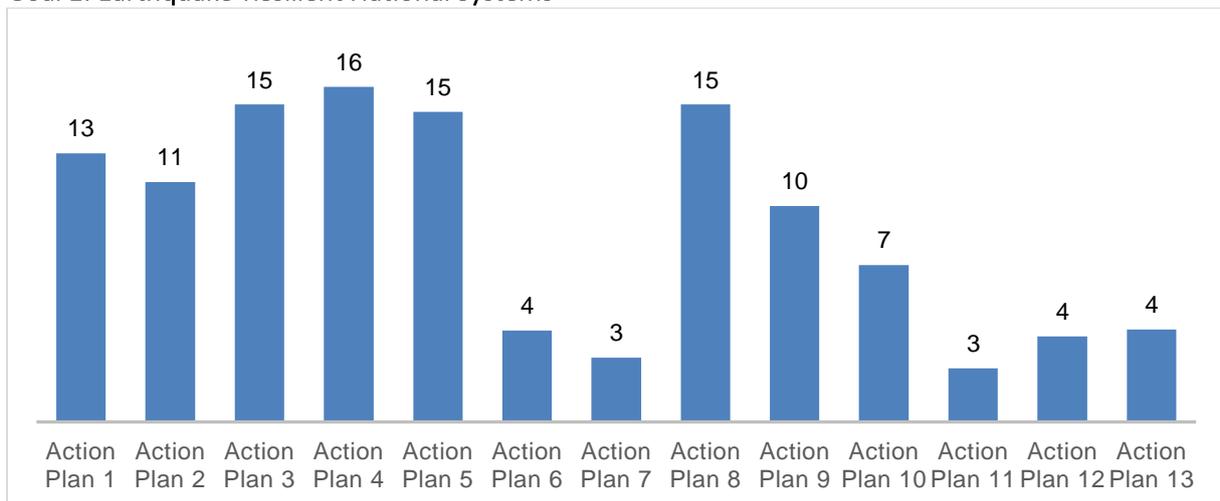


Figure 6. Status of accomplishment per action plan for Goal 1

For LGUs, the following action plans were found to be highly implemented:

- Action Plan 2: Regular conduct of emergency evacuation drills for national/regional/local government offices
- Action Plan 3: Develop in-house earthquake emergency services skills of teams

- Action Plan 4: Provide basic earthquake emergency skills to staff
- Action Plan 5: Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of critical government facilities
- Action Plan 8: Assess and improve the integrity of business and commercial buildings against earthquakes and fire hazards

For NGAs, the following action plans were found to be highly implemented:

- Action Plan 1: Regular conduct of emergency evacuation drills for national/regional/local government offices
- Action Plan 4: Provide basic earthquake emergency skills to staff
- Action Plan 5: Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of national/regional/local government office

The regular conduct of emergency evacuation drills is being carried out in line with the national simultaneous earthquake drill by OCD-NDRRMC and the Metro Manila shake drill by MMDA. Moreover, there are earthquake drills conducted by the transmission sector (National Grid Corporation of the Philippines [NGCP]) to simulate the effects to the energy sector. As a way forward, DOE aims to develop an energy resiliency roadmap that will include a regular conduct of exercise drill/table top exercises on the effects and impact of a 7.2-magnitude earthquake in GMMA in the whole spectrum of the energy sector in coordination with the concerned agencies. Agency staff is being trained with emergency skills such as basic life support training from BFP. Other agencies attend seminars and training programs about basic emergency skills. However, some agencies, such as TESDA and MGB, just provide awareness to selected employees. Construction of infrastructures by NGAs is performed in compliance with new structural codes to ensure safety against disaster.

The action plans that had the lowest level of implementation for NGAs are the following:

- Action Plan 11: Establish measures to stabilize exchange rates and prices of commodities after earthquake disasters
- Action Plan 12: Establish transfer mechanisms for foreign disaster aid
- Action Plan 13: Emplace local emergency loan and disaster reconstruction fund into (banking) system

The NGAs declare that the aforementioned action plans were not accomplished because these are not within the mandate of their respective agencies. Moreover, these action plans are specific to only a few NGAs.

For CUs, the following action plans were identified to be highly implemented:

- Action Plan 1 (specific for CUs): Develop and enhance public service/business continuity plans
- Action Plan 9: Implement and develop backup systems, backup sites, or mirror sites for data security during earthquake and fire emergency with recovery time objective specified (specific to the power sector)
- Action Plan 10: Deconcentrate business operations to strategically located sub-office

Most CUs have developed and enhanced their business continuity plans, which have an existing PSCP. The LRTA has created an emergency quick response team that assigns certain employees to specific tasks in case of severe emergency condition. Annual fire/earthquake drills are conducted and benchmarked by PLDT-Smart Communications, Inc. Power utilities, such as NAPOCOR, NEA, and NGCP, have their own backup systems for service continuity during calamities and emergencies with recovery time specified. They have also established linkages among support groups within and outside the corporation. NEA has different sub-offices that are located strategically in different municipalities of their coverage area. NGCP has a backup system as defined in their corporation's procedure. MERALCO

has operating centers (sectors and business centers) strategically located within the franchise areas, aside from their central office. Each of these sectors has its own resources (materials and equipment stockpile) and response capabilities that include both regular employees and contractors.

Goal 2: Earthquake-Resilient Urban Structures

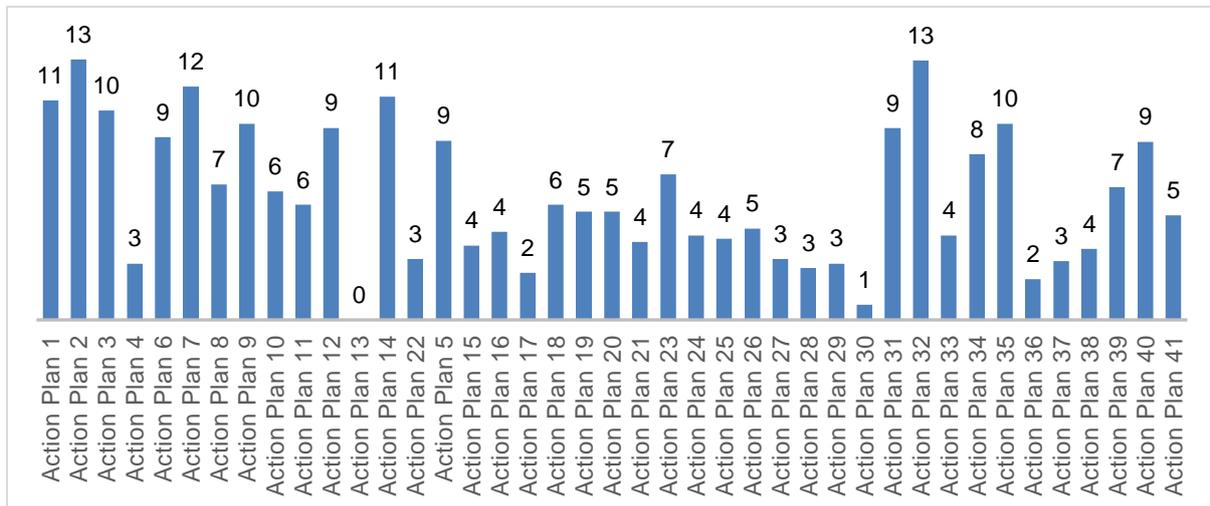


Figure 7. Status of accomplishment per action plan for Goal 2

For LGUs, the following action plans were found to be highly implemented:

- Action Plan 2: Strengthen buildings from impacts of earthquake hazards
- Action Plan 7: Mainstream disaster risk reduction and climate change adaptation (DRR-CCA) into the comprehensive land use plan (CLUP)
- Action Plan 32: Develop earthquake emergency operation team and support system for lifeline

For NGAs, the following action plans were found to be highly implemented:

- Action Plan 9: Strengthen buildings against fire hazards
- Action Plan 13: Set a proportion of open space (relative to population) for mass earthquake evacuation
- Action Plan 32: Develop earthquake emergency operation team and support system for lifeline

NGAs comply with the existing National Building Code of the Philippines to ensure the integrity of buildings being constructed and maintained against fire hazards. Even the laboratories are ISO-certified to ensure that the quality management system is appropriate and effective. Evacuation plans are already incorporated in the NDRP and other contingency plans. Included in these plans are open spaces dedicated to serve as an evacuation area in case of an event of disaster. CHED, for instance, has a one (1) square meter per person space with a 10-meter step-back from building line approximately good for 500 persons. Moreover, MMDA gives suggestions on possible open space and evacuation drills. When it comes to the development of earthquake emergency operation team and support systems, the NGAs reported that there are already existing teams in their respective agencies. NEDA has its DRRM organization with their chief of staff as head. DTI has a “big one” operations manual called the “Disaster Preparedness and Management Plan”.

Below are the action plans had the lowest level of implementation for NGAs based on the survey results. This can be attributed to the specificity of the action plans to select NGAs and are not applicable to most NGAs due to mandates, and technical scope:

- Action Plan 4: Develop and introduce affordable seismic retrofitting measures to non-engineered houses
- Action Plan 34: Establish a standard GIS database of lifeline nodes and network for comprehensive lifeline risk assessment
- Action Plan 36: Replace cast iron water distribution pipes with earthquake-resistant pipes

For the CUs, the following action plans were identified to be highly implemented:

- Action Plan 31: Conduct regular emergency operation exercise for lifeline
- Action Plan 32: Develop earthquake emergency operation team and support system for lifeline
- Action Plan 35: Develop lifeline earthquake emergency operation manuals

CUs conduct in-house exercises and drills in coordination with the external agencies. These emergency exercises and business continuity drills are conducted on a regular basis as specified in their respective agencies' plans. Regarding the development of an earthquake emergency operation team and support system, CUs have their own quick response teams/groups and security committees as part of disaster recovery plans. This includes firefighting, rescue, evacuation, and medical/first aid teams, as well as disaster assessment and response team. Moreover, CUs reported that they have emergency preparedness manuals, which are either already existing or in the process of improvement or revision.

Goal 3: Enhanced Emergency Risk Management

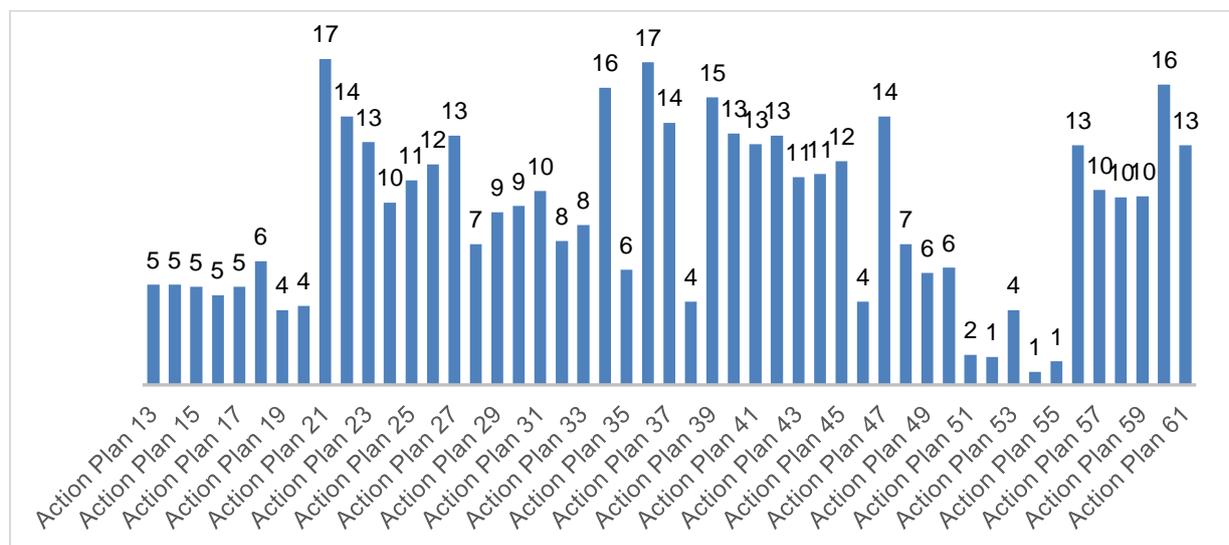


Figure 8. Status of accomplishment per action plan for Goal 3

For the LGUs, the following action plans were found to be highly implemented:

- Action Plan 21: Install local government level DRRM office with yearly budget allocation
- Action Plan 23: Mainstream disaster risk reduction into local sectoral development plan
- Action Plan 26: Educate and train local barangay officials in community-based DRRM
- Action Plan 34: Develop standard relief and response resources based on national guidelines
- Action Plan 47: Enhance emergency response capacities of DRRM organizations
- Action Plan 56: Educate and train search and rescue personnel

For the NGAs, the following action plans were found to be highly implemented:

- Action Plan 34: Develop standard relief and response resources based on national guidelines
- Action Plan 36: Develop inter-organizational protocols and standard operating procedures (SOPs) for key response functions
- Action Plan 42: Establish mutual support system and mutual aid agreements through memorandum of agreements or understanding

The development of standard relief and response resources is already incorporated in the NDRP, which is the government's "multihazard" response plan. The plan necessitates the Operational Plan at the agency and regional levels, and the Tactical or Contingency Plan at the LGUs to fully enact the directives and realize the objectives. However, some agencies have their own agency-specific guidelines, such as the DOH, which has administrative orders and joint memorandum circulars. DSWD has its own DRR guidelines, manuals, protocols, etc., which are internal to the department. All policy documents are based on the RA 10121 and other pertinent laws.

When it comes to the development of inter-organizational protocols and SOPs for key response functions, NGAs reported that they are in close coordination with the NDRRMC through workshops and meetings. For DOTr, the development of such protocols and SOPs for key response functions is emphasized in the Incident Command System per Oplan Metro Yakal Plus. DA has its own DRRM operations manual. In addition, DSWD has joint memorandum circulars signed by relevant national agencies, NGOs, and other stakeholders for this matter.

The establishment of mutual support system and mutual aid agreements through memorandum of agreements or understanding was also found to be highly implemented by NGAs. DA partners with its international counterpart, the Food and Agriculture Organization, which is a specialized agency of the United Nations that leads international efforts to defeat hunger. DOH has a memorandum of agreement with its partners and stakeholders. AFP coordinates with foreign counterparts who offer assistance for humanitarian assistance and disaster relief operations. DOE has established a partnership with DOST-PHIVOLCS for the REDAS training, with the Safety and Health Association of the Philippine Energy Sector, Inc. and the Philippine Disaster Resilience Foundation, Inc. for the mainstreaming of energy resiliency in the plans and policies of the energy sector.

For the CUs, the following action plans were identified to be highly implemented:

- Action Plan 23: Mainstream disaster risk reduction into local sectoral development plan
- Action Plan 29: Regularly evaluate the Greater Metro Manila level disaster preparedness plans
- Action Plan 41: Establish emergency information and communication system, and redundant systems among and between DRRM organizations

NEA requires its electric cooperatives to submit their resiliency compliance plan and emergency response plan every year. NGCP has its Environmental Resource Management Manual, Business Continuity Management Manual, Business Continuity Plan, BCAP, IDAP, and emergency preparedness and response plan. MERALCO continues to build structural assessment and retrofitting for identified facilities. NAPOCOR evaluates its disaster preparedness plans through its corporate contingency plan/manual. Some CUs already have existing manuals that have undergone revisions. When it comes to the establishment of emergency information and communication system and redundant systems, DRRM organizations is in regular coordination with the BFP, LGUs, MERALCO, and other power cooperatives. MERALCO has been an active member of DOE's Task Force *Kapatid*, OCD, BFP, and NDRRMC. LWUA coordinates particularly with MWSS, Maynilad, and Manila Water.

Goal 4: Increased Community Resilience

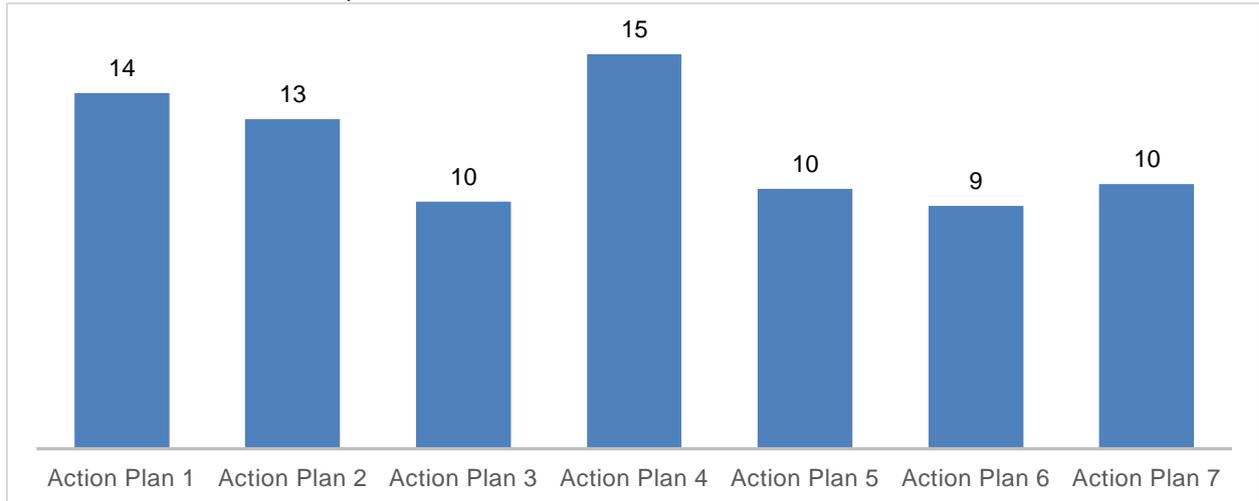


Figure 9. Status of accomplishment per action plan for Goal 4

For the LGUs, all the action plans under goal 4 appear to be highly implemented. This means that LGUs are well-involved when it comes to activities concerning community resiliency. Below is the list of all action plans under the fourth goal:

- Action Plan 1: Knowledge development and enhancement about earthquake hazards and vulnerabilities
- Action Plan 2: Increase community participation for community governance in disaster risk reduction and climate change adaptation
- Action Plan 3: Mainstream programs that emphasize the four thematic areas in school curricula
- Action Plan 4: Develop and enhance evacuation plans
- Action Plan 5: Capacity development and capability enhancement of school emergency personnel
- Action Plan 6: Inclusion of parent–teacher association in school emergency planning activities
- Action Plan 7: Conduct of periodic earthquake evacuation exercises in schools

For NGAs, these are the action plans that were identified to be highly implemented:

- Action Plan 1: Knowledge development and enhancement about earthquake hazards and vulnerabilities
- Action Plan 2: Increase community participation for community governance in disaster risk reduction and climate change adaptation
- Action Plan 4: Develop and enhance evacuation plans

Some NGAs reported that they send their personnel to attend meetings, conferences, or workshops about knowledge development and enhancement about earthquake hazards and vulnerabilities. They also participate in community-based disaster preparedness trainings, which involve communities that are at the heart of decision-making regarding the identification, assessment, and management of disaster risks at the local level.

Goal 5: Reconstruction Systems

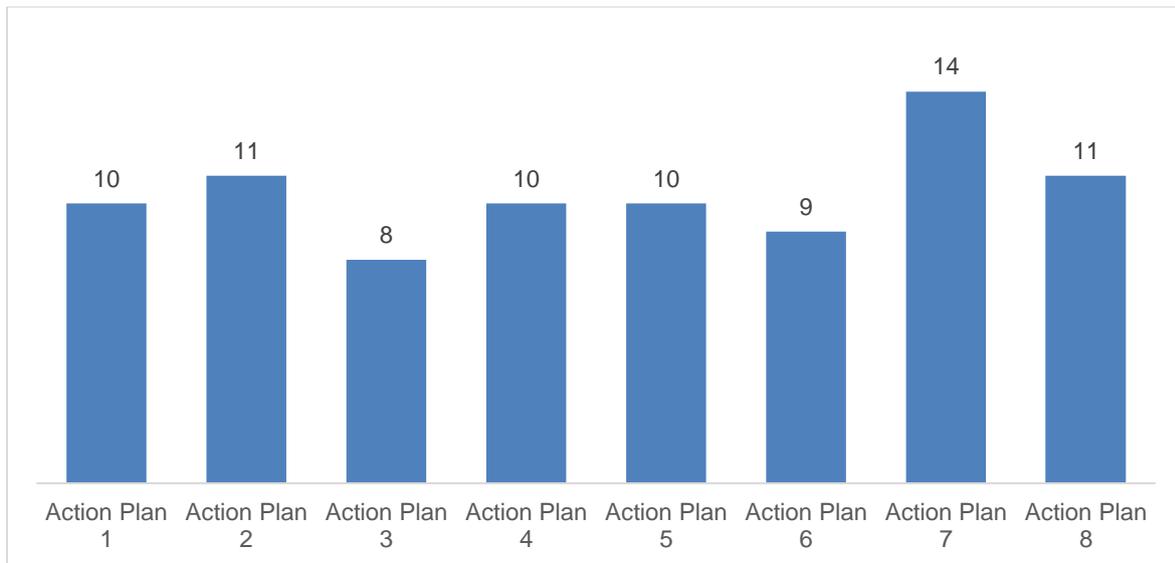


Figure 10. Status of accomplishment per action plan for Goal 5

For the LGUs, the following action plans were found to be highly implemented:

- Action Plan 1: Formulate temporary refugee housing plan
- Action Plan 2: Formulate basic policy for emergency assistance for everyday life
- Action Plan 4: Formulate basic policy for post-disaster peace-and-order-keeping activities

The action plans that had the lowest level of implementation for LGUs are the following:

- Action Plan 3: Formulate debris clearance plan for LGUs
- Action Plan 5: Formulate basic reconstruction policies for living, housing, employment, and economic activities
- Action Plan 6: Formulate guidelines to urban reconstruction and make a scheme of finances and credits

For the NGAs, these are the action plans that were identified to be highly implemented:

- Action Plan 5: Formulate basic reconstruction policies for living, housing, employment, and economic activities
- Action Plan 7: Establish pre-disaster policies and institutional arrangements for post-disaster reconstruction and mitigation
- Action Plan 8: Prepare pre-disaster recovery plans and procedures to ease post-disaster human and physical recovery and rehabilitation

The NHA has a Memorandum Circular No. 2465 that defines the “guidelines by which NHA shall assist its communities and project beneficiaries in times of calamities, and implement mitigating measures through a disaster risk reduction plan in coordination with the national and regional disaster risk reduction agencies as a long-term response”. Moreover, NGAs have incorporated their pre-disaster and post-disaster reconstruction and mitigation policies in their own disaster recovery plans and in the Oplan Yakal Plus.

Goal 6: Earthquake and Tsunami Resilience Research and Development

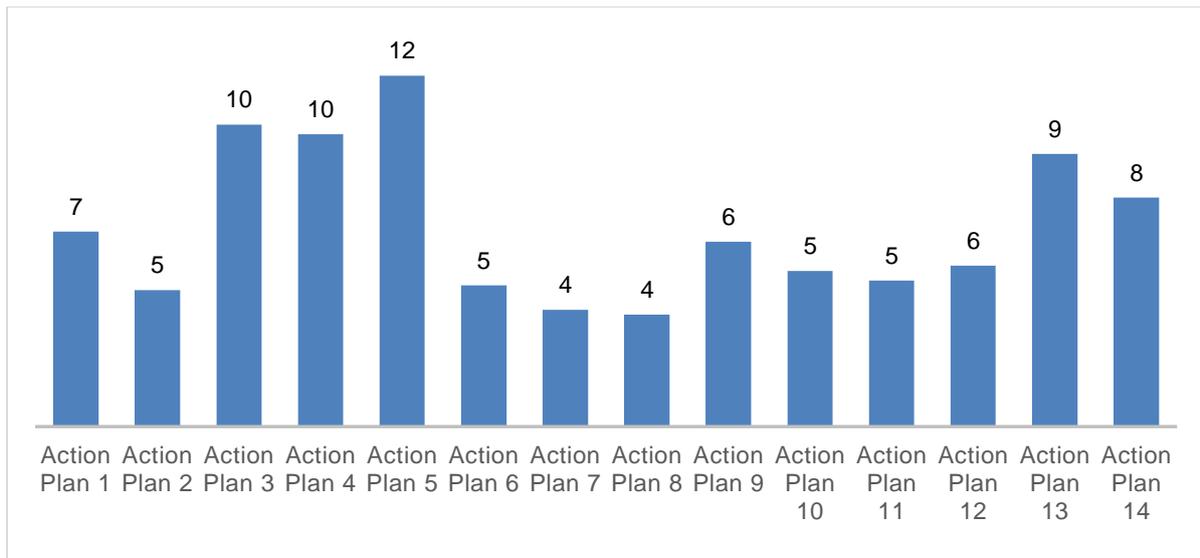


Figure 11. Status of accomplishment per action plan for Goal 6

For LGUs, the following action plans were found to be highly implemented:

- Action Plan 1: Evaluate the activity of the VFS
- Action Plan 2: Expand basic inventory on buildings and population for detailed damage estimation purpose
- Action Plan 4: Conduct detailed risk damage estimation using current inventory of risk elements (using rapid earthquake damage assessment system [REDAS] or similar tool)

The action plans that had the lowest level of implementation for LGUs are Action Plan 9 (Install tsunami hazard markers) and Action Plan 10 (Establish tsunami evacuation routes and sites).

For NGAs, these are the action plans that were identified to be highly implemented:

- Action Plan 5: Distribute risk and damage estimate to the public
- Action Plan 9: Install tsunami hazard markers
- Action Plan 13: Conduct community-wide earthquake evacuation exercises

High accomplishment for Action Plan 5 is evident in the programs of DOST-PHIVOLCS which makes earthquake risk and damage estimates highly accessible to the public. As mentioned in the previous goals, NGAs participate in earthquake drills conducted by OCD-NDRRMC and MMDA, which is reflected of the high accomplishment for Action Plan 13.

Direct and Indirect Earthquake Impact Reduction

Identifying whether the action plans have direct or indirect earthquake impact reduction is essential in gathering the baseline data for the completion of the GMMEIRS. During the second day of the Third Workshop to Develop the GMMEIRS, critical utilities were asked to indicate in the questionnaire form if the action plans and other initiatives specific to their sectors directly or indirectly reduce earthquake impact. For purposes of clarity and to guide participants in their assessment, the TWG agreed on the following operational definition of direct and indirect impacts, which was included in the form:

- **Direct impact.** Direct impact refers to awareness and preparedness, reduction of elements at risk, lower number of affected population, casualties, lower cost of damage, etc.

- **Indirect impact.** Indirect impact includes management of disaster, building forward better, recovery and rehabilitation, response mechanisms, contingency and backup system, service continuity plans, post-disaster needs assessment, reconstruction plans, etc.

The TWG further differentiated both indicators as follows: direct impact to mean “pre-disaster”, action plans that address vulnerabilities; whereas, indirect impact to mean “post-disaster”, action plans that are not related to life-saving or life preservation. Appendix 5 contains a summary of the action plans that have high and low levels of accomplishment for the identified direct and indirect earthquake impact reduction among the critical utilities.

In reducing earthquake risk, actions should be primarily geared toward addressing the action plans that have direct impact to risk reduction. Table 1 summarizes the number of direct and indirect action plans for each goal. Of all the six (6) goals, the goal on earthquake-resilient urban structures has the highest number of action plans with direct impact to earthquake risk reduction. This is because this goal primarily involves addressing the concerns of the elements-at-risk. Ironically, this goal has also the lowest level of accomplishment relative to other goals. On the other hand, goal 4 on increasing community resilience has the highest level of accomplishment as previously presented. It can be seen from Figure 12 that almost all the action plans in Goal 6 are directly related to the reduction of earthquake risk.

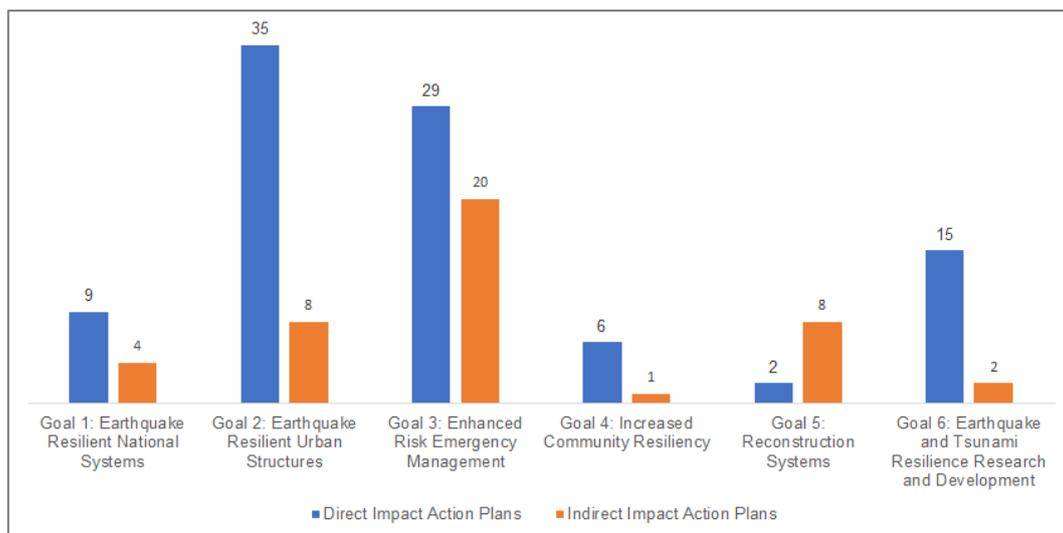


Figure 12. Direct and indirect action plans per goal

The results of the identification of direct and indirect impact action plans were used in the prioritization of action plans which is discussed in Chapter 4.

CHAPTER 4

CHAPTER 4. STREAMLINING OF ACTION PLANS

The approach for streamlining the action plans focuses on making the masterplan more understandable for key actors, aligned to the current DRRM framework of the country, and integrates latest plans and policies for earthquake resilience in GMMA. The approach emphasizes the following aspects:

- **Strategic framework** from MMEIRS was retained since this is still applicable according to experts and key informants during the consultation workshops. Given this, the entry points for the streamlining are the action plans under each goal.
- **Implementing strategy**
 - **Aligning the action plans based on the 4 thematic pillars** of NDRRMP 2011-2028 for consistency with plans being prepared mostly at the local level
 - **Identification of key implementers of the action plans** at various governance level (national, local [regional and city/municipality], and units of society (private sector, community, household)

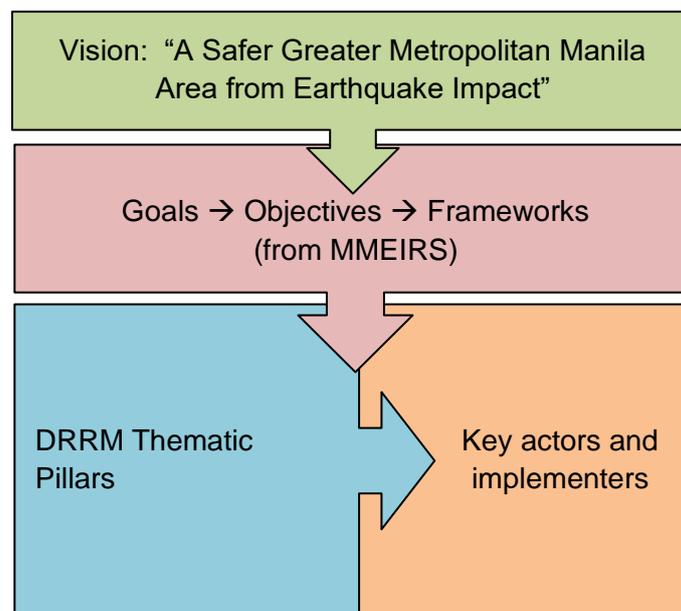


Figure 13. Approach for streamlining the GMMEIRS Action Plans

4.1 Implementation strategy

The DRRM's four (4) thematic pillars are the primary existing categorization of DRRM initiatives in the country. The NDRRM Key outcomes and outputs, as well as the achievements of the Philippines are organized according to these thematic pillars. Considering the familiarity of most DRRM practitioners at the national, regional and local level, and for consistency with the NDRRMP for 2011 to 2028, the four thematic pillars were the basis for categorizing the action plans for GMMEIRS, thus aligning both. Moreover, categorizing the action plans based on the thematic pillars is also assumed to align key actors for each GMMEIRS action plans with identified responsible agencies and implementing partners in the NDRRMP and other plans which were also informed by the latter. This made key actors for each action plan more identifiable. Refer to Appendix 1 for the master list of action plans per goals with labels on DRRM thematic pillar categorization and key implementer.

4.1.1 Aligning the action plans based on DRRM thematic pillars

The action plans were aligned based on the DRRM thematic pillars by categorizing their relevance and contribution to each pillar. The process for categorization of the action plans into the DRRM thematic pillars is enumerated as follows:

- Prior to the categorization, some goals, frameworks and action plans were restated to make it more relevant to GMMA, and reflecting updates on accomplishments. Action plans which are understood to be redundant and have insignificant difference in terms of scope and purpose with similar action plans were merged. Some action plans were also transferred to other goals to make the organization of the master plan more consistent¹.
- Operational definition of DRRM thematic pillars (prevention and mitigation, preparedness, response, rehabilitation and recovery) in Philippine Disaster Risk Reduction and Management Act of 2010 / Republic Act 10121 were used, supplemented by United Nations Office for Disaster Risk Reduction (UNDRR) definition.
- Though most action plans are exclusively categorized under one pillar, there are some which are relevant to more than one pillar due to their encompassing scope and purpose. Moreover, time element was one of the considerations in categorizing the action plans, which was related to the scope of the DRRM thematic pillars. Frequencies/counts and percentages were used to quantify the categorization of the action plans.
- To address the multiple relevance and as an attempt to rank the contribution of the action plans to multiple DRRM thematic pillars, a rating matrix was used (see table below). A scale of 1 to 4 was used to rate the contribution of the action plans to each of the DRRM thematic pillars.

¹ Reorganization of action plans were agreed by the writers and OCD-CBTS, but may be subject for review and update based on more recent and relevant information, and agreements by authorized body/ies.

Table 6. Rating matrix used for quantifying relevance of action plans to DRRM thematic pillars

Score	Prevention and Mitigation	Preparedness	Response	Recovery & Rehabilitation
4	Fully contributes towards lessening or avoidance of the adverse impacts of earthquake and related disasters	Fully contributes to increasing the capacities of government, organizations, communities and individuals prior to anticipate, respond and recover from the likely impacts of an earthquake	Fully contributes to the provision of emergency services and public assistance during or immediately after a disaster to save lives, ensure public safety and meet the basic subsistence needs of the people affected.	Fully contributes to the restoration of basic services and facilities, for communities and a society to attain its original functioning state
3	Mostly contributes to prevention and mitigation	Mostly contributes to preparedness	Mostly contributes to response	Mostly contributes to reconstruction/rehabilitation
2	Partly contributes to prevention and mitigation, but mostly to other DRRM pillars	Partly contributes to preparedness, but mostly to other DRRM pillars	Partly contributes to response but mostly to other DRRM pillars	Partly contributes to reconstruction and rehabilitation but mostly to other DRRM pillars
1	May contribute equally to the 4 pillars. If the item is a plan, this can be a preliminary score which can be updated once the details of the plan are known	May contribute equally to the 4 pillars. If the item is a plan, this can be a preliminary score which can be updated once the details of the plan are known	May contribute equally to the 4 pillars. If the item is a plan, this can be a preliminary score which can be updated once the details of the plan are known	May contribute equally to the 4 pillars. If the item is a plan, this can be a preliminary score which can be updated once the details of the plan are known

The succeeding figures present the summary of the relevance and contribution of the action plans into the 4 DRRM thematic pillars using categorization counts and weighted counts adopting the rating matrix. Comparing the two types of categorization, the categorization by relevance shows that most of the action plans are applicable to response while based on categorization by contribution, most support prevention and mitigation. This contrast does not make the results invalid; rather, it poses an interesting analysis of the action plans as these are related to the DRRM thematic pillars.

Most action plans are not exclusively relevant to a single DRRM thematic pillar. Based on the scope and purpose of the action plans, **most are relevant to response and preparedness, but this does not mean these are exclusively contributory** to the mentioned thematic pillars (see Figure 14 and Figure 15). Action plans relevant to evacuation, search and rescue, logistics, generation of resources for relief are some of the plans categorized under response. However, some action plans relevant to formulation of plans and capacity building which contains guidelines and protocols for response are examples of action plans that are relevant but are not exclusively contributory to response.

Though **there are few action plans categorized under prevention and mitigation, most of these are exclusively contributory** to the pillar (see Figure 14 and Figure 15). These include mostly risk assessment, earthquake research and development, structural and fire-hazard guidelines. Thus, impact

reduction of prevention and mitigation action plans may be easier to assess since these are exclusively contributory to one thematic pillar, unlike preparedness and response. On another note, the impact reduction of response-relevant actions plans may be challenging since these are also contributory to other DRRM pillars.

A consistent finding is the action plans’ relevance and contribution to recovery and rehabilitation which had the least counts for both methods. This consistency is a strong basis that **recovery and rehabilitation has the fewest relevant and contributory action plans**, thus needing attention for future planning. This may also be an important consideration since recovery and rehabilitation is vital for communities’ return to normalcy. The lack of sufficient action plans for this DRRM pillar may have longer impact and greater magnitude to the functioning of communities, and government systems as it **critically defines the quality of a “new normal”** after the earthquake.

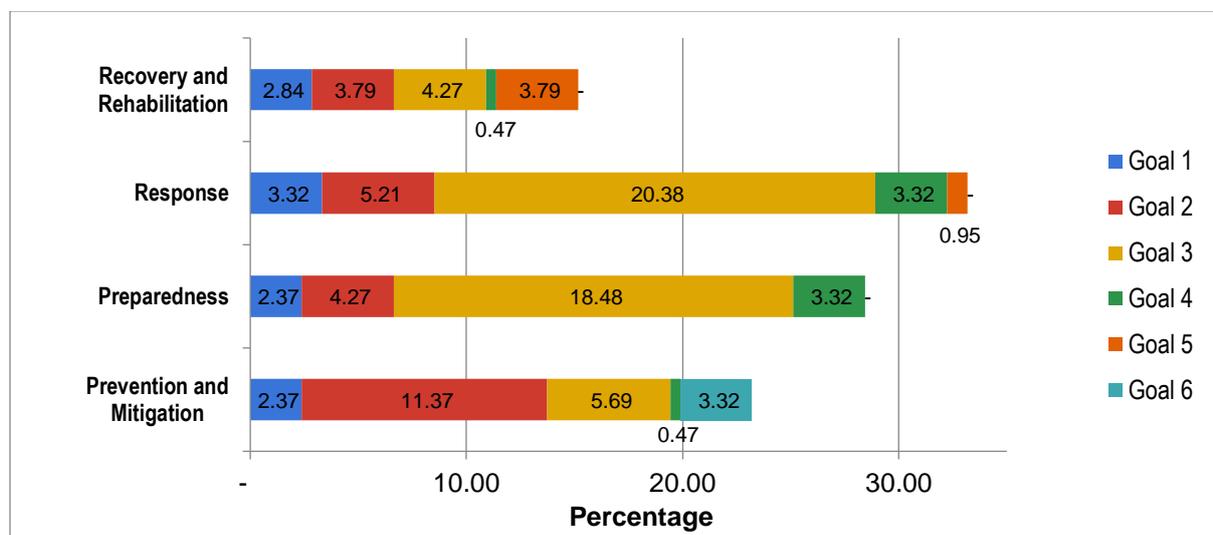


Figure 14. Categorization of Action Plans by Relevance into the DRRM Thematic Pillars

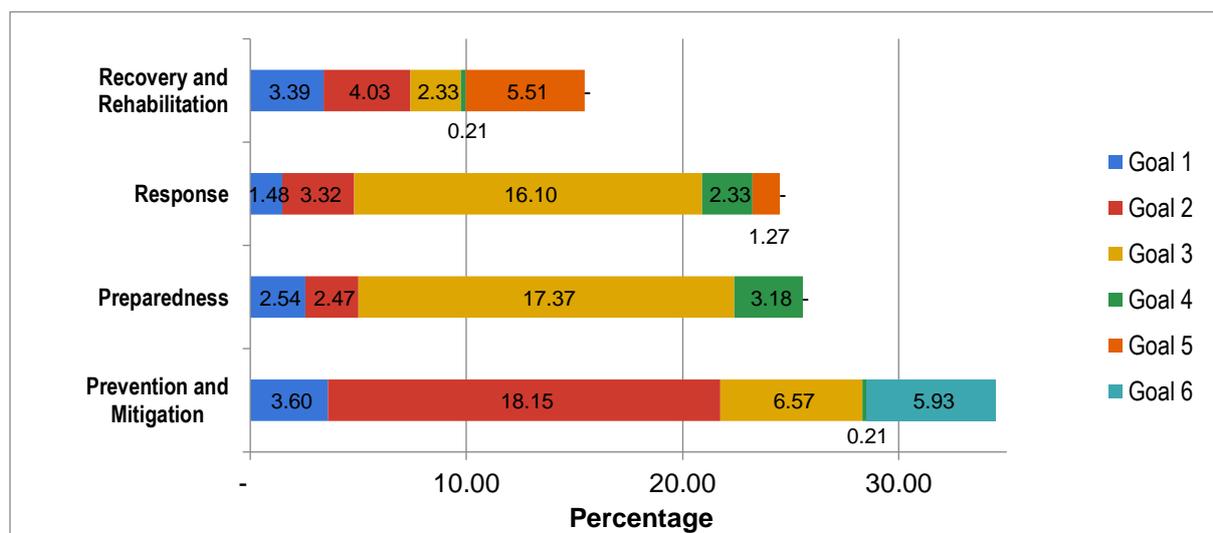


Figure 15. Relevance of the Action Plans by Contribution to DRRM Thematic Pillars

Comparing the categorization of action plans using relevance and contribution (Figures 15 to 18), below are the other findings:

- Goals 2 (Earthquake-Resilient Urban Structures) and 6 (Earthquake and Tsunami Research and Development) are consistently relevant and contributory to Prevention and Mitigation
- Goals 3 (Enhanced Emergency Risk Management) and 4 (Increased Community Resilience) are consistently relevant and contributory to Preparedness
- Goals 2 and 3 are consistently relevant and contributory to Response
- Goals 1 (Earthquake-Resilient National Systems), 2 and 5 (Reconstruction Systems) are consistently relevant and contributory to Recovery and Rehabilitation
- Goals 2 and 3 are consistently relevant and contributory to all DRRM Thematic Pillars

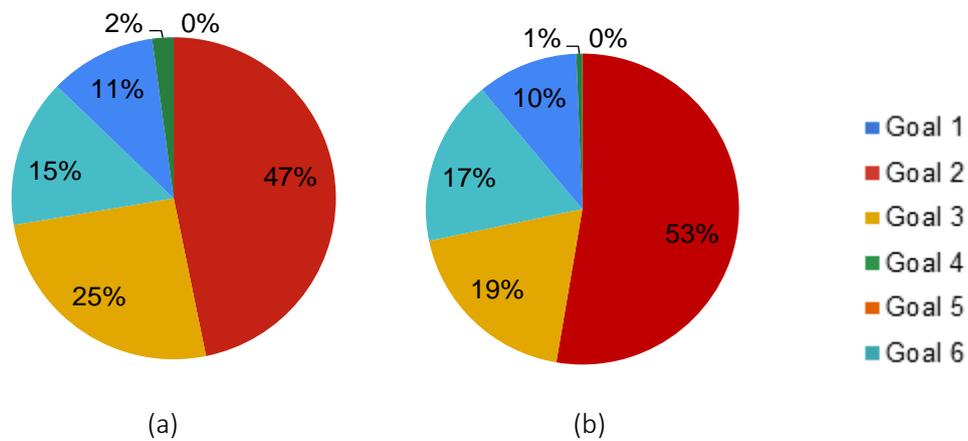


Figure 16. Actions Plans' Relevance (a) and Contribution (b) to Prevention and Mitigation

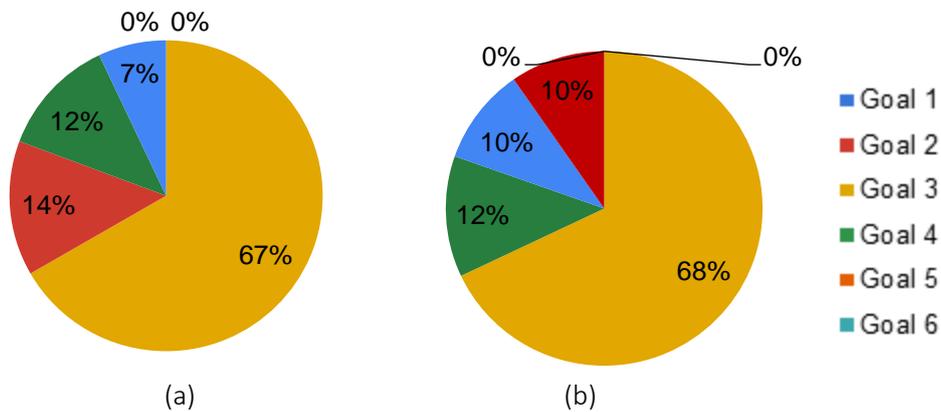


Figure 17. Actions Plans' Relevance (a) and Contribution (b) to Preparedness

NEW

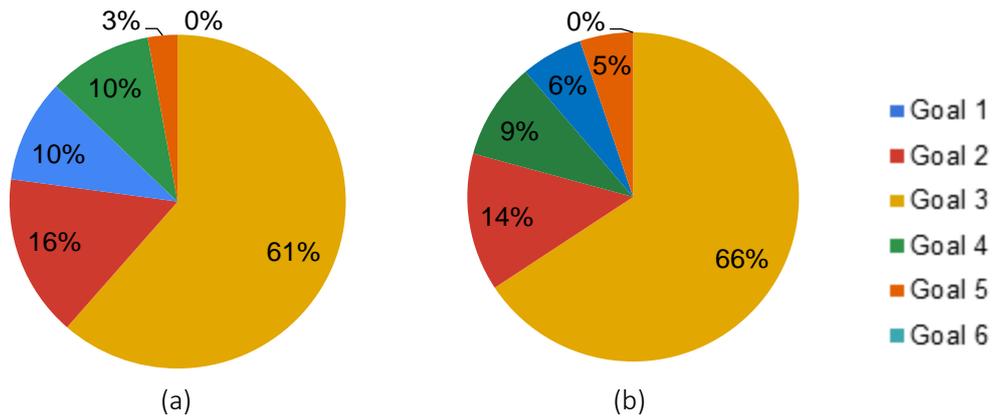


Figure 18. Action Plans' Relevance (a) and Contribution (b) to Response

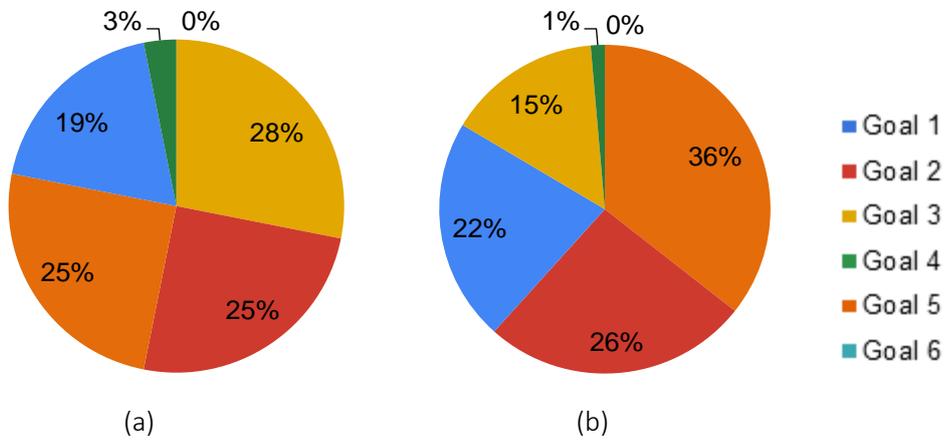


Figure 19. Action Plans' Relevance (a) and Contribution (b) to Recovery and Rehabilitation

4.1.2 Identification of key implementers of the action plans

Action plans were reviewed based on their scope and relevance to mandates of various NGAs, LGUs, critical utility service providers, and other organizations. The trend observed in the identification of key actors for each of the action plans are:

- **NGAs** have the largest influence over the other actors since they provide most of the guideline and plans. They also influence the allocation of resources to implement the guidelines and plans.
- **LGUs** have the best influence and power in terms of implementing the action plans in each locality. However, the efficiency of implementation is affected by their understanding of guidelines and plans, and availability and quality of resources
- **Critical Utility Service Providers**, which may happen to be either/both NGAs and private sector have limited function in terms of the management of critical facilities (power, water, and communications). On another hand, the private sector has resources that may be shared with implementers such as LGUs.

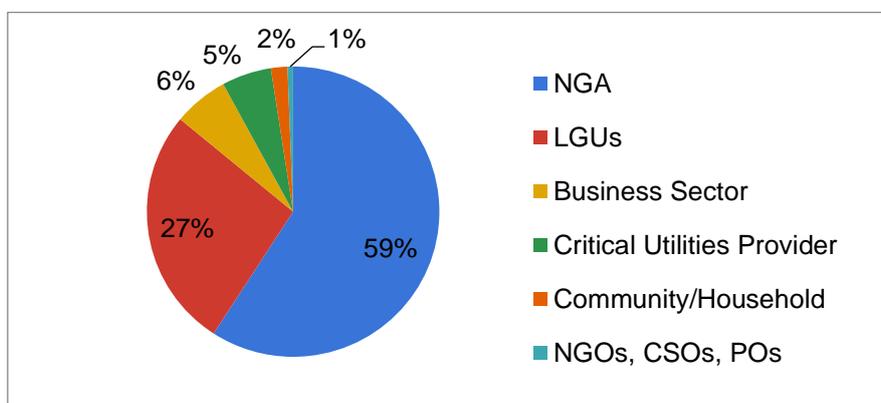


Figure 20. Percentage of Key Implementers for All Action Plans

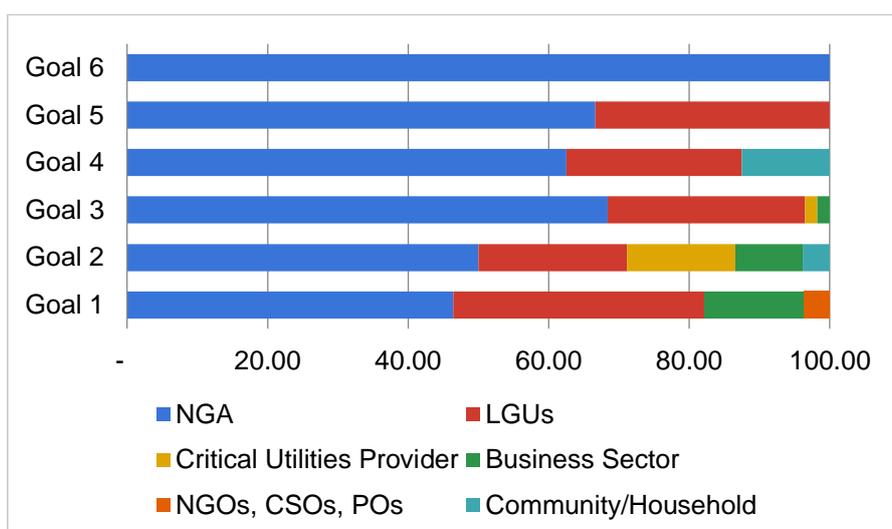


Figure 21. Key Implementers per Goal

4.2 Prioritization of Action Plans

Priority action plans for implementation have also been identified in the study. The action plans identified to have **direct impact reduction** (refer to Chapter 3 for the discussion of “Direct” Action Plans), which also have the **lowest level of accomplishment** were deemed to be the **high priority action plans**. Direct action plans which have low to partial level of accomplishment were the **medium priority action plans**. Moreover, possible key implementers were also identified for each priority action plans (refer to Appendix 1 for the complete list of action plans).

Table 7. Recommended priority action plans for NGAs

Action Plans	Priority Level
Goal 1: Earthquake-Resilient National Systems	
1. Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of critical government facilities	Mid-priority
2. Promote and designate earthquake and fire resistant area surrounding or nearest to N/R/L government offices or business offices	Mid-priority
3. Develop in-house earthquake emergency services skills of teams	Mid-priority
4. Develop and enhance national/regional/local government and public service/business continuity plan	Mid-priority
5. De-concentrate government operations to strategically located sub-office	Mid-priority
6. Assess and improve integrity of business and commercial buildings against earthquake and fire hazards	Mid-priority
Goal 2: Earthquake-Resilient Urban Structures	
1. Develop and introduce affordable seismic retrofitting technologies and methods to building owners and developers	High Priority
2. Establish a standard GIS database of lifeline nodes and network for comprehensive lifeline risk assessment	High Priority
3. Introduce and use earthquake-resistant water distribution pipes	High Priority
4. Develop guidelines for designing and building earthquake- and fire-resistant homes	Mid-priority
5. Develop and introduce affordable seismic retrofitting measures to non-engineered houses	Mid-priority
6. Consider urban redevelopment of former informal settlement areas	Mid-priority
7. Secure possible sources of fire such as LPG tanks, gasoline refilling stations, oil depot, bottled gasoline-vending stores, illegal power connections, and other hazardous materials	Mid-priority
8. Develop fire prevention and suppression guidelines	Mid-priority
9. Set and implement standards for road width and proportion of open spaces (relative to population) for mass earthquake evacuation	Mid-priority
10. Conduct research and development for alternative, affordable, lightweight, non-flammable construction materials	Mid-priority
11. Educate and train human resources for building (structural) engineering	Mid-priority
12. Evaluate seismic performance of public buildings and government-owned/managed buildings	Mid-priority

Action Plans	Priority Level
13. Retrofit public buildings and government-owned/managed buildings with low seismic-performance rating	Mid-priority
14. Develop lifeline earthquake emergency operation manuals with recovery time objective specified	Mid-priority
15. Conduct regular emergency operation exercise for lifeline with recovery time objective specified	Mid-priority
16. Enhance end-to-end communication system among DRR institutions	Mid-priority
Goal 3: Enhanced Emergency Risk Management	
1. Retrofit Manila port to earthquake and tsunami-resistant construction	High Priority
2. Conduct annual inventory of civil defense emergency management personnel	High Priority
3. Construct Laguna de Bay northern shore unloading facility	High Priority
4. Set regulation and permit for storing, handling, and selling flammable products	Mid-priority
5. Establish long-term plan for relocating facilities handling hazardous materials	Mid-priority
6. Educate, train, and maintain fire emergency teams in establishments	Mid-priority
7. Improve BFP personnel and firefighting capability to international standards	Mid-priority
8. Improve access to water sources for firefighting	Mid-priority
9. Establish tsunami warning systems	Mid-priority
10. Develop and distribute recent Earthquake Mitigation Handbook and Earthquake Mitigation and Response Checklist	Mid-priority
11. Regularly evaluate and update the Greater Metro Manila disaster preparedness plans (LGU), emergency plan (business sector) and manuals of DRRM	Mid-priority
12. Educate and train civil defense personnel on planning for emergency response	Mid-priority
13. Regularly evaluate and update the emergency plan and manuals of DRRM	Mid-priority
14. Conduct periodic simulation exercises to test the Greater Metro Manila Incident Command System (ICS) and response decision-making systems	Mid-priority
15. Disseminate Emergency Response Pocket Guide to agencies and LGUs	Mid-priority
16. Secure large scale water sources (e.g. water reservoirs)	Mid-priority
17. Improve government hospital capacities	Mid-priority
18. Educate and train search and rescue personnel	Mid-priority
Goal 4: Increased Community Resilience	
1. Mainstream programs that emphasize the 4 thematic areas in school curricula.	High Priority
2. Inclusion of parent-teachers association in school emergency planning activities	High Priority
3. Conduct of periodic earthquake evacuation exercises in schools	High Priority
4. Capacity development and capability enhancement of school emergency personnel	Mid-priority
Goal 5: Reconstruction Systems	
1. Establish pre-disaster policies and institutional arrangements for post disaster reconstruction and mitigation	Mid-priority

Action Plans	Priority Level
Goal 6: Earthquake and Tsunami Research and Development	
1. Evaluation activity of the Valley Fault System	High Priority
2. Estimate tsunami hazards along coastal areas	High Priority
3. Assess tsunami risk along coastal areas (using Rapid Earthquake Damage Assessment System (REDAS) or similar tool)	High Priority
4. Expansion of basic inventory on buildings and population for detail damage estimation purpose	Mid-priority
5. Promotion of detailed study on comprehensive earthquake disaster estimation	Mid-priority
6. Conduct detailed risk damage estimation using current inventory of risk elements (using Rapid Earthquake Damage Assessment System (REDAS) or similar tool)	Mid-priority

Table 8. Recommended priority action plans for LGUs

Action Plans	Priority Level
Goal 1: Earthquake-Resilient National Systems	
1. Deconcentrate government operations to strategically located sub-office	High priority
2. Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of critical government facilities	Mid-priority
3. Promote and designate earthquake and fire resistant area surrounding or nearest to N/R/L government offices or business offices	Mid-priority
4. Develop and enhance national/regional/local government and public service/business continuity plan	Mid-priority
Goal 2: Earthquake-Resilient Urban Structures	
1. Retrofit public buildings and government-owned/managed buildings with low seismic-performance rating	High priority
2. Mainstream Disaster Risk Reduction (DRR)-Climate Change Adaptation (CCA) into the Comprehensive Land Use Plans (CLUP), particularly earthquake resistant infrastructure	Mid-priority
3. Self-assess the safety of own homes using DOST-PHIVOLCS, Association of Structural Engineers of the Philippines (ASEP), Japan International Cooperation Agency-Japan Science and Technology (JICA-JST) "How safe is my house" tool	Mid-priority
4. Secure possible sources of fire such as LPG tanks, gasoline refilling stations, oil depot, bottled gasoline-vending stores, illegal power connections, and other hazardous materials	Mid-priority
5. Strengthen buildings against fire hazards	Mid-priority
6. Implement buffer zone against fire in locations surrounding critical areas and industrial zones	Mid-priority
7. Educate and train LGU and barangay human resource for permitting and monitoring of building construction	Mid-priority
8. Improve LGU permitting and monitoring system for building construction	Mid-priority
9. Educate and train human resources for Building (structural) Engineering	Mid-priority

Action Plans	Priority Level
Goal 3: Enhanced Emergency Risk Management	
1. Establish tsunami evacuation routes and sites	High priority
2. Educate, train, and maintain fire emergency teams in barangays	Mid-priority
3. Reinforce community-based firefighting capability through volunteer fire fighter	Mid-priority
4. Inform and educate communities on tsunami warning systems	Mid-priority
5. Enact local ordinances related to Greater Metro Manila Earthquake Impact Reduction	Mid-priority
6. Update mainstreamed approved sectoral development plan	Mid-priority
7. Establish guidelines for vertical evacuation during tsunami emergency	Mid-priority
8. Conduct community-wide earthquake evacuation exercises	Mid-priority
9. Conduct community-wide tsunami evacuation exercises	Mid-priority
Goal 5: Reconstruction Systems	
1. Establish pre-disaster policies and institutional arrangements for post disaster reconstruction and mitigation	Mid-priority
2. Prepare pre-disaster recovery plans and procedures to ease post-disaster human and physical recovery and rehabilitation	Mid-priority

Table 9. Recommended priority action plans for CUs

Action Plans	Priority Level
Goal 2: Earthquake-Resilient Urban Structures	
1. Introduce and use earthquake-resistant water distribution pipes	High priority
2. Strengthen buildings against fire hazards	Mid-priority
Goal 3: Enhanced Emergency Risk Management	
1. Secure large scale water sources (e.g. water reservoirs)	High priority
Other action plans	
<ul style="list-style-type: none"> Strengthen important airport facilities such as control tower (specifically for transportation sector) 	
<ul style="list-style-type: none"> Strengthen important harbor facilities such as docks exposed to liquefaction (specifically for transportation sector) 	
<ul style="list-style-type: none"> Secure cranes and container vans to prevent them from falling off during a strong ground shaking (specifically for transportation sector) 	
<ul style="list-style-type: none"> Introduce and use earthquake-resistant power distribution cables (both surface and subsurface) (specifically for power/telecommunication sector) 	
<ul style="list-style-type: none"> (Physically) Expand major hospitals in the four provinces (Bulacan, Rizal, Cavite, and Laguna) surrounding Metro Manila (specifically for hospital sector) 	

Action Plans	Priority Level
<ul style="list-style-type: none"> Functionally upgrade major hospitals in the four provinces (Bulacan, Rizal, Cavite, and Laguna) surrounding Metro Manila (specifically for hospital sector) 	

Based on gaps from MMEIRS as reported by experts, feedbacks from meetings with various organizations and LGUs, enumerated are gaps in the MMEIRS that may be considered for updating or future action:

- **Goal 2:** Improve GMMA’s urban structure resistant to earthquake (monitoring and outcome evaluation of various initiatives done for USI 1 to 7)
- **NSD 2:** Protect stability of socio-economic systems (identification and implementation of new action plans to operationalize this)
- **RMS 4:** Strengthen institutional capacity for implementing preparedness and mitigation measures (focusing on LGUs which were added to the scope of GMMEIRS such as those in the provinces of Bulacan, Rizal, Cavite and Laguna)
- **R&D 1:** Promote sustained research and development on earthquake (M&E and establishment of database for continuous updating)

CHAPTER 5

CHAPTER 5. SUMMARY AND CONCLUSION

In 2004, the MMEIRS revealed that a magnitude 7.2 WVF earthquake in Metro Manila could cause a catastrophic disaster of unparalleled proportions that would gravely affect millions of residents in Metro Manila. Fifteen years after its publication, the need to prioritize the preparations for a major threat has intensified. The growing urbanization of Metro Manila, along with its nearby provinces is creating unacceptable levels of an earthquake disaster in terms of both human and property losses. Considering that every aspect of society has undergone rapid urban development since 2004, it is high time to revisit, review, and update the MMEIRS with the end goal of making it reflective and indicative of the urban complex's current situation, and making it relevant for a greater geographic scope which is the GMMA, hence the urgent need to develop the GMMEIRS. The GMMEIRS covers five study objectives whose findings are summarized below:

Objective 1: Review of MMEIRS Action Plans

In general, the MMEIRS vision, objectives and frameworks are still applicable to the GMMA context. Some action plans were modified to reflect provisions from DRRM-related laws and plans, and earthquake-related information which were not yet existent when the MMEIRS was crafted. Action plans were also reviewed and re-stated as outputs of iterative workshops and meetings with stakeholders such as NGAs, LGUs, CUs, technical experts, and NGOs.

Objective 2: Assess the accomplishments of various actors (NGAs, LGUs and CUs)

Through a series of workshops and survey method, the accomplishment status of all the action plans was identified with LGUs, NGAs, and CUs. Goal 4 (Increased Community Resilience) was found to have the highest level of accomplishment as reported by survey respondents, while the results were otherwise for Goal 5 (Reconstruction Systems). Perceived impact reduction of the action plans were also assessed through workshops and surveys. Results revealed that Goal 2 (Earthquake Resilient Urban Structures) and Goal 3 (Enhanced Risk Emergency Management) have the most number of direct impact reduction action plans. Moreover, almost all of the action plans in Goal 6 (Earthquake and Tsunami Resilience Research and Development) are perceived to have direct impact reduction.

Objective 3: Streamline action plans based on the context of GMMA

The GMMEIRS action plans were categorized into the 4 DRRM Thematic Pillars: Prevention and Mitigation, Preparedness, Response, Recovery and Rehabilitation. Two methods of categorization were done: (a) categorization by relevance, and (b) categorization by contribution.

Comparing and relating the results of the two methods of categorization, most action plans are not exclusively relevant to a single DRRM thematic pillar. Based on the scope and purpose of the action plans, most are relevant to response and preparedness, but this does not mean these are exclusively contributory to the mentioned thematic pillars. Few action plans were found to be relevant under prevention and mitigation, but most of these are exclusively contributory to the said DRRM pillar. Recovery and rehabilitation has the fewest number of relevant and contributory action plans. This may be an important consideration for future plans since recovery and rehabilitation is vital for communities' return to normalcy.

Through the action plan categorization methods, the niche of goals in relation to the DRRM pillars were also identified: Goals 2 (Earthquake-Resilient Urban Structures) and 6 (Earthquake and Tsunami Research and Development) were identified to be consistently relevant and contributory to Prevention and Mitigation; Goals 3 (Enhanced Emergency Risk Management) and 4 (Increased Community Resilience) were found to be consistently relevant and contributory to Preparedness; Goals 2 and 3 were identified to be consistently relevant and contributory to Response; and, Goals 1 (Earthquake-Resilient National Systems), 2 and 5 (Reconstruction Systems) were categorized to be consistently relevant and contributory to Recovery and Rehabilitation. Moreover, Goals 2 and 3 were found to be encompassing since these were categorized to be consistently relevant and contributory to all DRRM thematic pillars.

Key actors and implementers for the action plans were also identified. It was consistent for all goals that the key implementers for most action plans are NGAs. Among the trends observed is that NGAs have the largest influence over the other actors (LGUs, CUs, etc.), while LGUs are critical to executing the plans and guidelines from NGAs at the local level.

Lastly, it is important to note that these categorizations (DRRM pillar and key implementers) are highly recommended to be reviewed and validated by LGUs, NGAs and other stakeholders since this was done mostly by the study team.

Objective 4: Recommendations for priority earthquake risk reduction action plans

Utilizing the results from objectives 2 and 3, priority action plans for implementation by NGAs, LGUs and CUs were identified. The action plans identified to have direct impact reduction, which also have the lowest level of accomplishment were considered to be the high priority action plans. Direct action plans which have low to partial level of accomplishment were identified to be medium priority action plans. For NGAs, 12 high priority actions plans were identified which belong to Goals 2, 3, 4, and 6. For LGUs, there are 3 high priority action plans under Goals 1, 2, and 3. For CUs, 2 high priority action plans were identified under Goals 2 and 3. Same with the results form Objective 4, these findings are highly recommended to be reviewed and validated with LGUs, NGAs and CUs to better reflect the realities of their initiatives, accomplishments and other gaps in terms of overall earthquake impact reduction.

Recognizing the major limitations of the MMEIRS, recommendations for earthquake disaster mitigation for the GMMA were formulated based on the findings of the study. The recommended action plans indicated in Chapter IV are the new high priority action plans that have emerged after the analysis of data. These recommendations were disaggregated and categorized according to key implementers to make the action plans more comprehensive, relevant, and reflective of the current situation and needs in GMMEIRS. Moreover, a functioning and active monitoring and evaluation system should also be developed to track the implementation and accomplishment of the recommended action plans from the GMMEIRS and to encourage accountability and transparency from stakeholders.

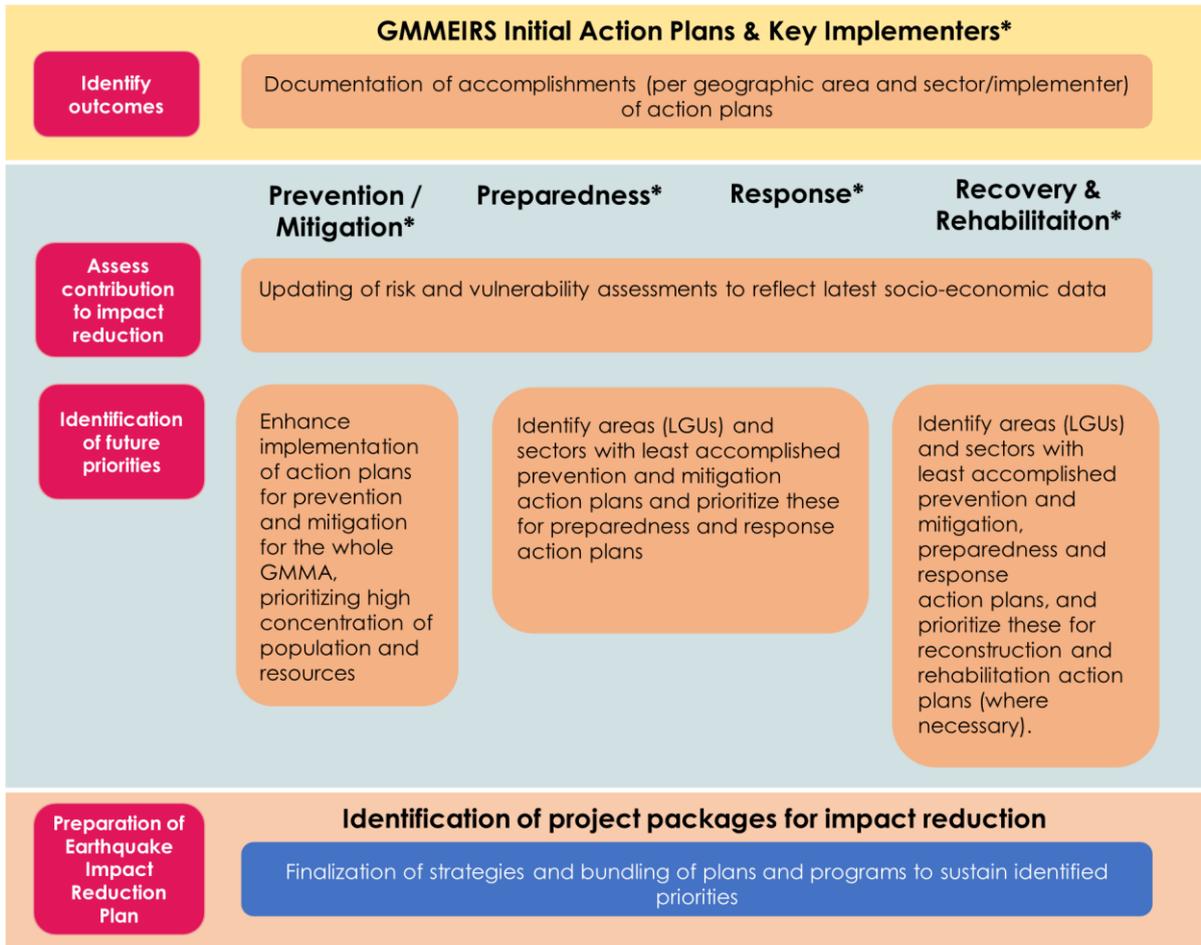
CHAPTER 6

CHAPTER 6. RECOMMENDATIONS

Given the scope and limitations of the study, and its achieved results, below are the identified recommendations:

1. The study included provinces with high earthquake impact results from Mag. 7.2 earthquake scenario from the West Valley Fault. However, the Executive Order 52 formally declares provinces included in the GMMA which shall be potentially affected by both the East and West Valley Faults. Given this, it is recommended to conduct a similar study to include other provinces of the declared GMMA per Executive Order 52 from the Office of the President.
2. Since the conducted survey focused on the perceived level of implementation of the MMEIRS action plans, it is recommended to further triangulate the survey results by conducting a review of latest accomplishment reports of policy/plan/programs of the agencies/organizations directly related to the MMEIRS action plans. This will help assess more in detail the level of implementation and percentage of accomplishment. Moreover, it is also recommended to conduct a supplementary survey to assess the level of accomplishment of the agencies/organizations identified as lead implementors of the action plan.
3. Validation of the categorized action plans is also vital to reflect the latest interventions, practices and accomplishments of NGAs, LGUs and CUs. This iterative approach will help updated the streamlined action plans based on latest initiatives of LGUs, NGAs and CUs. . Moreover, supplementary studies that will help transform the findings into a GMMA roadmap for earthquake impact reduction are enumerated below:
 - a. Development of an appropriate monitoring and evaluation tool to continually assess the status of implementation of the action plans;
 - b. Exploration of other methods for assessing the contribution of the action plans in significantly reducing earthquake impact;
 - c. Identification of action plans that focus on other earthquake generators that may affect GMMA (e.g., earthquake and tsunami hazards from the Manila Trench); and
 - d. Assessment of socio-economic vulnerabilities and identification of interventions for overall risk reduction.

To inform future studies, presented is a proposed framework that may help translate the GMMEIRS into a strategic plan for earthquake impact reduction:



**for discussion/further updating or approval by TWG/council*

Most importantly, given the establishment of the Project Management Office for Earthquake Resiliency of the Greater Metro Manila Area, and general risk of earthquakes prevalent in most parts of the country, it is recommended to conduct a nationwide earthquake impact reduction study which shall serve as a framework for earthquake resiliency that can guide plans at various levels and sectors.

REFERENCES

- Allen, T., Ryu, H., Bautista, B., Bautista, M. L., Narag, I., Sevilla, W. I., Melosantos, M. L. P., Papiona, K., & Bonita, J. (2014). *Enhancing risk analysis capacities for flood, tropical cyclone severe wind and earthquake for the Greater Metro Manila Area. Component 5–Earthquake risk analysis*. PHIVOLCS and Geoscience Australia: Manila, Philippines.
- Bautista, M & Bautista, B & Narag, Ishmael & Daag, A & Melosantos, M & Lanuza, A & Papiona, K & Enriquez, M & Salcedo, J & Perez, Jeffrey & Deocampo, Janila & Punongbayan, J & Banganan, E & Grutas, R & Olavere, E & Hernandez, V & Tiglao, R & Figueroa, M & Solidum, R & Punongbayan, R. (2021). The "Rapid Earthquake Damage Assessment System (REDAS)" Software.
- Bondoc, M. R. (2018). DPWH finishes structural audit on gov't buildings in Metro Manila. Retrieved November 20, 2019, from GMA News Online: <https://www.gmanetwork.com/news/news/metro/640081/dpwh-finishes-structural-audit-on-gov-quo-t-buildings-in-metro-manila/story/>
- Bullen, J. (2017). The science of earthquakes explained. Retrieved from <https://www.abc.net.au/news/science/2017-02-22/the-science-of-earthquakes/8163686>
- Camus, M. R. (2019). P393-B Metro Manila subway is 'project of the century' for PH. Retrieved November 20, 2019, from Business Inquirer: <https://business.inquirer.net/281164/p393-b-metro-manila-subway-is-project-of-the-century-for-ph>
- Center for Environmental Geomatics-Manila Observatory. (2005). Mapping Philippine vulnerability to environmental disasters. Retrieved from <http://vm.observatory.ph/>
- Center for Excellence in Disaster Management & Humanitarian Assistance. (2018). *Philippines: Disaster management reference handbook*. Ford Island, HI: Center for Excellence in Disaster Management and Humanitarian Assistance.
- Commission on Audit. (2013). *Disaster management practices in the Philippines: An assessment*. Report.
- CONCEP, & JICA. (2018). TOD Study for MCRP Clark-Calumpit Stations. Makati City: nd.
- Domingo, S. N., & Olaguera, M. C. (2017, May). Policy Notes: Have we institutionalized DRRM in the Philippines. ISSN 2508-0865 No.2017-12. Retrieved November 20, 2019, from Philippine Institute of Development Studies: <https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidspn1712.pdf>
- DOST-PHIVOLCS. (2012). Annual Report 2012. Quezon City: DOST-PHIVOLCS.
- DOST-PHIVOLCS. (2013). The 15 October 2013 Magnitude 7.2 Bohol Earthquake. Retrieved from https://drive.google.com/file/d/0B8_KPQhbpktXdmNHQmdQMGVnaWc/view
- DOST-PHIVOLCS. (2015). Geologic Impacts of the 06 February 2012 Negros Oriental Earthquake in Negros Oriental and Cebu. DOST-PHIVOLCS.
- DOST-PHIVOLCS. (2017). 2017 Annual Report. Quezon City: DOST-PHIVOLCS.

- DOST-PHIVOLCS. (2019). PHIVOLCS Observer Vol.30 No.5 Sept-Oct 2019 ISSN 2619-8010.
- DOST-PHIVOLCS. (2019, March). PHIVOLCS Observer Vol.30 No.2 Mar-April 2019 ISSN 2619-8010.
- DPWH. (2015.). National Building Code Department Order Memorandum Cicular1. Philippines.
- DPWH. (2019). DPWH Guide Specification: Seismic Retrofitting Manual for Highway Bridges. 1st edition. nd: DPWH.
- DPWH. (2019). DPWH Guide Specifications: Highway Bridge Seismic Isolation Design Specification. 1st edition. nd: DPWH.
- DPWH. (n.d.). National Building Code Department Order Memorandum Cicular 1 Series of 2015. Philippines.
- GeoRiskPH. (n.d.). HazardHunter. Retrieved November 20, 2019, from GeoRiskPH: <https://hazardhunter.georisk.gov.ph/>
- GFDRR. (n.d.). GMMA Ready Project Brief. Retrieved November 20, 2019, from GFDRR Website: https://www.gfdrr.org/sites/gfdrr/files/EAP_Field%20visit_GMMA%20READY%20Project_Brief.pdf
- Global Disaster Preparedness Center. (n.d.). Philippines. Retrieved from <https://www.preparecenter.org/countries/philippines>
- Gray, A. (2016). World economic forum: The science of earthquake prediction—explained. Retrieved from <https://www.weforum.org/agenda/2016/08/the-science-of-earthquake-prediction-explained/>
- Islam, T., & Ryan, J. (2016). Chapter 12: Mitigation best practices and resources [Abstract]. *Hazard Mitigation in Emergency Management*, 379-411.
- JICA, MMDA, & PHIVOLCS. (2004). *Earthquake impact reduction study for Metropolitan Manila (MMEIRS)*. Final report. Manila, Philippines.
- JICA. (2018). *Guidebook for urban resilience: Building disaster and climate resilient cities in ASEAN*. Tokyo, Japan: Japan International Cooperation Agency.
- MWSS. (nd, nd nd). Angat Dam and Dyke Strengthening Project. Retrieved August 23, 2020, from Metropolitan Waterworks and Sewerage System: <http://mwss.gov.ph/projects/ang-at-dam-and-dyke-strengthening-project-addsp/>
- NDRRMC, & ASEAN. (n.d.). *Y It Happened: Learning from Typhoon Yolanda*. Retrieved from <http://www.ndrrmc.gov.ph/>
- NDRRMC. (2012). SitRep No.08 re Effects of Earthquake in Guiuan, Eastern Samar. Retrieved from http://www.ndrrmc.gov.ph/attachments/article/2081/SitRep_No_08_re_Effects_of_Earthquake_in_Guiuan_Eastern_Samar_as_of_06SEP2012_0600H.pdf
- NDRRMC. (2012). SitRep No.22 re Effects of the 6.9 Earthquake in Negros Orienta. Quezon City, Philippines: NDRRMC.
- NDRRMC. (2017). NDRRMC Update: SitRep No.7 re Effects of April 2017 Series of Earthquakes in the Province of Batangas. Quezon City: NDRRMC.

- NDRRMC. (2019, Nov.11). SitRep 1 regarding Magnitude 6.6 and 6.5 Earthquakes in Tulunan, North Cotabato. Quezon City: NDRRMC.
- NDRRMC. (n.d.). *National Disaster Risk Reduction and Management Plan (NDRRMP): 2011-2028*. Retrieved from http://www.ndrrmc.gov.ph/attachments/article/41/NDRRM_Plan_2011-2028.pdf
- NDRRMC-OCD, & DSWD. (2018). *National Disaster Response Plan (NDRP): Earthquake and tsunami*. Retrieved from http://www.ndrrmc.gov.ph/attachments/article/3621/NDRP_Earthquake_2018.pdf
- NDRRMC-OCD, MMDRRMC, UNDP, & AusAid. (2015). *Oplan Metro Yakal Plus*. Retrieved from http://ocd.gov.ph/attachments/category/31/2015_Gazette_Vol_3_Issue_4.pdf and http://info-aid.net/CVRDRRMC/wp-content/uploads/2017/05/oplan_metro_yakal_plus.pdf
- NEDA. (2018). 2017-2022 Public Investment Program. Pasig City: National Economic Development Authority.
- OCD. (n.d.). Project DINA. Retrieved November 20, 2019, from Office of Civil Defense: <https://ocd.gov.ph/index.php/project-dina>
- Orallo, A.-L. D. (2011). Study on Earthquake Risk and Vulnerability Management and Lessons Learned. Quezon City, Philippines: Office of Civil Defense.
- Padagdag, J. M. (2018). The Philippine disaster risk reduction and management system. Retrieved from https://www.adrc.asia/countryreport/PHL/2018/Philippines_CR2018B.pdf
- Parrocha, A. (2019, July 2). Duterte OKs DOST-developed tech that locates hazards in PH. Retrieved from Philippine News Agency: <https://www.pna.gov.ph/articles/1073911>
- PHIVOLCS, OCD, & NDRRMC. (2014). The Valley Fault System in Greater Metro Manila Area. DOST-PHIVOLCS.
- PHIVOLCS. (2018). REDAS Activities. Retrieved November 20, 2019, from DOST-Philippine Institute of Volcanology and Seismology: <https://www.phivolcs.dost.gov.ph/index.php/redas>
- PIA. (2018). Philippine Earthquake Model Atlas for designing earthquake resilient buildings to be launched. Retrieved November 20, 2019, from Philippine Information Agency Website: <https://pia.gov.ph/news/articles/1004095>
- PMS. (2020, July 2). The President's Mid-term Report to the People 2016-2019. Retrieved from Republic of the Philippines Office of the President - Presidential Management Staff: https://pms.gov.ph/images/PeeDeeEf/PRP2016_2019.pdf
- PPP Center. (2014). Laguna Lakeshore Expressway Dike Project. Retrieved August 23, 2020, from PPP Center: https://ppp.gov.ph/in_the_news/laguna-lakeshore-expressway-dike-calamba-los-banos-toll-expressway/
- PPP, C. (n.d.). MRT Line 7. Retrieved November 20, 2019, from Public-Private Partnership Center: https://ppp.gov.ph/ppp_projects/mrt-line-7/
- Radtke, K., Mann, H., Weller, D., Kirch, L., & Prütz, R. (2018). Chapter 3: The world risk index 2018. In *World risk report*. Retrieved from <https://reliefweb.int/sites/reliefweb.int/files/resources/WorldRiskReport-2018.pdf>

- Sabornido, L. R. (2018, October 8). Top 10 Strongest Earthquakes to hit the Philippines. Retrieved November 20, 2019, from FAQ Philippines: <https://faq.ph/top-10-strongest-earthquakes-to-hit-the-philippines/>
- Senate Economic Planning Office. (2017). SEPO policy brief: Examining the Philippines' disaster risk reduction and management system. Retrieved from https://senate.gov.ph/publications/SEPO/PB_Examining%20PH%20DRRM%20System_05June2017.pdf
- Shaw, R., Srinivas, H., & Sharma, A. (Eds.). (2009). *Urban risk reduction: An Asian perspective*. Bingley, UK: Emerald Publishing Limited.
- Shaw, R., Takeuchi, Y., Fernandez, G., Walde, A. X., & Caro, A. R. (2010). *Metro Manila City profile: Climate and disaster resilience*. Kyoto, Japan: Climate and Disaster Resilience Initiative (CDRI) of Kyoto University and Metroplanado (Metro Manila Planning and Development Officers' Association, Inc.).
- Sphere India, & EFICOR. (2010). *Turning the tide: Good practices in community based disaster risk reduction*. New Delhi, India: Sphere India and EFICOR.
- Statista Research Department. (2019). Risk index of natural disasters in the Philippines for 2019, by type. Retrieved from <https://www.statista.com/statistics/921036/philippines-risk-index-for-natural-disasters/>
- Unite, B. K. (2019). DPWH to improve earthquake resiliency, response plan. Retrieved November 20, 2019, from Manila Bulletin Website: <https://news.mb.com.ph/2019/08/30/dpwh-to-improve-earthquake-resiliency-response-plan/>
- United Nations Development Programme (UNDP) and the European Commission Humanitarian Office (ECHO) through the Disaster Preparedness Programme (DIPECHO). (2010). Community-based best practices for disaster risk reduction. Retrieved from <https://www.undp.org/content/dam/mozambique/docs/Community%20based%20BP.pdf>
- United Nations International Strategy for Disaster Reduction (UNISDR). (2015). *Sendai framework for disaster risk reduction 2015-2030*. Geneva, Switzerland: UNISDR.
- United Nations International Strategy for Disaster Reduction (UNISDR), & United Nations Development Programme (UNDP). (2007). *Building disaster resilient communities: Good practices and lessons learned*. A publication of the "Global Network of NGOs" for disaster risk reduction. Geneva, Switzerland: UN.
- United Nations Office for Disaster Risk Reduction. (n.d.). Earthquake risk reduction. Retrieved from <https://www.preventionweb.net/go/5041>
- United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA). (2018). Are we ready for the 'Big One'? Preparing for a catastrophic Metro Manila earthquake. *Humanitarian Bulletin Philippines*. Retrieved from <https://www.unocha.org/philippines> and https://reliefweb.int/sites/reliefweb.int/files/resources/OCHAPhilippines_Humanitarian_Bulletin_No3_April_2018_FINAL.pdf
- United States Geological Survey (USGS). (2016). Earthquake hazards—A national threat. Retrieved from <https://pubs.usgs.gov/fs/2006/3016/2006-3016.pdf>
- University of Edinburgh. (2009). Seismic shift in methods used to track earthquakes. ScienceDaily. Retrieved from www.sciencedaily.com/releases/2009/09/090902112117.htm

- Villar, M. B. (2018). New city needed to ease congestion. Retrieved from <https://businessmirror.com.ph/2018/08/27/new-city-needed-to-ease-congestion/>
- Wannewitz, S., Hagenlocher, M., & Garschagen, M. (2016). Development and validation of a sub-national multi-hazard risk index for the Philippines. *GI Forum-Journal for Geographic Information Science*, 1, 133-140. doi: 10.1553/giscience2016_01_s133.
- Williams, M. (2015). What is the Pacific “ring of fire”? Space and astronomy news. Universe today. Retrieved from <https://www.universetoday.com/59341/pacific-ring-of-fire/>
- World Population Review. (2019). Manila population 2019. Retrieved from <http://worldpopulationreview.com/world-cities/manila-population/>

Official websites visited:

<http://ocd.gov.ph>

<http://www.geo.mtu.edu/UPSeis>

<http://www.ndrrmc.gov.ph>

<https://earthquake.usgs.gov/learn/glossary>

<https://kayaconnect.org>

<https://psa.gov.ph>

<https://www.phivolcs.dost.gov.ph>

APPENDICES

Appendix 1. Master list of GMMEIRS Action Plans

Appendix 2. Workshops, Meetings, and Survey Participants

Appendix 3. Risk Estimates for Metro Manila, CALABARZON, and Region III

Appendix 4. Questionnaires from Workshops 1-3

Appendix 5. Workshop Results for Action Plans Accomplishment

Appendix 6. Statistical Analysis of Survey Response

Appendix 7. Highlights of Key Informant Interviews

Appendix 1. Master list of GMMEIRS Action Plans

Goal 1: Earthquake-Resilient National Systems

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
NSD 1	1	Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of N/R/L government offices	Direct	4				Highest	Highest		NGA, LGU	DPWH	CIAP, NGOs (ASEP, PICE, UAP, PIEP)
NSD 1	2	Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of critical government facilities	Direct	4						Lowest	NGA, LGU	DPWH	CIAP, NGOs (ASEP, PICE, UAP, PIEP)
NSD 1	3	Promote and designate earthquake and fire resistant area surrounding or nearest to N/R/L government offices or business offices	Direct	4						Lowest	NGA, LGU	DOST-PHIVOLCS, BFP	DHSUD, DENR, DILG
NSD 1	4	Regular conduct of emergency evacuation drills for N/R/L government offices	Direct		3	1		Highest	Highest		NGA, LGU	OCD, MMDA, DILG	CSC
NSD 1	5	Develop in-house earthquake emergency services skills of teams	Direct		3	1		Highest			NGA, LGU, Private business sector	OCD	DILG, CSC
NSD 1	6	Provide basic earthquake emergency skills to staff	Direct		3	1		Highest	Highest		NGA, LGU, Private business sector	OCD	DILG, CSC
NSD 1	7	Develop and enhance national/regional/local government and public service/business continuity plan	Direct		2	1	1			Highest	NGA, LGU	OCD, LGU, Private business sector	
NSD 1	8	Implement and develop back-up systems, back-up sites, or mirror sites for data security during earthquake and fire emergency with RECOVERY TIME OBJECTIVE specified	Indirect			1	3			Highest	NGA, LGU	DICT	DOST, DPWH, DND, DILG
NSD 2	9	Deconcentrate government operations to strategically located sub-office	Direct	1	1	1	1	Lowest			NGA, LGU, Private business sector	DHSUD, NEDA	DSWD, PNP, AFP, DPWH, PCG, BFP, PA, CAAP, MIAA, MCIAA, DOTr, DOE, and volunteer and

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
													private groups acknowledged by NDRRMC
NSD 2	10	Assess and improve integrity of business and commercial buildings against earthquake and fire hazards	Direct	4				Highest			NGA, LGU	DTI-CIAP, DPWH	
NSD 2	11	Establish transfer mechanisms for foreign disaster aid	Indirect			1	3	Lowest	Lowest		NGA, NGOs	DFA, DSWD	NGOs, CSOs
NSD 2	12	Establish measures to stabilize exchange rates and price of commodities after earthquake disasters	Indirect				4	Lowest	Lowest	Lowest	NGA	DOF, DTI	DA, NEDA, DOE
NSD 2	13	Emplace local emergency loan and disaster reconstruction fund into (banking) system	Indirect				4	Lowest	Lowest		NGA	DSWD, DPWH, DTI, DOTr	NPA, AFP, DOH, PRC, DA, OCD

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Goal 2: Earthquake-Resilient Urban Structures

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
USI 1	1	Mainstream Disaster Risk Reduction (DRR)-Climate Change Adaptation (CCA) into the Comprehensive Land Use Plans (CLUP), particularly earthquake resistant infrastructure	Direct	4							LGU	LGUs (LPDO, LENR, LDRRMO)	DILG, DHSUD, CCC, DPWH, DOTr, DOST, DENR
USI 1	2	Develop guidelines for designing and building earthquake- and fire-resistant homes	Direct	4							NGA	DHSUD	DOST-PHIVOLCS, DPWH, ASEP, PICE, PICE
USI 1	3	Develop and introduce affordable seismic retrofitting measures to non-engineered houses	Direct	4							NGA	DOST-PHIVOLCS, DHSUD	DILG, ASEP, PICE, PIEP, DPWH, NGOs, Academe
USI 1	4	Self-assess the safety of own homes using DOST-PHIVOLCS, Association of Structural Engineers of the Philippines (ASEP), Japan International Cooperation Agency-Japan Science and Technology (JICA-JST) "How safe is my house" tool	Direct	3	1						LGU	Community, LGU (LEO, LBO)	DILG, ASEP, PICE, PIEP, DPWH, DHSUD
USI 1	5	Strengthen structure of own homes and buildings from impacts of earthquake hazards	Direct	3	1			Highest			NGA, LGU, Private Business Sector, Community	Community, LGU (LEO, LBO), DPWH, DTI-CIAP	DILG, ASEP, PICE, PIEP, DHSUD
USI 1	6	Consider urban redevelopment of former informal settlement areas	Direct	2			2				NGA	DHSUD, DILG	LGU, NGOs, MMDA
USI 2	7	Secure possible sources of fire such as LPG tanks, gasoline refilling stations, oil depot, bottled gasoline-vending stores, illegal power connections, and other hazardous materials	Direct	4							NGA, LGU	LGU, DTI, BFP, Business sector	
USI 2	8	Strengthen buildings against fire hazards	Direct	4					Highest		NGA, LGU, Critical Utilities, Private Business Sector	LBO, BFP	

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
USI 2	9	Develop fire prevention and suppression guidelines	Direct	4							NGA	BFP, DHSUD, DTI	
USI 2	10	Implement buffer zone against fire in locations surrounding critical areas and industrial zones	Direct	4							LGU	LGU, BFP	DHSUD, DILG, MMDA, PEZA, DTI, Business sector
USI 3	11	Introduce firebreak network elements (parks and other open spaces, roads and pedestrian alleys) in urban plans	Direct	4							NGA, LGU	DHSUD, DOTr, DILG	DENR BMB, MMDA, DPWH, LGU (Planning Office)
USI 3	12	Set and implement standards for road width (relative to population) for mass earthquake evacuation	Both	1.33	1.33	1.33					NGA	DHSUD, DOTr, DILG	DENR BMB, MMDA, DPWH, LGU (Planning Office)
USI 3	13	Set a proportion of open space (relative to population) for mass earthquake evacuation	Direct		2	2		Highest	Highest		NGA, LGU	DILG, DENR-BMB, MMDA	MMDA, DPWH, LGU (Planning Office)
USI 4	14	Educate and train LGU and barangay human resource for permitting and monitoring of building construction	Direct	4							LGU	DTI-CIAP, DPWH, LGU (LBO, LEO)	DOST-PHIVOLCS, ASEP, PICE,
USI 4	15	Improve LGU permitting and monitoring system for building construction	Direct	4							LGU	LGU (LBO, LEO)	DTI-CIAP, ASEP, PICE, PIEP
USI 4	16	Conduct research and development for alternative, affordable, lightweight, non-flammable construction materials	Direct	4						Lowest	NGA	DTI-CIAP, DPWH, Academe	NGOs (ASEP, PICE, UAP, PIA)
USI 4	17	Develop and introduce affordable seismic retrofitting technologies and methods to building owners and developers	Direct	4					Lowest		NGA	DTI-CIAP, DPWH, LGU (LBO, LEO)	DHSUD, NGOs (ASEP, PICE, UAP, PIA)
USI 4	18	Educate and train human resources for Building (structural) Engineering	Direct	4							NGA, LGU, Private business sector	DTI-CIAP, LGUs, Business Owners	
USI 5	19	Evaluate seismic performance of public buildings and government-owned/managed buildings	Direct	4							NGA	DPWH, DTI-CIAP	ASEP, PICE
USI 5	20	Retrofit public buildings and government-owned/managed buildings with low seismic-performance rating	Direct	4				Lowest			NGA, LGU, Private business sector	DTI-CIAP, DPWH, LGU (LBO, LEO)	NGOs (ASEP, PICE, UAP, PIA)
USI 6	21	Assess seismic performance of primary roads, bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems	Direct	4							NGA	DPWH, DOTr	DTI-CIAP, ASEP, PICE, PIEP

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
USI 6	22	Retrofit primary roads, bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems	Direct	4							NGA	DPWH, DOTr	DTI-CIAP, ASEP, PICE, PIEP
USI 6	23	Develop transport facility reconstruction plan with RECOVERY TIME OBJECTIVE specified	Indirect			1	3			Lowest	NGA	DPWH, DOTr	DTI-CIAP, ASEP, PICE, PIEP
USI 6	24	Establish back-up system and site for airport control center, air traffic tower and approach leader with RECOVERY TIME OBJECTIVE specified	Indirect			1	3	Lowest		Lowest	NGA	DOTr	
USI 7	25	Establish a standard GIS database of lifeline nodes and network for comprehensive lifeline risk assessment	Direct	3	1				Lowest		NGA, LGU	DOST (PHIVOLCS, PCIEERD, ASTI)	DICT, DPWH, DOTr, DILG, DOE
USI 7	26	Develop earthquake emergency operation team and support system for lifeline	Direct		2	2		Highest	Highest	Highest	NGA, Utility service providers	LWUA, NWRB, MWSS, DPWH, DOE, Transco, NGCP, NPC, Meralco, NEA, ERC, DICT	
USI 7	27	Develop lifeline earthquake emergency operation manuals with RECOVERY TIME OBJECTIVE specified	Direct		1	1	2			Highest	NGA, Utility service providers	LWUA, NWRB, MWSS, DPWH, DOE, Transco, NGCP, NPC, Meralco, NEA, ERC, DICT	
USI 7	28	Develop lifeline facility reconstruction plan with RECOVERY TIME OBJECTIVE specified	Indirect			2	2				NGA, Utility service providers	LWUA, NWRB, MWSS, DPWH, DOE, Transco, NGCP, NPC, Meralco, NEA, ERC, DICT	
USI 7	29	Conduct regular emergency operation exercise for lifeline with RECOVERY TIME OBJECTIVE specified	Direct		1	1	2			Highest	NGA, Utility service providers	LWUA, NWRB, MWSS, DPWH, DOE, Transco, NGCP, NPC, Meralco, NEA, ERC, DICT	
USI 7	30	Enhance end-to-end communication system among DRR institutions	Direct		2	2					NGA	OCD	DICT, MMDA, NTC, KBP, PCOO, PIA
USI 7	31	Introduce and use earthquake-resistant water distribution pipes	Direct	4					Lowest		NGA, Utility service providers	LWUA, NWRB, MWSS, DPWH	
USI 7	32	Install central control system to supply electricity in blocks or sectors	Indirect			1	3	Lowest			NGA, Utility service providers	DOE	Transco, NGCP, NPC, Meralco, NEA, ER

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Accomplishment status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
USI 7	33	Reinforce communication exchange facilities	Indirect			2	2				NGA, Utility service providers	DICT	MMDA, NTC, KBP, PCOO, PIA

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Goal 3: Enhanced Emergency Risk Management

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
RMS 1	1	Set regulation and permit for storing, handling, and selling flammable products	Direct	4						Lowest	NGA	DTI, BFP, DOH, DOLE	
RMS 1	2	Establish long-term plan for relocating facilities handling hazardous materials	Direct	4							NGA	DENR, BFP	
RMS 1	3	Educate, train, and maintain fire emergency teams in establishments	Direct		3	1					NGA	BFP	AFP, Fire volunteers
RMS 1	4	Educate, train, and maintain fire emergency teams in barangays	Direct		3	1					LGU	LGU	BFP, AFP, Fire volunteers
RMS 1	5	Reinforce community-based firefighting capability through volunteer fire fighter	Direct		3	1				Lowest	LGU	LGU	BFP, AFP, Fire volunteers
RMS 1	6	Improve BFP personnel and firefighting capability to international standards	Direct		3	1				Lowest	NGA	BFP	AFP, Fire volunteers
RMS 1	7	Establish auxiliary firefighting capability of private organizations	Direct		3	1				Lowest	Private business sector	Private business sector, fire volunteers	BFP, AFP
RMS 1	8	Improve access to water sources for firefighting	Direct		3	1				Lowest	NGA	BFP	MWSS, LWUA, DPWH, NWRB, NIA
RMS 2	9	Retrofit Manila port to earthquake and tsunami-resistant construction	Direct	4				Lowest	Lowest		NGA	DOTr (PPA)	DPWH, DHSUD, NGOs (ASEP, PICE, etc.)
RMS 2	10	Establish tsunami warning systems	Direct		3	1		Lowest			NGA	DOST - PHIVOLCS, NDRRMC	LGU (LDRRMO)
RMS 2	11	Install Tsunami hazard markers	Direct		3	1		Lowest	Highest		NGA	DOST - PHIVOLCS	LGU (LDRRMO)
RMS 2	12	Inform and educate communities on tsunami warning systems	Direct		4						LGU	LGU (LDRRMO)	CSO, NGOs, POs
RMS 3	13	Enact local ordinances related to Greater Metro Manila Earthquake Impact Reduction	Direct	4							LGU	LGU	OCD, DILG, MMDA, DOST-PHIVOLCS
RMS 4	14	Develop and distribute recent Earthquake Mitigation Handbook and Earthquake Mitigation and Response Checklist	Direct	4							NGA	OCD	LGU, OCD, DILG, MMDA, DOST-PHIVOLCS
RMS 4	15	Effectively utilize DRRM yearly budget		1	1	1	1				NGA, LGU	LGU (LDRRMO)	

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
RMS 4	16	Sufficient personnel handling DRRM-related matters		1	1	1	1				NGA, LGU	LGU (LDRRMO)	
RMS 4	17	Update mainstreamed approved sectoral development plan	Direct	1	1	1	1				LGU	LGU	
RMS 4	18	Educate and train local barangay officials in community-based DRRM	Direct	1	1	1	1	Highest			LGU	LGU	OCD, DILG, MMDA, DOST-PHIVOLCS
RMS 4	19	Regularly evaluate and update the Greater Metro Manila disaster preparedness plans (LGU), emergency plan (business sector) and manuals of DRRM	Direct		3	1				Highest	NGA	PMO ERG, MMDA	DILG, DTI, OCD
RMS 4	20	Educate and train civil defense personnel on planning for emergency response	Direct		3	1					NGA	OCD	LGU, DILG, MMDA, DOST-PHIVOLCS
RMS 4	21	Conduct annual inventory of civil defense emergency management personnel	Direct		3	1			Lowest		NGA	OCD, PMO ERG, MMDA, DILG	
RMS 4	22	Establish emergency information and communication system, and redundant systems among and between DRRM organizations	Indirect		2	2				Highest	NGA	PMO-ERG	OCD, DOST-PHIVOLCS, MMDA, DILG
RMS 5	23	Conduct periodic simulation exercises to test the Greater Metro Manila Incident Command System (ICS) and response decision-making systems	Direct		2	2					NGA	MMDA, OCD, DILG	
RMS 5	24	Establish inter-local government clusters and mutual aid agreement	Indirect		2	2					NGA	PMO ERG, MMDA	DILG
RMS 5	25	Establish mutual support system and mutual aid agreements through memorandum of agreements or understanding	Indirect			1	3		Highest		NGA	PMO-ERG	DILG, DSWD, MMDA
RMS 6	26	Disseminate Emergency Response Pocket Guide to agencies and LGUs	Direct		1	3					NGA	OCD	LGU, DILG, MMDA
RMS 6	27	Development of standard relief and response resources based on national guidelines	Direct		1	3		Highest	Highest		NGA	OCD, DILG, DSWD	
RMS 6	28	Establish scheme and protocol for mobilizing resources for evacuation	Indirect		2	2					NGA, LGU	DILG, LGU (LDRRMO)	OCD, DSWD, DOTr, DND
RMS 6	29	Enhance emergency response capacities of DRRM organizations	Indirect		2	2					NGA	OCD	NGOs, Private business sectors

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
RMS 7	30	Develop inter-organizational protocols and SOPs for key response functions	Indirect		1	3			Highest		NGA	OCD, PMO ERG, MMDA	Other members of NDRRMC
RMS 7	31	Establish Emergency Operations Centers	Indirect		1	3					NGA, LGUs	OCD, PMO ERG, MMDA, LGUs	
RMS 7	32	Establish guidelines for vertical evacuation during tsunami emergency	Direct		3	1					LGU	DILG, DPWH	LGU (Local Engineering Office, Building Official, LDRRMO)
RMS 7	33	Conduct community-wide earthquake evacuation exercises	Direct		3	1			Highest		LGU	LGU (LDRRMO)	DILG, OCD, CSO, NGOs, POs
RMS 7	34	Conduct community-wide tsunami evacuation exercises	Direct		3	1					LGU	LGU (LDRRMO)	DILG, OCD, CSO, NGOs, POs
RMS 9	35	Formulate evacuation plan and establish evacuation routes, signages and sites in the LGU for earthquake according to the standard set by the national government	Indirect		2	2					NGA, LGU	DILG, LGU (LDRRMO)	DOTr
RMS 9	36	Establish tsunami evacuation routes and sites	Direct		3	1		Lowest			LGU	MMDA, LGU (LDRRMO)	DOTr, DPWH, DSWD
RMS 10	37	Establish supply system of water, food, and other necessities	Indirect		2	2					NGA	DSWD	NGOs, DA, DTI, Business sector
RMS 10	38	Secure large scale water sources (e.g. water reservoirs)	Direct		2	2		Highest		Lowest	NGA, Utility service providers	MWSS, NWRB, LWUA, DPWH, NIA	
RMS 10 and 13	39	Establish local level system to accept emergency aid (both national and international)	Indirect		1	3					LGU	LGU (LSWDO, LDRRMO)	DSWD, NGOs, POs, CSOs, Private business sector
RMS 11	40	Improve government hospital capacities	Direct		1	3					NGA	DOH	LGUs, Business sector, Academe (with hospital counterparts)
RMS 12	41	Construct Laguna de Bay northern shore unloading facility	Direct	4					Lowest	Lowest	NGA	DOTr	DPWH
RMS 12	42	Establish metro-wide emergency road network	Indirect		1	3					NGA	DOTr, DPWH	DILG, DND
RMS 12	43	Establish equipment arrangements for emergency road clearing	Indirect			3	1			Lowest	NGA	DOTr, DPWH	DILG, DND
RMS 12	44	Establish emergency protocol for road-use priority between Batangas Port and Metro Manila south region	Indirect			3	1			Lowest	NGA	DOTr	DILG, DND

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
RMS 12	45	Establish emergency protocol for road-use priority between Subic-Clark to Metro Manila North region	Indirect			3	1	Lowest			NGA	DOTr	DILG, DND
RMS 12	46	Establish emergency protocol for securing Ninoy Aquino International Airport functions	Indirect			3	1	Lowest			NGA	DOTr (CAAP)	DND, DFA
RMS 13	47	Educate and train search and rescue personnel	Direct		2	2		Highest			NGA	MMDA, DILG, DND	
RMS 14 & 15	48	Educate and train personnel on information communication system for DRRM	Indirect		1	3					NGA	OCD	LGU (LDRRMO), DILG, DICT, MMDA
RMS 15	49	Establish portal for accessing GIS-hazard and managing information on disaster	Indirect	2	1	1					NGA	DOST	DICT, DILG, OCD, DENR, MMDA
RMS 16	50	Establish partnerships with media for DRRM related information	Indirect	1	2	1					NGA	DICT	PCOO, PIA, KBP, DOST, OCD

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Goal 4: Increased Community Resilience

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
CR 1	1	Develop and enhance knowledge about earthquake hazards and vulnerabilities	Direct		3	1		Highest	Highest		NGA	DOST- PHIVOLCS, OCD	LDRRMO, INGOs, CSOs, POs, DepEd, DSWD
CR 1	2	Increase community participation for community governance in DRR-CCA	Direct		2	2		Highest	Highest		LGU	LDRRMO	INGOs, CSOs, POs, DepEd, DSWD
CR 2	3	Mainstream programs that emphasize the 4 thematic areas in school curricula.	Direct	1	1	1	1	Highest	Lowest		NGA	DepEd, CHED	DSWD, LDRRMO, INGOs, CSOs, POs,
CR 2	4	Develop and enhance evacuation plans	Indirect		1	3		Highest	Highest		LGU	LDRRMO	INGOs, CSOs, PO, DILG (?)
CR 2	5	Develop capacity and enhance capability of school emergency personnel	Direct		3	1		Highest			NGA	DepEd, CHED	DSWD, DILG, LDRRMO, INGOs, CSOs, POs
CR 2	6	Include parent-teachers association in school emergency planning activities	Direct		2	2		Highest	Lowest		NGA	DepEd, CHED	DSWD, DILG, LDRRMO, INGOs, CSOs, POs
CR 2	7	Conduct periodic earthquake evacuation exercises in schools	Direct		3	1		Highest	Lowest		NGA	DepEd, CHED	DSWD, DILG, LDRRMO, INGOs, CSOs, POs

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Goal 5: Reconstruction Systems

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
RSF 1	1	Formulate temporary refugee housing plan	Indirect				4	Highest			NGA	NHA, DSWD	LGU, HUDCC, NGOs
RSF 2	2	Formulate basic policy for emergency assistance for everyday life	Indirect				4	Highest	Lowest		LGU	LGU (LSWDO)	NGOs, Pos, CSOs,
RSF 3	3	Formulate debris clearance plan for LGUs	Indirect			3	1	Lowest	Lowest		NGA, LGU	DPWH, LGU	MMDA, DILG, DOTr
RSF 4	4	Formulate basic policy for post-disaster peace and order keeping activities	Indirect			3	1	Highest	Lowest		NGA	DILG	DSWD, DOJ, LGU
RSF 4	5	Formulate basic reconstruction policies for living, housing, employment, and economic activities	Indirect				4	Lowest	Highest		NGA	NEDA, DHSUD	DSWD, DILG, DOLE, PIEP, NGOs, INGOs, LGUs,
RSF 4	6	Formulate guidelines for urban reconstruction and make a scheme of finances and credits	Indirect				4	Lowest			NGA	NEDA, DHSUD	DoF, DILG-BLGF, INGOs, NGOs (ASEP, PICE, PIEP, etc.)
RSF 6	7	Establish pre-disaster policies and institutional arrangements for post disaster reconstruction and mitigation	Both				4		Highest		NGA, LGU	NDRRMC, DILG	DPWH, DENR, DHSUD, LGU, NGOs
RSF 6	8	Prepare pre-disaster recovery plans and procedures to ease post-disaster human and physical recovery and rehabilitation	Both				4		Highest		LGU	LGU	DILG, OCD, NEDA, DPWH, NGOs, INGOs

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Goal 6: Earthquake and Tsunami Research and Development

Framework	No.	Action Plan	Impact ^a	DRRM Thematic Pillars ^b				Implementation status ^a			Main Actors	Implementers	
				P/M	P	R	Rc/Rh	LGU	NGA	CU		Primary	Supporting
R&D 1	1	Evaluate activity of the Valley Fault System	Both	4				Highest	Lowest		NGA	DOST - PHIVOLCS	Academe
R&D 1	2	Expand basic inventory on buildings and population for detail damage estimation purpose	Direct	4				Highest			NGA	DPWH	LGU (Local Engineering Office, Building Official, LDRRMO)
R&D 1	3	Promote detailed study on comprehensive earthquake disaster estimation	Direct	4							NGA	DOST - PHIVOLCS, OCD, DILG, MMDA	LGU (LDRRMO), Academe
R&D 1	4	Conduct detailed risk damage estimation using current inventory of risk elements (using Rapid Earthquake Damage Assessment System (REDAS) or similar tool)	Direct	4				Highest			NGA	DOST - PHIVOLCS	LGU (LDRRMO)
R&D 1	5	Distribute risk and damage estimate to the public	Direct	4					Highest		NGA	DOST - PHIVOLCS, NDRRMC	LGU (LDRRMO), Academe, CSO, NGOs, POs
R&D 1	6	Estimate tsunami hazards along coastal areas	Direct	4					Lowest		NGA	DOST - PHIVOLCS	LGU (LDRRMO), Academe, DENR
R&D 1	7	Assess tsunami risk along coastal areas (using Rapid Earthquake Damage Assessment System (REDAS) or similar tool)	Direct	4					Lowest		NGA	DOST - PHIVOLCS	LGU (LDRRMO), DENR

Notes:

a/ Information from perception survey

b/ Weighted categorization based on contribution to DRRM Thematic Pillars: P/M – Prevention and Mitigation; P – Preparedness; R – Response; Rc/Rh – Recovery and Rehabilitation

Appendix 2. Workshop, Meeting, and Survey Participants

FIRST WORKSHOP TO DEVELOP THE GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY (GMMEIRS)	
May 24–25, 2018 Makati Palace Hotel, Makati City	
Facilitators:	
Director Susana G. Juangco	OCD
Ishmael C. Narag	DOST-PHIVOLCS
Mabelline Cahulogan	DOST-PHIVOLCS
Charmaine V. Villamil	DOST-PHIVOLCS
Robin E. Lim	DILG
Rose Ann S. Tierra	OCD
Alyssa Aimee S. Batle	OCD
Secretariat:	
Dominique B. Towanna	OCD
Malonda Gulmatico	OCD
Local Government Units:	
Ronnel L. Santos	Bulacan PDRRMO
Nerissa T. Bautista	Bulacan PDRRMO
Alex P. Nadurata	Caloocan City DRRMO
Julius A. Baylon	Caloocan City DRRMO
Alejandro S. dela Merced	Las Piñas City DRRMO
Paul Jay D. Gordove	Las Piñas City DRRMO
Irene G. Gapay	Makati City DRRMO
Giovanni Antonius S. Reyes	Malabon City DRRMO
Mark Lawrence P. Peralta	Mandaluyong City DRRMO
Antonio C. Panelo	Mandaluyong City DRRMO
Daryl Tesoro	Mandaluyong City CPDO
Vonne B. Villanueva	Navotas City DRRMO
Angelica Louise P. Perez	Navotas City DRRMO
Dianne G. Mora	Navotas City DRRMO
Beam Joseph Arada	Pampanga PDRRMO
Jose C. Amian	Parañaque City CPDO
Zareena Trixia I. Lambarte	Parañaque City DRRMO
Rene Luis R. Ipac	Pasay City CPDO
James Joaquin M. Santos	Pasay City DRRMO
Ruth Anne V. Salimbangon	Pasay City DRRMO
Juan Carlos G. Jabson	Pasig City DRRMO
Enecito T. Lamanilao	Pateros DRRMO
Marko S. Pielago	Pateros DRRMO
Bianca D. Perez	Quezon City DRRMO
Erwin Carlos N. Valdez	Quezon City DRRMO
Jade Ashley R. Maclalad	Quezon City DRRMO
Honorio S. Mateo	Rizal PDRRMO
Bryant Q. Wong	San Juan City DRRMO
Stephanie Joy L. Yao	San Juan City DRRMO

Erwin Nino C. Palima	Taguig City DRRMO
Glenn Mark P. Lanozo	Valenzuela City DRRMO
Michelle B. Bajaro	Valenzuela City DRRMO

SECOND WORKSHOP TO DEVELOP THE GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY (GMMEIRS)	
January 15–16, 2019	
Madison 101 Hotel + Tower, Quezon City	
Facilitators:	
Alyssa Aimee S. Batle	OCD
Rose Ann S. Tierra	OCD
Robert G. Padillo	OCD
Robin E. Lim	DILG
Charmaine V. Villamil	DOST-PHIVOLCS
Jeffrey S. Perez	DOST-PHIVOLCS
Ishmael C. Narag	DOST-PHIVOLCS
GMMEIRS Researchers and Technical Writers:	
Abelyn V. Bunagan	
Kenneth D. Gesmundo	
Miguel M. Pilarta	
Genevieve Q. Villanueva	
Secretariat:	
Domingo L. Leoncio III	OCD
Teresita dela Rosa	OCD
National Government Agencies:	
Jeni Rose T. Lee	BFP
Maria Angelyn Therese B. Omamalin	BFP
Jaime N. Aquino, Jr.	CHED
Perla I. Gines	DA
Arron Luccus B. Herbon	DA
Francis Rci S. Javier	DBM
Liza Socorro J. Manzano	DENR-MGB
Marywil Krystal Cabahug	DENR-MGB
Ed Yulo	DFA
Ricardo A. Buston	DICT
Aries Diaz	DILG
Arnel C. Antonio	DOE
Magnolia B. Olvido	DOE
Francis Raize Nicholas L. Bautista	DOH
Irvin Miranda	DOH
Encar Marie T. Ilao	DOTr
Eduardo S. Cayetano	DOTr
Noel M. Fallaria	DPWH
Ernie Leo C. Laput	DPWH
Aubrey A. Bautista	DSWD

Hillary Mary N. Ratilla	DSWD
Elsie D. Raquino	DTI-CPAB
Marie Claire Tiglao	DTI-CPAB
Ana Liza Mirada	HUDCC
Noreen may A. Elaydo	MMDA
Aldo R. Mayor	MMDA
Germaine Fay M. Ramirez	MMDA
Ryan James V. Ayson	MWSS
Ma. Paz L. Montano	NAMRIA
Pinky T. De Chavez	NAMRIA
Quintin Dwight G. de Luna	NEDA
William Sese	NEDA
Nestor S. Guinto, Jr.	NHA
Abigail Ann A. Cadores	NHA
Rosario Gerard Salcedo	NHA
Gilbert H. Conde	OCD
Jacqueline Manara	OCD
Emma Paulina Hernandez	OCD
Princess Duque	PCOO
Fe Emelle Padillo	PCOO
Rodette L. Aguila	PCOO
PSupt Johnny I. Capalos	PNP
Kathleen Rose A. Nava	TESDA
Christian C. Apulog	TESDA
Erwen S. Dimploma	505 SRG
LTC Roque D. Dupa (CE) PA	525 ECB

THIRD WORKSHOP TO DEVELOP THE GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY (GMMEIRS)	
March 21–22, 2019	
Madison 101 Hotel + Tower, Quezon City	
Facilitators:	
Joe-Mar S. Perez	OCD
Robert G. Padillo	OCD
Alyssa Aimee S. Batle	OCD
Rose Ann S. Tierra	OCD
Jeffrey S. Perez	DOST-PHIVOLCS
Arturo Daag	DOST-PHIVOLCS
Charmaine V. Villamil	DOST-PHIVOLCS
Maria Isabel T. Abigania	DOST-PHIVOLCS
Aries Diaz	DILG
GMMEIRS Researchers and Technical Writers:	
Abelyn V. Bunagan	
Kenneth D. Gesmundo	
Miguel M. Pilarta	
Genevieve Q. Villanueva	

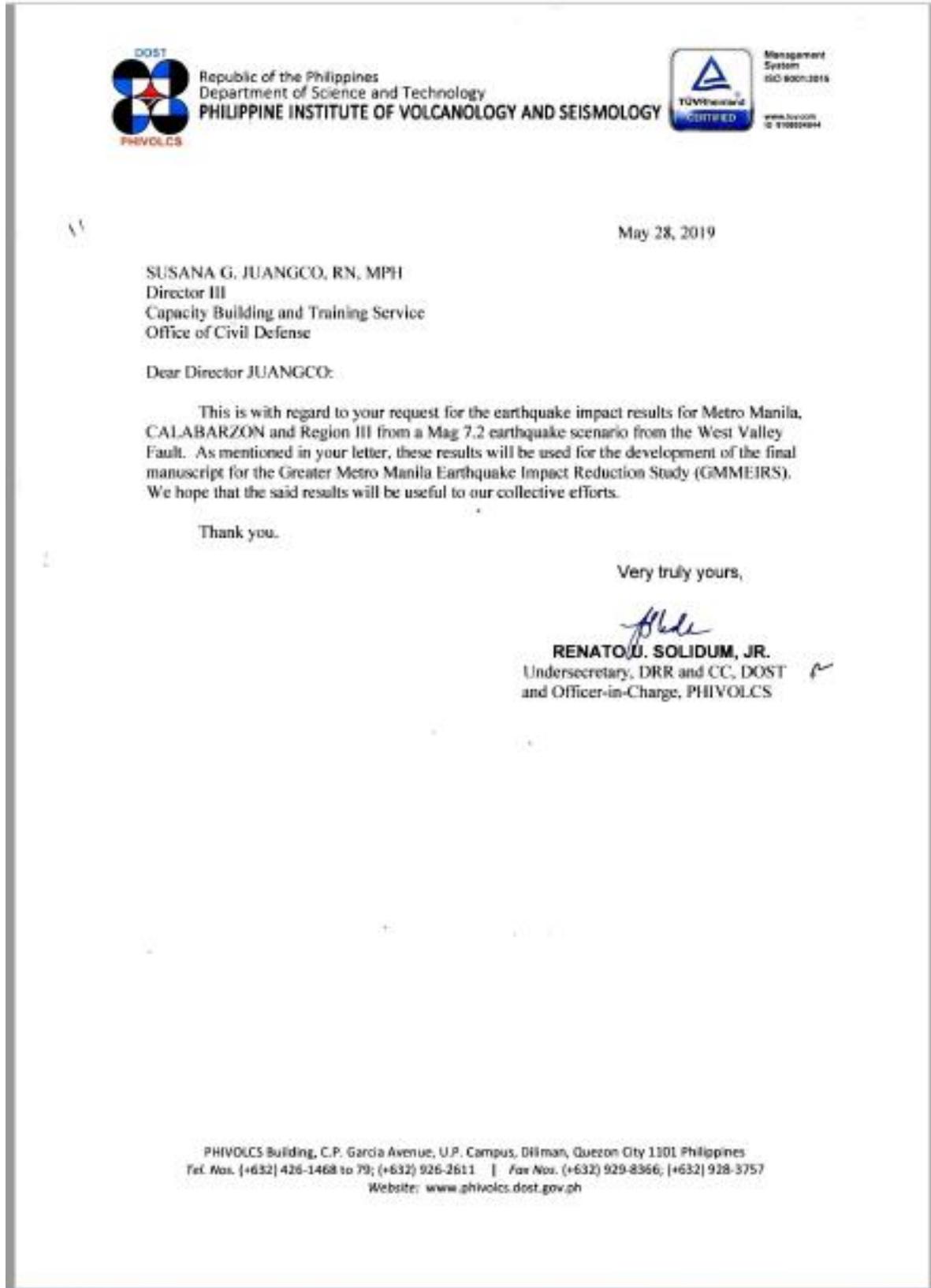
Secretariat:	
Teresita dela Rosa	OCD
Critical Utility Companies:	
Rodrigo Rebello Jr.	CDA
Severino B. Reyes III	DOH
Francis Raize Nicholas L. Bautista	DOH
Isabelito P. delos Santos Jr.	Globe Telecom
Isagani C. Custodio	Globe Telecom
Jimmy Chua	LRTA
Carnilo Orevillo	LWUA
Antonio M. Abuel Jr.	MERALCO
Jose Rafael C. Atienza	MERALCO
Enrique B. Flores	MERALCO
Efren V. Olpindo	MERALCO
Enrico G. Velgado	NEA
Garizaldy E. Bontile	NFA
Christian M. Empasis	NGCP
Roger S. Dormido Jr.	NAPOCOR
Jesusa B. Lee	NTC
Ruben Valeros	NTC
Milan M. Topacio	PLDT/Smart Communications, Inc.
Carl M. Nohay	PNRI
Rolando Y. Reyes	PNRI

FOCUS GROUP DISCUSSION TO DEVELOP THE GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY (GMMEIRS)	
June 11, 2019	
Media Briefing Room, First Floor, New NDRRMC Building, Camp General Emilio Aguinaldo, Quezon City	
Facilitators:	
Director Susana G. Juangco	OCD
Joe-Mar S. Perez	OCD
Robert G. Padillo	OCD
Technical Working Group:	
Jeffrey S. Perez	DOST-PHIVOLCS
Erlinton Olavere	DOST-PHIVOLCS
Robin E. Lim	DILG
GMMEIRS Researchers and Technical Writers:	
Abelyn V. Bunagan	
Kenneth D. Gesmundo	
Miguel M. Pilarta	
Genevieve Q. Villanueva	
Other Agencies:	
Jemrose T. Lee	BFP

Jill J. Jaime	DOH
Encar Marie T. Ilao	DOTr
Noel M. Fallaria	DPWH
William Sese	NEDA

FOLLOW-UP MEETINGS TO DEVELOP THE GREATER METRO MANILA EARTHQUAKE IMPACT REDUCTION STUDY (GMMEIRS)	
November to December 2019	
Media Briefing Room, First Floor, New NDRRMC Building, Camp General Emilio Aguinaldo, Quezon City	
GMMEIRS Researchers and Technical Writers:	
Abelyn V. Bunagan	
Ma. Criscia D. Alonte	
Representatives from Participating Agencies and Organizations:	
Prof. Antonia Yulo-Loyzaga	Manila Observatory (Nov.15, 2019)
Bianca Perez	Quezon City DRRMO (Nov.18, 2019)
Anthony Zuñiga	Philippine Disaster Resilience Foundation (Nov. 28, 2019)
Arvin Caro	
Veronica Gabaldon	
Undersecretary Renato U. Solidum , Jr.	DOST-PHIVOLCS (Dec. 3, 2019)
Mabelline T. Cahulogan	
Arturo S. Daag	
Jeffrey Perez	
Charmaine Villamil	Laguna PDRRMO (Dec. 12, 2019)
Aldwin M. Cejo	

Appendix 3. Risk Estimates for Metro Manila, CALABARZON, and Region III





**Earthquake Impact Assessment Results
for Metro Manila, CALABARZON and Region III**

The following presents the scenario used, results obtained and explanation as to the contents of results:

I: Earthquake parameters used in the calculations:

Mag 7.2; Depth 5km, Epicenter 121.0705 E Long, 14.5835 N Lat, along the West Valley Fault

II: The following summarizes the earthquake impact results:

a) Earthquake Impact Assessment for Metro Manila using RAP data (2014)

MUNICIPALITY/CITY	Floor Area (sqm)					Economic Loss (Millions PHP)	Casualties			
	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Collapse		Slight Injuries	Non-life-threatening Injuries	Life-threatening Injuries	Fatalities
CALOCAN	3479808	5232422	4087406	5072035	625858	119027	42943	12662	1900	1711
LAS PIÑAS	1888996	3036596	2420619	2990543	405259	70416	19647	5902	869	1695
MAKATI	2239291	4293650	4261378	6223447	618800	234346	15806	4913	784	1543
MALABON	1012122	1678251	1477221	1960091	227640	41751	10454	3139	461	899
MANDALUYONG	1159782	2083208	1912450	2249883	253941	76352	10383	3083	441	836
CITY OF MANILA	4010957	8103927	9825526	11969904	1305187	400031	63456	19213	2864	5595
MARIKINA	1214505	2396756	2707179	4002510	548329	87926	18507	5717	876	1716
MUNTINLUPA	1718660	3020253	2877865	3845083	476438	101281	18350	4925	689	1334
NAVOIAS	394736	707097	709675	1016582	117412	20429	9399	2798	393	782
PANAPANAGUE	2897909	4893277	4307947	5249340	683479	121292	29209	5785	805	1689
PASAY	1096852	2129076	2479783	3042884	368315	100485	14071	4343	675	1324
PASIG	2213476	4156819	4708861	6922002	856014	190686	25845	8029	1248	2448
PATEROS	83341	187761	222650	472378	58103	7263	2759	940	126	245
QUEZON CITY	11049940	17663877	14187637	15434994	1997223	449234	78574	22757	3291	6410
SAN JUAN	699746	1156132	951902	920029	114219	31760	1812	1341	174	340
TAGUIG	2014722	3173491	3300500	4544379	532398	118643	30022	9021	1300	2528
VALENZUELA	5321678	4786840	3073894	2633501	356300	87908	18205	4826	695	1353
GRAND TOTAL	64804993	78074262	70490680	89089537	11052845	2472785	467873	140590	21019	41994

b) Earthquake Impact Assessment for Metro Manila using PSA data (2010)

MUNICIPALITY/CITY	Number of Buildings					Economic Loss (Millions PHP)	Casualties			
	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Collapse		Slight Injuries	Nonlife-Threatening Injuries	Life-Threatening Injuries	Fatalities
CALOOCCAN	9640	64970	49962	67774	5932	34239	43647	21793	1394	2182
LAS PIÑAS	13055	24798	28502	30222	2375	48785	17085	4677	633	1239
MAKATI	7609	14658	17230	19983	1827	49963	10431	5168	720	1445
MANABON	10924	15529	14948	12580	1023	15034	7973	1949	258	520
MANDALUYONG	6833	12539	12968	13758	1379	21683	10465	2923	417	833
CITY OF MANILA	31449	47931	49843	46386	4649	79140	66220	11760	1546	3389
MARINA	8952	16692	18978	20192	1784	34137	14149	3996	538	1062
MUNTINLUPA	9123	13297	19799	23117	1891	34082	14230	3957	549	1073
NAVOTAS	9552	14826	13818	10365	881	78286	2887	749	91	191
PALAŀAQUE	13399	25865	30404	34200	3001	59098	19461	5434	758	1508
PASAY	7440	12342	14053	15228	1336	23013	12665	3402	473	1004
PANG	12394	23500	28973	33386	3294	51813	24599	8955	978	1953
PATEROS	1413	2592	3134	3899	368	4323	2324	644	89	182
QUEZON CITY	62178	87170	94853	200226	15163	207930	137278	38219	4894	9654
SAN JUAN	2094	2570	4020	4290	427	10774	3945	1103	157	338
TAGUIG	11962	22827	27361	33462	2898	42410	21849	8099	845	1698
VALENZUELA	13804	22838	21971	17732	1538	32992	15788	3627	480	950
GRAND TOTAL	254340	429024	476970	582780	58124	882530	488518	112382	15696	30295

c) Earthquake Impact Assessment for Region III using PSA data (2010)

PROVINCE	Number of Buildings					Economic Loss (Million PHP)	Casualties			
	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Collapse		Slight Injuries	Nonlife-Threatening Injuries	Life-Threatening Injuries	Fatalities
AURORA	1257	306	46	3	0	232	0	0	0	0
BATAAN	24098	12150	3078	586	26	6650	437	9	0	0
BULACAN	105958	141616	108419	89503	5613	145669	48937	11670	1378	2529
NUEGA ECIA	57578	27595	7384	1431	82	34294	592	70	0	8
PAMPANGA	37966	84260	21944	5670	399	40600	5111	590	24	96
TARLAC	25845	8094	1319	167	1	5103	68	0	0	0
ZAMBALES	5572	1098	112	8	0	1142	2	0	0	0
GRAND TOTAL	318246	256037	142362	77372	6323	219980	54647	12339	1402	3013

d) Earthquake Impact Assessment for Region IV (CALABARZON) using PSA data (2010)

PROVINCE	Number of Buildings					Economic Loss (Millions PHP)	Casualties			
	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage	Collapse		Slight Injuries	Nonlife-Threatening Injuries	Life-Threatening Injuries	Fatalities
BATANGAS	101098	60599	23300	6172	370	35089	4323	496	29	92
CAVITE	101706	154933	138030	105775	8605	224970	83924	16053	1944	4093
LAGUNA	101347	118518	90754	67228	5493	146897	40496	10152	1263	2588
QUEZON	34064	15183	3886	861	27	8234	338	10	0	0
RIZAL	82645	117524	101370	77763	6513	144520	48914	12668	1635	3283
GRAND TOTAL	421360	672799	357948	257603	21068	566130	158015	30183	4873	10953

2

III. Definition of Damage

D1. Slight damage state- hairline cracks on concrete or masonry walls, unnoticeable to no damage on wooden structures, hairline cracks on few welds and minor deformations on connections for steel structures.

D2. Moderate damage state- criss-crossing hairline cracks on concrete walls, tightening or loosening of door and window frames, cracks in bolts and enlarged boltholes for steel structures

D3. Extensive damage state- spalling or flaking of columns, flexural cracks on beams of concrete structures, damage on corners of wooden structures, heavy damage on walls of CHB structures, buckling and large cracks on welds of flange-web connections broken bolts for steel structures

D4. Complete damage without collapse state- heavily damaged main structural supports but the structure is still standing and may have an impending collapse

D5. Complete damage with collapse state- structure is flattened or has toppled to the ground, significant permanent displacement of walls with respect to the vertical

IV: Definition of Casualty Levels:

S1: Slight injuries- abrasions, severe cut requiring stitches, injuries requiring basic medical aid, minor burn, bump on the head without loss of consciousness

S2: Non-Life-Threatening injuries- Injuries requiring a greater degree of medical care, third degree burns or second degree burns on large parts of the body, fractured bone, loss of consciousness, dehydration

S3: Life-Threatening injuries- uncontrolled bleeding, punctured organ, spinal injuries, crush syndrome and other injuries that pose immediate life-threatening condition if not treated immediately

S4: Fatalities- instantaneous death or mortally injured during the main shock.

V: Explanation:

- Ground shaking was simulated using an epicenter along the West Valley Faults from a Mag 7.2 earthquake.
- For Metro Manila, two sets of exposure database were used: one inferred from the 2010 census data and the other inferred using land use mapping method developed under the Risk Analysis Project (RAP, 2014). It will be noticed that the use of the RAP-derived exposure database yielded a higher value.
- For both Region III and CALABARZON, the exposure database used were based on the 2010 national census data. For this type of exposure data, the building types were inferred from statistical building types based on previous surveys using wall and roof material combination and floor area. The population was derived from the household population from the same census data. The use of the census 2010 data for the three areas of interest was resorted to in order for users to be able to compare the impacts from the same Mag 7.2 scenario.
- Damage and Casualty descriptions were adopted from HAZUS.
- Earthquake impacts were done using the PHIVOLCS REDAS Software version 2.9h.

VI: Disclaimer:

The results are indicative and may be improved should impact-ready exposure data become available and are used. The availability and use of more detailed information on earthquake source zone characteristics and local ground conditions which may affect site simplification during ground shaking may also improve accuracy of results.

Requested by: OCD

Date Request Received: May 16, 2019

Prepared by:  Clint Drexel Ongue (Science Research Specialist, PHIVOLCS-DOST)

Reviewed by:  R. Javier (Science Research Specialist, PHIVOLCS-DOST)

Noted by:  Maria Leonila P. Bautista (Associate Scientist, DOST-PHIVOLCS)

Appendix 4. Survey Questionnaires from Workshops 1-3

Workshop 1 (Goals 1, 5, and 6)

QUESTION	YES	NO	COMMENTS
1. Do you regularly update the Earthquake Emergency Plan for Malacañang Palace and other Government Offices?			
2. Do you regularly conduct an earthquake emergency evacuation drill for Malacañang Palace and other Government Offices?			
3. Did you develop in-house earthquake emergency services skills of teams?			
4. Do you provide basic earthquake emergency skills to all your staff?			
5. Do you assess and improve the integrity of Malacañang Palace and other Government Offices against earthquake and fire hazards?			
6. Do you promote earthquake- and fire-resistant area surrounding Malacañang Palace?			
7. Do you promote earthquake- and fire-resistant area surrounding Malacañang Palace?			
8. Do you assess and improve integrity of Business and Commercial buildings against earthquakes and fire hazards?			
9. Do you implement back-up systems, back-up sites, or mirror sites for data security during earthquake and fire emergency with recovery time objective specified?			
10. Do you deconcentrate business operations to strategically located sub-office?			
11. Do you establish measures to stabilize exchange rates and prices of commodities after earthquake disasters?			
12. Do you establish transfer mechanisms for foreign disaster aid?			
13. Do you emplace local emergency loan and disaster reconstruction fund into (banking) system?			
14. Do you regularly update the Earthquake Emergency Plan for Malacañang Palace and other Government Offices?			

Goal 5: Reconstruction Systems

QUESTION	YES	NO	COMMENTS
1. Do you formulate temporary emergency shelter plans?			
2. Do you formulate basic policy and plan for emergency daily assistance for affected population?			
3. Do you formulate debris management plan of the LGUs?			
4. Do you formulate policy and plan for post-disaster peace and order?			
5. Do you formulate basic reconstruction policies for living, housing, employment and economic activities?			
6. Do you formulate guidelines for urban reconstruction and scheme for financing and credits?			
7. Do you establish pre-disaster policies and institutional arrangements for post-disaster reconstruction and mitigation?			
8. Do you prepare pre-disaster recovery plans and procedures to ease post-disaster human and physical recovery and rehabilitation?			

Goal 6: Earthquake and Tsunami Resilience Research and Development

QUESTION	YES	NO	COMMENTS
1. Do you evaluate earthquake potential of the Valley Fault System?			
2. Do you evaluate earthquake and tsunami potential of Manila Trench?			
3. Do you maintain a current inventory of risk elements?			
4. Do you conduct detailed risk and damage estimation using current inventory of risk elements (using rapid earthquake damage assessment system (REDAS) or similar tool)?			
5. Do you distribute risk and damage estimates to the public?			
6. Do you estimate tsunami hazards along coastal areas?			
7. Do you assess tsunami risk along coastal areas (using rapid earthquake damage assessment system (REDAS) or similar tool)?			
8. Do you establish tsunami warning systems?			
9. Do you install tsunami hazard markers (example tsunami inundation and wave height)?			
10. Do you establish tsunami evacuation routes and sites?			
11. Do you educate communities on Tsunami Warning System?			
12. Do you establish guidelines for vertical evacuation during tsunami emergency?			
13. Do you conduct community-wide earthquake and tsunami evacuation exercises?			
14. Do you conduct earthquake and tsunami evacuation exercises in coastal schools?			

Updates on the Action Plans from the MMEIRS

In 2002 to 2004, the Metro Manila Development Authority (MMDA) and the Philippine Institute of Volcanology and Seismology (PHIVOLCS), supported by the Japan International Cooperation Agency (JICA), conducted a comprehensive assessment and evaluation of earthquake hazards and risks that may potentially affect Metro Manila. The results of that endeavor were published in a volume set, called the Master Plan for Earthquake Impact Reduction Study for Metropolitan Manila (MMEIRS) in 2004.

The document was, and still remains, a landmark, first-of-its kind document in the Philippines, that defined a vision and the road leading to that end. It contained six (6) goals that translated logically into 10 objectives, 34 frameworks, and 105 action plans. Of the latter, 40 were selected to be high-priority action plans that were to be implemented in the short and medium-term.

MMEIRS serves as a primary resource for developing disaster risk reduction and management plans by national agencies, local governments, and even private and non-government organizations. Its usefulness is attested by the continued reference to this document in relation to describing and addressing the threat of an earthquake in the biggest metropolis of the nation.

The Philippines has experienced several damaging earthquakes in different regions and there are new knowledge gained from each event. As PHIVOLCS implements more research on the earthquake phenomena and their impacts, new earthquake information (such as Risk Analysis Project in 2014) are generated that are essential in informing a more relevant and responsive earthquake master plan. Now on its 17th year since publication and the need to prioritize the preparations for the major threat that the country faces: the 7.2 Magnitude Earthquake of the West Valley Fault (WVF), it is proposed during the Third Inter-Agency Resiliency Team Meeting that the Master Plan be revisited with the end view of making it reflective of current situation and needs.

In this regard, the OCD, with the technical support from the DOST-PHIVOLCS, and other relevant stakeholders shall lead to conceptualize and develop the Greater Metro Manila Earthquake Impact Reduction Study (GMMEIRS). The status of the Action Plans in the MMEIRS in relation to the actual reduction of the impacts reported by the National Government Agencies through a workshop will be done. Assessing the status of the Action Plans will provide the necessary input from which estimates of the impact reduction since the publication of the MMEIRS on 2004 may be gauged.

* Required

I. Earthquake-Resilient National Systems

1. Develop and enhance National/Regional/Local Government continuity plan *

- Yes
- No
- Partial
- Not Applicable

If yes or partial, provide Means of Verification. If no, explain. *

Your answer

Prioritization *

- High priority
- Medium priority
- Low priority

2. Regular conduct of emergency evacuation drills for N/R/L government offices *

- Yes
- No
- Partial
- Not Applicable

If yes or partial, provide Means of Verification. If no, explain. *

Your answer

Workshop 3 Water Utility

A	B	C	D	E	F	G
Identification of Updates on the MMEIRS Action Plans and Other Initiatives: Water Utility						
<p>On identifying prioritization: Contribution: Do the action plans contribute significantly to accomplishment of goals and objectives? Appeal: Do the action plans appeal to common sense? Do they obviously reduce earthquake risk? Support: Are the action plans supported by the organization(s) required for the implementation? Practicability: Are the action plans easy to implement? Do they appear to be cost-effective? Are they politically and technically practical to implement? Sustainability: Are the action plans sustainable?</p>						
ACTION PLAN	MEANS OF VERIFICATION <i>(If yes or partial, please provide the Means of Verification. If no, please explain.)</i>	PRIORITIZATION				
Goal 1: Earthquake Resilient National Systems		Contribution				
1. Do you develop and enhance business/service continuity plan?		Appeal		0	LOW	
		Support				
		Practicability				
		Sustainability				
2. Do you develop back-up systems, back-up sites, or mirror sites for business/service continuity during earthquake and fire emergency with RECOVERY TIME OBJECTIVE specified?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
3. Do you implement back-up systems, back-up sites, or mirror sites for business/service continuity during earthquake and fire emergency with RECOVERY TIME OBJECTIVE		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
4. Do you regularly conduct emergency evacuation drills for your offices?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
5. Do you deconcentrate business operations to strategically located sub-office?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
6. Do you establish transfer mechanisms for foreign disaster aid?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
Goal 2: Earthquake Resilient Urban Structures		Contribution		0	LOW	
1. Do you develop earthquake emergency operation team and support system for lifeline?		Appeal				
		Support				
		Practicability				
		Sustainability				
2. Do you develop lifeline earthquake emergency operation manual with RECOVERY TIME OBJECTIVE specified?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
3. Do you develop lifeline facility reconstruction plan with RECOVERY TIME OBJECTIVE specified?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
4. Do you conduct regular emergency operation exercise for lifeline with RECOVERY TIME OBJECTIVE specified?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
5. Do you introduce and use earthquake-resistant water distribution pipes?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				
		Sustainability				
Goal 3: Enhanced Risk and Emergency Management		Contribution		0	LOW	
1. Do you update mainstreamed approved sectoral (e.g. infrastructure) development plan?		Appeal				
		Support				
		Practicability				
		Sustainability				
2. Do you use recent protocols, guidelines, and checklist on disaster prevention and mitigation, preparedness, and response?		Sustainability		0	LOW	
		Contribution				
		Appeal				
		Support				
		Practicability				
		Sustainability				
3. Do you evaluate disaster preparedness plans?		Contribution		0	LOW	
		Appeal				
		Support				
		Practicability				

5. Do you cascade plans to the 46 local water districts in Bulacan, Cavite, Laguna, and Rizal?	Contribution Appeal Support Practicability Sustainability	0	LOW	
6. Do you cascade plans to Regions I, II, and V who would be the first responders in the event of the WVF earthquake?	Contribution Appeal Support Practicability Sustainability	0	LOW	
7. Do you include budget on the proposed fund to serve as subsidy for local water districts that need to be assisted in the plans?	Contribution Appeal Support Practicability Sustainability	0	LOW	
8. Do you look into the possibility of injecting flood water back to the aquifer?	Contribution Appeal Support Practicability Sustainability	0	LOW	
9. Do you conduct a structural integrity study on the Ipo and La Mesa dams?	Contribution Appeal Support Practicability Sustainability	0	LOW	
10. Do you coordinate on the acquisition of sites for water reservoirs, including the provision of emergency water reservoir in critical facilities (i.e. hospitals)?	Contribution Appeal Support Practicability	0	LOW	
11. Do you submit the specific locations of the 60 reservoirs of Maynilad and MWCI?	Contribution Appeal Support Practicability Sustainability	0	LOW	
12. Do you consider the establishment of additional water supply facilities (e.g. dams, tunnels, aqueducts, treatment plant)?	Contribution Appeal Support Practicability Sustainability	0	LOW	
13. Do you water recovery plan: scarce water within the first three (3) days following a major WVF movement due to the probable breakage of dams and/or supply lines; two (2) weeks to repair the	Contribution Appeal Support Practicability Sustainability	0	LOW	
14. Do you tighten and firm-up the arrangement involving the activation of substitute personnel to operate mobile water treatment plants through the signing of an agreement	Contribution Appeal Support Practicability	0	LOW	

Appendix 5. Workshop Results for Action Plans Accomplishment

Goal 1: Earthquake-Resilient National Systems									
NSD-1 Protect stability of national government functions									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	8	47	0	0	2	12	7	41
	NGA	9	38	10	42	4	17	1	4
	CU	10	71	2	14	2	14	0	0
Action Plan 2	LGU	11	65	0	0	0	0	6	35
	NGA	18	75	5	21	1	4	0	0
	CU	1	100	0	0	0	0	0	0
Action Plan 3	LGU	11	65	0	0	0	0	6	35
	NGA	13	54	7	29	3	13	1	4
Action Plan 4	LGU	11	65	0	0	0	0	6	35
	NGA	16	67	5	21	3	13	0	0
Action Plan 5	LGU	9	53	0	0	1	6	7	41
	NGA	17	71	3	13	2	8	2	8
Action Plan 6	LGU	6	38	0	0	0	0	10	63
	NGA	11	46	6	25	4	17	3	13
	CU (CBRN)	0	0	0	0	1	50	1	50
	CU (CBRN)	1	50	0	0	0	0	1	50
	CU (CBRN)	1	50	0	0	0	0	1	50
	CU (CBRN)	1	50	0	0	0	0	1	50

Action Plan 7	LGU	13	87	0	0	0	0	2	13
	NGA	10	42	4	17	2	8	8	33
	CU (Transportation, CBRN, Hospitals)	0	0	1	100	0	0	0	0
	CU (Transportation, CBRN, Hospitals)	1	100	0	0	0	0	0	0
	CU (Transportation, CBRN, Hospitals)	0	0	0	0	1	50	1	50
	CU (Transportation, CBRN, Hospitals)	0	0	0	0	0	0	2	100
	CU (Transportation, CBRN, Hospitals)	0	0	1	100	0	0	0	0
	CU (Transportation, CBRN, Hospitals)	0	0	0	0	0	0	1	100
	CU (Transportation, CBRN, Hospitals)	1	100	0	0	0	0	0	0
	CU (Transportation, CBRN, Hospitals)	0	0	0	0	0	0	1	100
Action Plan 8	LGU	13	87	0	0	0	0	2	13
	NGA	11	46	7	29	3	13	3	13
Action Plan 9	LGU	5	31	0	0	6	38	5	31
	NGA	11	46	7	29	4	17	2	8
	CU (Power, food and business, telecom, water)	7	70	2	20	1	10	0	0
	CU (Power, food and business, telecom, water)	5	50	3	30	2	20	0	0
NSD-2 Protect stability of socioeconomic systems									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 10	LGU	4	27	0	0	3	20	8	53

	NGA	11	46	3	13	2	8	8	33
	CU (All)	9	64	2	14	1	7	2	14
	CU (All)	0	0	0	0	0	0	1	100
Action Plan 11	LGU	3	20	0	0	2	13	10	67
	NGA	4	17	2	8	1	4	17	71
	CU (Food and Business)	0	0	0	0	1	50	1	50
	CU (Food and Business)	0	0	0	0	1	50	1	50
Action Plan 12	LGU	3	20	0	0	3	20	9	60
	NGA	3	13	0	0	2	8	19	79
	CU (All)	6	46	0	0	4	31	3	23
	CU (All)	1	100	0	0	0	0	0	0
Action Plan 13	LGU	4	29	0	0	3	21	7	50
	NGA	2	8	1	4	3	13	18	75
Goal 2: Earthquake-Resilient Urban Structures									
USI-1 Promote earthquake-resistant urban development									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 1	LGU	12	71	0	0	3	18	2	12
	NGA	6	25	2	8	4	17	12	50
Action Plan 2	LGU	15	88	0	0	1	6	1	6
	NGA	6	25	4	17	5	21	9	38
Action Plan 3	LGU	11	65	0	0	1	6	5	29

	NGA	8	33	2	8	0	0	14	58
Action Plan 4	LGU	6	35	0	0	2	12	9	53
	NGA	1	4	0	0	2	8	21	88
Action Plan 6	LGU	11	69	0	0	1	6	4	25
	NGA	6	25	0	0	2	8	16	67
USI 2-Promote flameproof urban development									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 7	LGU	13	81	0	0	1	6	2	13
	NGA	9	38	0	0	2	8	13	54
Action Plan 8	LGU	7	44	0	0	5	31	4	25
	NGA	9	38	2	8	0	0	13	54
	CU (CBRN)	1	50	0	0	0	0	1	50
Action Plan 9	LGU	11	65	0	0	1	6	5	29
	NGA	13	54	5	21	1	4	5	21
	CU (Hospital)	1	100	0	0	0	0	0	0
Action Plan 10	LGU	14	82	0	0	0	0	3	18
	NGA	8	33	2	8	1	4	13	54
	CU (Hospital)	0	0	1	100	0	0	0	0
	CU (Hospital)	1	100	0	0	0	0	0	0
Action Plan 11	LGU	5	31	0	0	2	13	9	56

Action Plan 12	LGU	9	56	0	0	2	13	5	31
	NGA	3	13	3	13	1	4	17	71
Action Plan 13	LGU	15	94	0	0	0	0	1	6
	NGA	16	67	1	4	2	8	5	21
Action Plan 14	LGU	13	81	0	0	0	0	3	19
	NGA	7	29	3	13	0	0	14	58
Action Plan 22	LGU	6	38	0	0	0	0	10	63
	CU (CBRN)	0	0	0	0	0	0	2	100
USI-3 Promote spatial urban development									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 5	LGU	10	59	0	0	1	6	6	35
	NGA	5	21	3	13	1	4	15	63
USI-4 Promote earthquake-resistant buildings									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 15	LGU	2	13	0	0	5	31	9	56
Action Plan 16	LGU	4	25	0	0	1	6	11	69
Action Plan 17	LGU	4	25	0	0	2	13	10	63
Action Plan 18	LGU	5	31	0	0	2	13	9	56

Action Plan 19	LGU	8	50	0	0	1	6	7	44
	NGA	2	8	0	0	1	4	21	88
Action Plan 20	LGU	8	50	0	0	0	0	8	50
	NGA	1	4	2	8	1	4	20	83
Action Plan 21	LGU	7	44	0	0	1	6	8	50
	NGA	0	0	0	0	1	4	23	96
USI-5 Promote earthquake-resistant public facilities									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 23	LGU	7	44	0	0	1	6	8	50
	NGA	5	21	2	8	2	8	15	63
Action Plan 24	LGU	7	44	0	0	2	13	7	44
	NGA	0	0	0	0	2	8	22	92
Action Plan 25	LGU	8	50	0	0	1	6	7	44
	NGA	1	4	1	4	3	13	19	79
	CU (CBRN)	1	50	0	0	0	0	1	50
Action Plan 26	LGU	5	31	0	0	2	13	9	56
	NGA	1	4	2	8	3	13	18	75
USI-6 Promote earthquake-resistant infrastructure									

		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 27	LGU	3	19	0	0	2	13	11	69
	NGA	4	17	0	0	1	4	19	79
	CU (Transportation)	1	100	0	0	0	0	0	0
Action Plan 28	LGU	2	13	0	0	2	13	12	75
	NGA	3	13	1	4	1	4	19	79
	CU (Transportation)	1	100	0	0	0	0	0	0
Action Plan 29	LGU	3	19	0	0	2	13	11	69
	NGA	2	8	3	13	1	4	18	75
	CU (Transportation)	0	0	0	0	1	100	0	0
Action Plan 30	LGU	1	6	0	0	0	0	15	94
	NGA	1	4	1	4	1	4	21	88
	CU (Transportation)	0	0	0	0	0	0	1	100
	CU (Transportation)	0	0	0	0	0	0	1	100
USI-7 Promote earthquake-resistant lifeline									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 31	LGU	7	44	0	0	2	13	7	44
	NGA	6	25	4	17	3	13	11	46
	CU (All)	8	57	4	29	1	7	1	7
Action Plan 32	LGU	14	82	0	0	1	6	2	12
	NGA	9	38	4	17	1	4	10	42

	CU (All)	11	85	1	8	1	8	0	0
Action Plan 33	LGU	8	47	0	0	1	6	8	47
Action Plan 34	LGU	8	50	0	0	5	31	3	19
	NGA	2	8	6	25	2	8	14	58
Action Plan 35	LGU	9	56	0	0	3	19	4	25
	NGA	4	17	5	21	4	17	11	46
	CU (All)	8	57	2	14	3	21	1	7
Action Plan 36	LGU	4	25	0	0	1	6	11	69
	NGA	0	0	1	4	2	8	21	88
	CU (Water)	0	0	0	0	1	100	0	0
Action Plan 37	LGU	1	7	0	0	2	13	12	80
	NGA	1	4	1	4	1	4	21	88
	CU (Power and Telecom)	5	71	0	0	0	0	2	29
Action Plan 38	LGU	7	44	0	0	0	0	9	56
Action Plan 39	LGU	10	63	0	0	0	0	6	38
	NGA	6	25	2	8	1	4	15	63
	CU (Telecom)	2	67	0	0	0	0	1	33

Action Plan 40	LGU	13	76	0	0	1	6	3	18
	NGA	9	38	1	4	3	13	11	46
	CU (Telecom)	1	33	2	67	0	0	0	0
Action Plan 41	LGU	8	50	0	0	4	25	4	25
	NGA	2	8	4	17	5	21	13	54
	CU (All except transportation)	2	17	2	17	5	42	3	25
	CU (Hospital)	0	0	0	0	0	0	1	100
Goal 3: Enhanced Risk Emergency Management									
RMS-1 Promote fire preparedness and mitigation including handling hazardous materials									
Action Plan 13	LGU	12	71	0	0	2	12	3	18
	NGA	1	4	1	4	1	4	21	88
	CU (CBRN)	1	50	0	0	0	0	1	50
Action Plan 14	LGU	11	65	0	0	2	12	4	24
	NGA	3	13	1	4	1	4	19	79
	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 15	LGU	12	71	0	0	5	29	0	0
	NGA	1	4	0	0	2	8	21	88
	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 16	LGU	8	47	0	0	1	6	8	47
	CU (CBRN)	1	50	0	0	0	0	1	50

Action Plan 17	LGU	13	76	0	0	1	6	3	18
	NGA	1	4	1	4	1	4	21	88
	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 18	LGU	12	71	0	0	0	0	5	29
	NGA	5	21	3	13	1	4	15	63
	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 19	LGU	10	59	0	0	0	0	7	41
	NGA	1	4	0	0	2	9	20	87
	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 20	LGU	7	41	0	0	2	12	8	47
	NGA	3	13	0	0	2	8	19	79
	CU (CBRN)	1	50	0	0	0	0	1	50
Educate, train, and maintain hazardous materials handling teams	CU (CBRN)	2	100	0	0	0	0	0	0
Improve personnel and hazardous materials handling capability to international standards	CU (CBRN)	2	100	0	0	0	0	0	0

Establish auxiliary hazardous materials handling capability of private organizations	CU (CBRN)	1	50	0	0	0	0	1	50
RMS-3 Enhance legal basis for disaster management									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 21	LGU	17	100	0	0	0	0	0	0
Action Plan 22	LGU	13	76	0	0	3	18	1	6
Action Plan 23	LGU	17	100	0	0	0	0	0	0
	CU	7	50	1	7	2	14	4	29
Action Plan 24	LGU	16	94	0	0	1	6	0	0
	NGA	1	4	2	8	1	4	20	83
Action Plan 25	LGU	15	88	0	0	1	6	1	6
	NGA	6	24	0	0	0	0	19	76
RMS-4 Strengthen institutional capacity for implementing preparedness and mitigation measures									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 26	LGU	17	100	0	0	0	0	0	0
	NGA	6	25	0	0	0	0	18	75

Action Plan 27	LGU	12	71	0	0	3	18	2	12
Use recent protocols, guidelines, and checklist on disaster prevention and mitigation, preparedness, and response	CU	13	93	1	7	0	0	0	0
RMS-5 Strengthen inter-institutional disaster response capacity									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 28	LGU	7	41	0	0	1	6	9	53
Action Plan 29	LGU	8	47	0	0	2	12	7	41
	NGA	3	13	4	17	1	4	16	67
	CU	11	79	2	14	0	0	1	7
Action Plan 30	LGU	9	53	0	0	1	6	7	41
	NGA	8	33	2	8	0	0	14	58
Action Plan 31	LGU	16	94	0	0	1	6	0	0
	NGA	2	9	3	13	0	0	18	78
	CU	9	64	1	7	1	7	3	21
RMS-6 Strengthen institutional disaster response capacity									
		Yes	%	Partial	%	No	%	N/A	%
		F		F		F		F	

Action Plan 32	LGU	12	71	0	0	0	0	5	29
	NGA	2	8	1	4	1	4	20	83
Action Plan 33	LGU	10	59	0	0	2	12	5	29
	NGA	6	25	0	0	0	0	18	75
Action Plan 34	LGU	17	100	0	0	0	0	0	0
	NGA	13	54	1	4	1	4	9	38
Action Plan 35	LGU	11	65	0	0	0	0	6	35
	NGA	0	0	1	4	1	4	22	92
RMS-7 Develop operation systems and procedures									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 36	LGU	15	88	0	0	1	6	1	6
	NGA	16	67	0	0	7	29	1	4
Action Plan 37	LGU	15	88	0	0	2	12	0	0
	NGA	10	42	2	8	1	4	11	46
Action Plan 38	LGU	4	24	0	0	1	6	12	71
Action Plan 39	LGU	16	94	0	0	1	6	0	0
	NGA	13	54	1	4	0	0	10	42
RMS-8 Enhance capability of fire suppression and hazardous materials									

		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 40	LGU	15	88	0	0	2	12	0	0
	NGA	10	42	4	17	2	8	8	33
	CU	9	64	1	7	2	14	2	14
Action Plan 41	LGU	16	94	0	0	1	6	0	0
	NGA	9	38	2	8	1	4	12	50
	CU	7	50	5	36	1	7	1	7
Action Plan 42	LGU	15	88	0	0	1	6	1	6
	NGA	10	42	6	25	1	4	7	29
	CU	7	50	3	21	1	7	3	21
RMS-9 Secure evacuation route and evacuation sites									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 43	LGU	16	94	0	0	1	6	0	0
	NGA	4	17	2	8	0	0	18	75
Action Plan 44	LGU	15	88	0	0	2	12	0	0
	NGA	7	29	1	4	4	17	12	50
	CU	7	50	1	7	2	14	4	29
RMS-10 Secure water, food, and other necessities									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 45	LGU	16	94	0	0	1	6	0	0
	NGA	5	21	2	8	2	8	15	63

Action Plan 46	LGU	8	47	0	0	4	24	5	29
	NGA	2	8	2	8	1	4	19	79
	CU (Water)	0	0	0	0	0	0	1	100
RMS-11 Enhance emergency health and medical response system									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 47	LGU	17	100	0	0	0	0	0	0
	NGA	9	38	3	13	0	0	12	50
Action Plan 48	LGU	11	65	0	0	2	12	4	24
	NGA	2	8	1	4	1	4	20	83
Relocate or transfer parts of major government hospitals in central Metro Manila areas	CU (Hospital)	0	0	0	0	0	0	1	100
Make a list of essential medical supplies and consumables for use during health emergency response operations	CU (Hospital)	1	100	0	0	0	0	0	0
Purchase essential medical	CU (Hospital)	1	100	0	0	0	0	0	0

supplies and consumables									
Distribute them to medical institutions	CU (Hospital)	0	0	0	0	0	0	1	100
Expand space to stock them in the institutions based on the so-called "running stock system"	CU (Hospital)	0	0	1	100	0	0	0	0
RMS-12 Enhance emergency health and medical response system									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 49	LGU	7	41	0	0	3	18	7	41
	NGA	3	13	1	4	0	0	20	83
Action Plan 50	LGU	13	81	0	0	3	19	0	0
	NGA	4	17	0	0	1	4	19	79
	CU (Transportation)	0	0	0	0	0	0	1	100
Action Plan 51	LGU	0	0	0	0	2	13	14	88
	NGA	4	17	0	0	0	0	20	83
	CU (Transportation, CBRN)	0	0	0	0	0	0	3	100
Action Plan 52	LGU	0	0	0	0	1	6	15	94
	NGA	4	17	0	0	0	0	20	83

	CU (CBRN)	0	0	0	0	0	0	2	100
Action Plan 53	LGU	0	0	0	0	1	6	15	94
	NGA	4	17	0	0	19	79	1	4
	CU (CBRN)	1	50	0	0	0	0	1	50
Action Plan 54	LGU	0	0	0	0	1	6	15	94
	NGA	0	0	1	4	1	4	22	92
Action Plan 55	LGU	3	19	0	0	1	6	12	75
	NGA	0	0	0	0	1	4	23	96
	CU (Transportation)	0	0	0	0	0	0	1	100
RMS-13 Establish search and rescue system									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 56	LGU	17	100	0	0	0	0	0	0
	NGA	6	25	3	13	0	0	15	63
Action Plan 57	LGU	16	94	0	0	1	6	0	0
	NGA	3	13	1	4	1	4	19	79
RMS-14 Establish information and communication systems									
		Yes	%	Partial	%	No	%	N/A	%
Action Plan 58	LGU	16	94	0	0	1	6	0	0
	NGA	8	33	2	8	3	13	11	46
	CU (Telecommunications)	2	67	1	33	0	0	0	0

RMS-15 Establish information and communication systems									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 59	LGU	10	59	0	0	6	35	1	6
	NGA	5	21	3	13	2	8	14	58
RMS-16 Manage emergency public information									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 60	LGU	15	88	0	0	2	12	0	0
	NGA	6	24	3	12	0	0	16	64
Action Plan 61	LGU	14	82	0	0	3	18	0	0
	NGA	10	42	0	0	0	0	14	58
Goal 4: Increased Community Resiliency									
CRI-1 Enhance self-reliance and mutual help for efficient risk management capacity									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	16	94	0	0	1	6	0	0
	NGA	9	39	3	13	0	0	11	48
Action Plan 2	LGU	16	94	0	0	1	6	0	0
	NGA	9	38	0	0	0	0	15	63
Action Plan 3	LGU	16	94	0	0	1	6	0	0
	NGA	2	8	0	0	2	8	20	83
CRI-2 Inculcate a disaster mitigation culture in future generations									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 3	LGU	16	94	0	0	1	6	0	0

	NGA	2	8	0	0	2	8	20	83
Action Plan 4	LGU	16	94	0	0	1	6	0	0
	NGA	13	54	1	4	1	4	9	38
Action Plan 5	LGU	16	94	0	0	1	6	0	0
	NGA	3	13	1	4	0	0	20	83
Action Plan 6	LGU	16	94	0	0	1	6	0	0
	NGA	1	4	1	4	2	8	20	83
Action Plan 7	LGU	17	100	0	0	0	0	0	0
	NGA	3	13	0	0	1	4	20	83
Goal 5: Reconstruction Systems									
RSF-1 Supply temporary refugee housings									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	14	82	0	0	1	6	2	12
	NGA	5	21	0	0	4	17	15	63
RSF-2 Prepare emergency assistance for everyday life									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	15	88	0	0	1	6	1	6
	NGA	4	17	2	8	2	8	16	67
RSF-3 Establish debris clearance and management system									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	11	69	0	0	3	19	2	13
	NGA	2	8	2	8	2	8	18	75
RSF-4 Restore public and social services									

		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	14	88	0	0	1	6	1	6
	NGA	4	17	1	4	1	4	18	75
RSF-5 Establish post-disaster reconstruction system of the damaged area									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 5	LGU	11	69	0	0	3	19	2	13
	NGA	6	25	2	8	3	13	13	54
Action Plan 6	LGU	10	63	0	0	3	19	3	19
	NGA	6	25	1	4	3	13	14	58
RSF-6 Enhance institutional aspect									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 7	LGU	15	94	0	0	0	0	1	6
	NGA	10	42	2	8	3	13	9	38
Action Plan 8	LGU	13	81	0	0	2	13	1	6
	NGA	7	29	0	0	3	13	14	58
Goal 6: Earthquake and Tsunami Resilience Research and Development									
R&D-1 Promote sustained research and development on earthquake									
		Yes	%	Partia l	%	No	%	N/A	%
Action Plan 1	LGU	10	63	0	0	3	19	3	19
	NGA	1	4	1	4	2	9	19	83
Action Plan 2	LGU	5	31	0	0	3	19	8	50
	NGA	1	4	2	8	3	13	18	75
Action Plan 3	LGU	16	94	0	0	1	6	0	0

	NGA	2	8	2	8	3	13	17	71
Action Plan 4	LGU	13	76	0	0	4	24	0	0
	NGA	3	13	2	9	4	17	14	61
Action Plan 5	LGU	13	81	0	0	3	19	0	0
	NGA	5	23	0	0	15	68	2	9
Action Plan 6	LGU	7	41	0	0	1	6	9	53
	NGA	2	9	0	0	1	4	20	87
Action Plan 7	LGU	5	29	0	0	2	12	10	59
	NGA	1	4	1	4	2	9	19	83
Action Plan 8	LGU	4	24	0	0	3	18	10	59
	NGA	2	9	0	0	2	9	19	83
Action Plan 9	LGU	3	18	0	0	4	24	10	59
	NGA	2	9	0	0	19	86	1	5
Action Plan 10	LGU	4	24	0	0	3	18	10	59
	NGA	5	22	0	0	2	9	16	70
Action Plan 11	LGU	5	29	0	0	3	18	9	53
	NGA	3	13	0	0	3	13	17	74
Action Plan 12	LGU	6	35	0	0	2	12	9	53
	NGA	3	13	1	4	2	8	18	75

Action Plan 13	LGU	9	53	0	0	2	12	6	35
	NGA	8	35	1	4	1	4	13	57
Action Plan 14	LGU	9	53	0	0	2	12	6	35
	NGA	5	22	0	0	3	13	15	65

Action Plans with Direct and Indirect Impact

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
1	Action Plan 1	Develop and enhance national/regional/local government continuity plan	x	
	Action Plan 2	Regular conduct of emergency evacuation drills for N/R/L government offices	x	
	Action Plan 3	Develop in-house earthquake emergency services skills of teams	x	
	Action Plan 4	Provide basic earthquake emergency skills to staff	x	
	Action Plan 5	Conduct infra audit assessment and assess compliance to structural codes (building, fire) of N/R/L government office	x	
	Action Plan 6	Promote earthquake- and fire-resistant area surrounding N/R/L government offices	x	
	Action Plan 7	Conduct infrastructure audit assessment and assess compliance to structural codes (building, fire) of critical government facilities	x	
	Action Plan 8	Assess and improve integrity of business and commercial buildings against earthquake and fire hazards	x	
	Action Plan 9	Implement and develop backup systems, backup sites, or mirror sites for data security during earthquake and fire emergency with recovery time objective specified		x
	Action Plan 10	Deconcentrate business operations to strategically located sub-office	x	
	Action Plan 11	Establish measures to stabilize exchange rates and price of commodities after earthquake disasters		x
	Action Plan 12	Establish transfer mechanisms for foreign disaster aid		x
	Action Plan 13	Emplace local emergency loan and disaster reconstruction fund into (banking) system		x
2	Action Plan 1	Self-assess the safety of own homes using DOST-PHIVOLCS, Association of Structural Engineers of the Philippines (ASEP), Japan International Cooperation Agency-Japan Science and Technology (JICA-JST) "How safe is my house" tool	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 2	Strengthen own homes from impacts of earthquake hazards	x	
	Action Plan 3	Develop guidelines for designing and building earthquake- and fire-resistant homes	x	
	Action Plan 4	Develop and introduce affordable seismic retrofitting measures to non-engineered houses	x	
	Action Plan 5	Set and implement standards for road width and proportion of open spaces	x	x
	Action Plan 6	Consider urban redevelopment of former informal settlement areas	x	
	Action Plan 7	Mainstream disaster risk reduction and climate change adaptation (DRR-CCA) into the comprehensive land use plan (CLUP)	x	
	Action Plan 8	Secure possible sources of fire such as LPG tanks, gasoline refilling stations, oil depot, bottled gasoline-vending stores, illegal power connections, and other hazardous materials	x	
	Action Plan 9	Strengthen buildings against fire hazards	x	
	Action Plan 10	Develop fire prevention and suppression guidelines	x	
	Action Plan 11	Regulate bottled gasoline-vending	x	
	Action Plan 12	Implement buffer zone against fire in areas surrounding critical areas and urban industrial zones	x	
	Action Plan 13	Set a proportion of open space (relative to population) for mass earthquake evacuation	x	x
	Action Plan 14	Introduce firebreak network elements (parks and other open spaces, roads, and pedestrian alleys) in urban plans	x	
	Action Plan 15	Establish training center for masonry workers	x	
	Action Plan 16	Educate and train masonry workers on proper building practices	x	
	Action Plan 17	Develop simple construction manual for masonry buildings	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 18	Educate and train construction supervisors	x	
	Action Plan 19	Educate and train LGUs and barangay human resource for permitting and monitoring of building construction	x	
	Action Plan 20	Improve LGU's permitting and monitoring system for building construction	x	
	Action Plan 21	Develop and introduce affordable seismic retrofitting technologies and methods to building owners and developers	x	
	Action Plan 22	Conduct research and development for alternative, affordable, lightweight, nonflammable construction materials	x	
	Action Plan 23	Educate and train human resources for building (structural) engineering	x	
	Action Plan 24	Develop alternative, affordable seismic retrofitting methods	x	
	Action Plan 25	Evaluate seismic performance of public buildings	x	
	Action Plan 26	Retrofit public buildings with low seismic-performance rating	x	
	Action Plan 27	Assess seismic performance of bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems	x	
	Action Plan 28	Retrofit bridges, flyovers, tunnels, airport facilities, seaport facilities, and railway systems	x	
	Action Plan 29	Develop transport facility reconstruction plan with recovery time objective specified		x
	Action Plan 30	Establish backup systems and sites for airport control center, air traffic tower and approach leader with recovery time objective specified		x
	Action Plan 31	Conduct regular emergency operation exercise for lifeline with recovery time objective specified	x	
	Action Plan 32	Develop earthquake emergency operation team and support system for lifeline	x	
	Action Plan 33	Establish a lifeline subcommittee within the MMDRRMC	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 34	Establish a standard GIS database of lifeline nodes and network for comprehensive lifeline risk assessment	x	
	Action Plan 35	Develop lifeline earthquake emergency operation manuals with recovery time objective specified	x	
	Action Plan 36	Replace cast iron water distribution pipes with earthquake-resistant pipes	x	
	Action Plan 37	Install central control system to supply electricity in blocks or sectors		x
	Action Plan 38	Reduce the number of illegal power connections	x	
	Action Plan 39	Reinforce communication exchange facilities		x
	Action Plan 40	Enhance end-to-end communication system among DRR institutions		x
	Action Plan 41	Develop lifeline facility reconstruction plan with recovery time objective specified		x
3	Action Plan 13	Educate, train, and maintain fire emergency teams in establishments and barangays	x	
	Action Plan 14	Reinforce community-based firefighting capability through volunteer fire fighter	x	
	Action Plan 15	Improve BFP personnel and firefighting capability to international standards	x	
	Action Plan 16	Increase proportion of fire stations per square area	x	
	Action Plan 17	Establish auxiliary firefighting capability of private organizations	x	
	Action Plan 18	Improve access to water sources for firefighting	x	
	Action Plan 19	Set regulation and permit for storing, handling, and selling flammable products	x	
	Action Plan 20	Establish long-term plan for relocating facilities handling hazardous materials	x	
	Action Plan 21	Install local government level DRRM office with yearly budget allocation	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 22	Appoint permanent DRRM officers	x	
	Action Plan 23	Mainstream DRR into local sectoral development plan	x	
	Action Plan 24	Enact local ordinances related to Greater Metro Manila Earthquake Impact Reduction	x	
	Action Plan 25	Institutionalize financing for DRRM activities	x	
	Action Plan 26	Educate and train local barangay officials in community-based DRRM	x	
	Action Plan 27	Develop and distribute Earthquake Mitigation Handbook and Earthquake Mitigation and Response Checklist	x	
	Action Plan 28	Update Metro Manila DRRM Council organizational structure	x	
	Action Plan 29	Regularly evaluate the Greater Metro Manila level disaster preparedness plans	x	
	Action Plan 30	Conduct periodic simulation exercises to test the Greater Metro Manila Incident Command System (ICS) and response decision-making systems	x	
	Action Plan 31	Establish inter-local government clusters and mutual aid agreement		x
	Action Plan 32	Educate and train Civil Defense personnel on planning for emergency response	x	
	Action Plan 33	Disseminate Emergency Response Pocket Guide to agencies and LGUs	x	
	Action Plan 34	Development of standard relief and response resources based on national guidelines	x	
	Action Plan 35	Conduct annual inventory of civil defense emergency management personnel	x	
	Action Plan 36	Develop inter-organizational protocols and SOPs for key response functions		x
	Action Plan 37	Regularly conduct simulation exercises to test inter-organizational protocols and SOPs for key response functions	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 38	Develop MMDA Metro Base capabilities for emergency operations center (EOC) operations		x
	Action Plan 39	Establish emergency operations centers		x
	Action Plan 40	Regularly evaluate and update the emergency plan and manuals of DRRM	x	
	Action Plan 41	Establish emergency information and communication system, and redundant systems among and between DRRM organizations		x
	Action Plan 42	Establish mutual support system and mutual aid agreements through memorandum of agreements or understanding		x
	Action Plan 43	Formulate evacuation plan and establish evacuation sites in the LGU for earthquake according to the standard set by the national government		x
	Action Plan 44	Establish scheme and protocol for mobilizing resources for evacuation		x
	Action Plan 45	Establish supply system of water, food, and other necessities		x
	Action Plan 46	Secure large-scale water sources (e.g., water reservoirs)	x	
	Action Plan 47	Enhance emergency response capacities of DRRM organizations		x
	Action Plan 48	Improve government hospital capacities	x	
	Action Plan 49	Establish metro-wide emergency road network		x
	Action Plan 50	Establish equipment arrangements for emergency road clearing		x
	Action Plan 51	Establish emergency protocol for road-use priority between Batangas Port and Metro Manila south region		x
	Action Plan 52	Establish emergency protocol for road-use priority between Subic-Clark and Metro Manila north region		x
	Action Plan 53	Establish emergency protocol for securing Ninoy Aquino International Airport functions		x

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 54	Retrofit Manila port to earthquake- and tsunami-resistant construction	x	
	Action Plan 55	Construct Laguna de Bay northern shore unloading facility	x	
	Action Plan 56	Educate and train search and rescue personnel	x	
	Action Plan 57	Establish local level system to accept emergency aid		x
	Action Plan 58	Educate and train personnel on information communication system for DRRM		x
	Action Plan 59	Establish portal for accessing GIS-hazard and managing information on disaster		x
	Action Plan 60	Establish inter-governmental policy and protocol for managing information on disaster		x
	Action Plan 61	Establish partnerships with media for DRRM-related information		x
4	Action Plan 1	Knowledge development and enhancement about earthquake hazards and vulnerabilities	x	
	Action Plan 2	Increase community participation for community governance in disaster risk reduction and climate change adaptation (DRR-CCA)	x	
	Action Plan 3	Mainstream programs that emphasize the four thematic areas in school curricula	x	
	Action Plan 4	Develop and enhance evacuation plans		x
	Action Plan 5	Capacity development and capability enhancement of school emergency personnel	x	
	Action Plan 6	Inclusion of parent-teachers association in school emergency planning activities	x	
	Action Plan 7	Conduction of periodic earthquake evacuation exercises in schools	x	
5	Action Plan 1	Formulate temporary refugee housing plan		x

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 2	Formulate basic policy for emergency assistance for everyday life		x
	Action Plan 3	Formulate debris clearance plan for LGUs		x
	Action Plan 4	Formulate basic policy for post-disaster peace-and-order-keeping activities		x
	Action Plan 5	Formulate basic reconstruction policies for living, housing, employment, and economic activities		x
	Action Plan 6	Formulate guidelines to urban reconstruction and make a scheme of finances and credits		x
	Action Plan 7	Establish pre-disaster policies and institutional arrangements for post-disaster reconstruction and mitigation	x	x
	Action Plan 8	Prepare pre-disaster recovery plans and procedures to ease post-disaster human and physical recovery and rehabilitation	x	x
6	Action Plan 1	Evaluate the activity of the VFS	x	x
	Action Plan 2	Promote detailed study on comprehensive earthquake disaster estimation	x	
	Action Plan 3	Expand basic inventory on buildings and population for detail damage estimation purpose	x	
	Action Plan 4	Conduct detailed risk damage estimation using current inventory of risk elements (using rapid earthquake damage assessment system [REDAS] or similar tool)	x	
	Action Plan 5	Distribute risk and damage estimate to the public	x	
	Action Plan 6	Estimate tsunami hazards along coastal areas	x	
	Action Plan 7	Assess tsunami risk along coastal areas (using rapid earthquake damage assessment system [REDAS] or similar tool)	x	
	Action Plan 8	Establish tsunami warning systems	x	

Goal	Action Plan Number	Action Plan Name	Direct Impact	Indirect Impact
	Action Plan 9	Install tsunami hazard markers	x	
	Action Plan 10	Establish tsunami evacuation routes and sites	x	
	Action Plan 11	Establish guidelines for vertical evacuation during tsunami emergency	x	
	Action Plan 12	Inform and educate communities on tsunami warning systems	x	
	Action Plan 13	Conduct community-wide earthquake evacuation exercises	x	
	Action Plan 14	Conduct community-wide tsunami evacuation exercises	x	
	Action Plan 15	Maintain a current inventory of risk elements	x	x

Attempts/Combinations	P-value
1. YES, NO, PARTIAL, N/A, and blanks	1.4
2. Blanks were subtracted from the TOTAL and only YES, NO, and PARTIAL were considered	6.5
3. Blanks were subtracted from the TOTAL and YES, NO, PARTIAL, and N/A were considered	2.0

Appendix 6. Statistical Analysis of Survey Response

ANOVA

In the attempt to use ANOVA for analysis, several combinations were used to see if there will be a significant difference between groups.

1. Grouped according to responses (YES, NO, PARTIAL, N/A)
2. Grouped According to participants (LGU, NGA, critical lifeline and utility sectors)

Attempts/Combinations	P-value
1. Blanks were subtracted from the TOTAL and only YES, NO, and PARTIAL were considered	1
2. Blanks were subtracted from the TOTAL and YES, NO, PARTIAL, and N/A were considered	1

Regression Method:

Earthquake Impact is derived from the combination of the action plan implementation (yes, no, partial) and action plan prioritization (High, Moderate, Low). This combination is assumed to represent a degree of earthquake impact. However, to quantify these, numerical values should be assigned. Values attributed are as follows: No-High (8), No-Moderate (7), No- Low (6), Partial- High (5), Partial-Moderate (4), Partial-Low (3), Yes-High (2), Yes-Moderate (1), Yes-Low (0). The numerical values are arranged as such because it is considered that earthquake impact is the strongest when an action plan is High Priority and is not carried out. On the other hand, earthquake impact is the weakest when the action plan is implemented even if its prioritization is low. Furthermore, status of Implementation refers to the compliance of the institution to the action plan. It is simply the degree of the implementation (Partial, Yes, No). Also, to allow for measurement, these should be given respective numerical values. Values attributed are: Yes (2), Partial (1), and No (0)

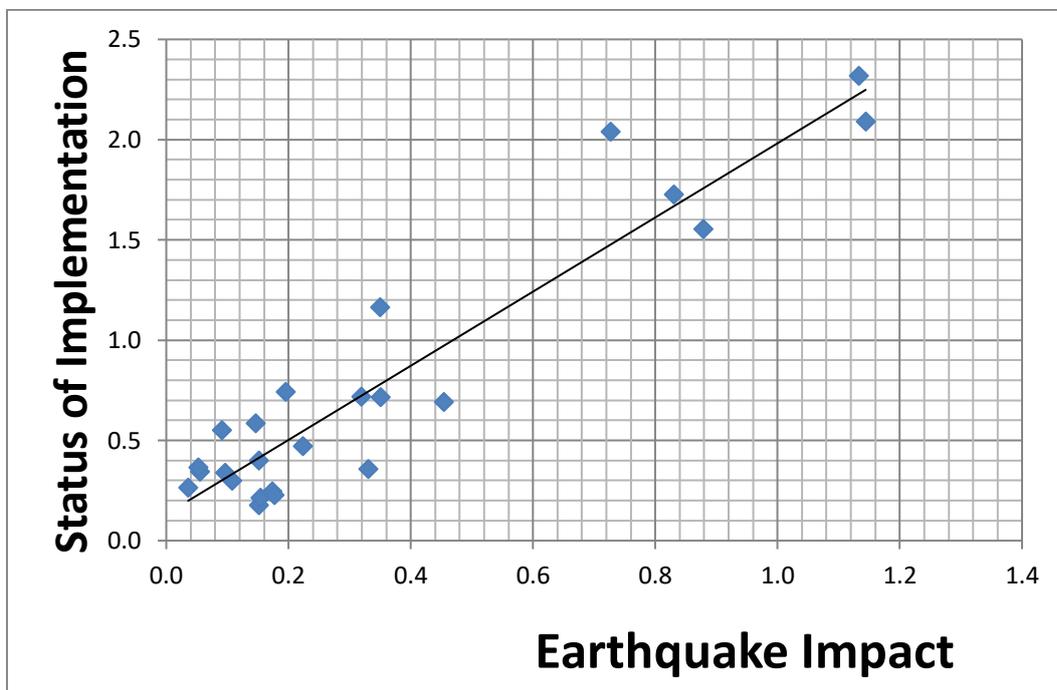
Earthquake Impact

Implementation and Prioritization	Value
No- High	8
No-Moderate	7
No-Low	6
Partial-High	5
Partial-Moderate	4
Partial-Low	3
Yes-High	2
Yes-Moderate	1
Yes-No	0

Status of Implementation

Response	Value
Yes	2
Partial	1
No	0

The resulting graph (combination of NGA and utility companies) shows that as Action Plans are accomplished, earthquake impact increases as well. This result will negate the usefulness of the Action Plans for earthquake impact reduction. Furthermore, it should be recognized that this result from a number of limitations from the data gathering process (LGU participants did not have a part of the survey questionnaire that qualifies data from them to be included in this analysis) and the answers of the participants.



Appendix 7. Highlights of Key Informant Interviews

A series of key informant interviews were conducted to supplement the initial findings of the study. The main topics for discussion throughout the interviews are the 1) framework/process for streamlining and prioritization of action plans, and 2) current initiatives for DRRM emphasizing impact reduction for earthquake. The highlights of the KIIs are discussed in the succeeding section.

Participants for the KIIs are listed below:

Name of Organization	Participants
Manila Observatory & Ateneo de Manila University	Ma. Antonia Yulo-Loyzaga
Center for Disaster Preparedness (CDP)	Mayfourth Luneta
Philippine Disaster Resilience Foundation (PDRF)	Veronica Gabaldon Anthony Zuñiga Arvin Caro
DOST-PHIVOLCS	Undersecretary Renato U. Solidum , Jr. Mabelline T. Cahulogan Arturo S. Daag Jeffrey Perez Charmaine Villamil
Quezon City DRRMO	Bianca Perez
Laguna PDRRMO	Aldwin M. Cejo

Framework/Process for streamlining and prioritization of action plans

Below is the summary of all recommendations for this topic:

- For the prevention and mitigation aspect, the study can investigate **the implementation of existing laws** that targets to decrease risk of earthquake such as the National Structural Code and National Building Code. Despite DPWH auditing government infrastructure, private buildings/structures should also be audited.
- Aside from using the 4 pillars in the framework for categorization/prioritization, another approach is to use the **risk management cycle** (assessment – measures – decision-making) since not action plans can be exclusively categorized under one pillar only.
- Another recommendation is to **include slow onset events such as climate-change related events/hazards** since this will possibly aggravate the risks from earthquakes such as those in reclaimed areas. In the Philippines, they have an observation that DRR is separate from Climate Change specifically the slow onset events since DRR is extreme events. It could be a high time to interconnect DRR and Climate Change manifestations.
- MMEIRS is a framework for action; for implementation purpose, the frameworks can be further subdivided based on key actors. Prioritization based on different governance level (national, regional, local and community). Aside from this, the strategic framework (in terms of conceptual structure) can also be updated.
- Plans may be made more understandable to make these more actionable. Despite the current leaps on studies about earthquakes in the country, one of the challenges is that not all can comprehend, adopt and translate these into implementable action plans.

- Framework of resilience can also be used in streamlining the action plans such as, which focuses on these three aspects: 1) reduction of risk prior to the event; 2) effective and efficient response (thus need for preparedness measures), and 3) recover and build better
- Another effort that should be highlighted in GMMEIRS action plan is the public service continuity plan.

Aside from the above recommendations on streamlining, policies to strengthen and standard procedure to regularly update information management for earthquake risk and vulnerability assessment are suggested to be established.

Current initiatives for DRRM emphasizing earthquake impact reduction

Local Government Units

In the case of Quezon City DRRMO, critical resources and back-up systems for utilities are already in place. Response plan based on GMMA RAP are also established together with building the adaptive capacity of high-risk communities. Among the identified best practices shared by Quezon City DRRM is the localization of programs usually implemented at the national level. In terms of implementation, they make use of the whole of society approach wherein LGU offices have various but clear entry points in mainstreaming disaster risk reduction in their operations. They are also in close coordination with the private sector which supplements the efforts and resources of the LGU. Moreover, they identify partner LGUs which can help in possible earthquake response operations.

For information management which supports the DRRM Plan, Quezon City conducts the following:

- Ground truthing and validation of mapped open spaces from NAMRIA and assessment of its suitability as temporary evacuation area
- Digitization of structural assessment in preparation for future studies such as earthquake damage modelling.
- Mapping of heritage sites structures which are included in damage projections.

Non-government Organizations

PDRF’s initiatives include Micro, Small, and Medium Enterprise (MSME) resilience by providing support in their capacity building. Local businesses can help fill in the gap in relief and response operations and help in overall preparedness and resilience of communities.

Identified programs and activities of PDRF organized per MMEIRS goals are:

Goal	Programs and activities of PDRF
Goals 1, 2 and 4	SAFE Program which includes development of preparedness plan for workforce, infrastructure, and utilities at the community level. Family-preparedness which focuses on capacitating households. This is also connected to workforce resilience strategy of PDRF. Community resilience program, in partnership with barangays, this program includes the Participatory 3-Dimensional Mapping for the community to have their own version of scale model map with identifies vulnerable group, and evacuation routes.
Goal 3	Participatory 3D Mapping indirectly addresses the conduct of firefighting capacities among communities by identifying fire-prone areas. They also have a collaboration with Meralco wherein they identified fire-prone areas due to “spaghetti” wires. This has been accomplished in the whole of Metro Manila. Also, under the SAFE Schools (a component of SAFE Program) they

Goal	Programs and activities of PDRF
	train select students/school watching team which checks on potential hotspots for hazards that could lead to disaster. This includes identification of potential fire hazard hotspot. This is in partnership with DepEd.
Goal 6	In terms of initiatives for research and development of new materials/curriculum for DRRM trainings, PDRF has various training materials and capacity building activities for businesses.

National government agency

Key informants from PHIVOLCS provided the latest updates

- The data set for the structural audit of government infrastructure are still ongoing. This shall also be updated by the existing efforts of DPWH in retrofitting priority infrastructure.
- Under the GeoRisk project (GeoAnalytics Component), multihazard maps for GMMA have already been prepared. PHIVOLCS submitted earthquake hazard maps for GMMA to NEDA last 2018 for the National Physical Framework Plan. The multihazard maps made use of 2015 PSA data in terms of population.
- Since MMEIRS, the following were the improvements when it comes to risk assessment:
 - Better and faster scenario generation
 - Improved data sets from various INGO funded studies on earthquakes such as GMMA Ready Project
 - More sophisticated modelling of ground shaking acceleration
 - Better earthquake models
 - More monitoring stations
 - Improvement of software for earthquake models
 - GeoRisk Philippines initiative

Organizations and groups that have substantial contribution to risk and exposure database include DPWH, MGB-DENR, PAGASA, DOH, NAMRIA. Inherent for all hazard maps is the use of IFSAR data as base maps. DILG can better contribute to the risk and exposure database thru the data included in the CLUP, as well as in cascading data from earthquake studies into local plans. Another agency which may contribute to the risk and exposure database are housing agencies such as HUDCC, HLURB.

Other topics:

Improvements in mechanisms and practices in terms of earthquake preparedness

- Recognition of the role of business sector in DRM: The language of business sector in DRM is more on business continuity. There has been an improvement in prioritizing the adaptive capacity of workforce, as part of business continuity. One of PDRF's contributions in this improvement is the generation of knowledge base and conduct of capacity building activities among private business groups. PDRF also helped in institutionalization business continuity to contribute to overall workforce resilience.
- Better coordination with other sectors: The concept of interoperability has been strengthened; this is manifested in the clearer mechanisms of public-private partnership in terms of their roles and responsibilities. Both sectors are currently observed to operate using

the “same language”. There are programs and activities by government that are being adopted by private business sector, such as the Incident Command System. The private sector has their version of crisis management that is a little modified to fit to the operational context of the business sector, but still having same mechanisms with the government.

- Inclusion of private sector lens in the plans and tools of government: This includes recognition of business continuity plans, and metrics pertaining to activities of the private business sector that may be affected by hazards, as well as metrics for possible assistance of private business sector. Another example is the Public Service Continuity Plan (PSCP) which have been recognized to help augment operations of public sector when it comes to DRM.

Gaps from MMEIRS which can be used in updating action plans:

- Risk analysis in MMEIRS is focused on night-time scenario, not daytime. One implication of this is the large student population in Metro Manila during daytime.
- Linking of provinces’ efforts towards earthquake risk reduction and identification of which LGUs to assist and how they can efficiently reach cities that they should assist given the damages from earthquake event
- Creation of subsequent framework-specific bundle of plans and projects. For example, Yakal plus is an offshoot plan from MMEIRS but this plan is mostly for preparedness for response (Goal 3, Obj.3). There may be other project bundles to address a group of objectives/goals, key aspects of the masterplan. Identification of project bundles can also help in identifying agencies/LGUs who can implement and champion the implementation of the bundled plans.
- A proper branding for these initiatives or key aspects of the master plan may also help in building collective effort and public awareness/acceptance/appreciation, and to make it sustainable despite changes in leadership and priorities.

Since the MMEIRS is a framework of action, the meat of the plan and post-evaluation of how the master plan is carried out, may be one of the targets of GMMEIRS, rather than revising the framework. Moreover, existing efforts can be documented and organized to identify which goals and frameworks have already been substantially addressed, supported by empirical data instead of perception of a person whose response may not represent the real accomplishments of the organization.