VULNERABILITY ASSESSMENT IN THE MUNICIPALITY OF MASINLOC, ZAMBALES

ACE ANGELO A. LABUGUEN

An Undergraduate Thesis Submitted to the Faculty of the Department of Environmental Science, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of

BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE
(Environmental Conservation and Management)

FEBRUARY 2020

ACCEPTANCE SHEET

This undergraduate thesis proposal entitled **"VULNERABILITY ASSESSMENT IN THE MUNICIPALITY OF MASINLOC, ZAMBALES,"** prepared and submitted by **ACE ANGELO A. LABUGUEN**, in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE (ENVIRONMENTAL CONSERVATION AND MANAGEMENT),** is hereby accepted:

GELLA PATRIA A. ABELLA, Ph.D.
Adviser

01-22-2020
Date Signed

CESAR V. ORTINERO, Ph.D.
Critic

1.23.2020
Date Signed

LUZVIMINDA S. QUITOS, Ph.D.
Department Research Coordinator

1-22-2020
Date Signed

Accepted as partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE (ENVIRONMENTAL CONSERVATION AND MANAGEMENT)**

SHARON E. LAZARO, Ph.D.
Chair, Department of Environmental Science

22 January 2020
Date Signed

KRISTINE GRACE D. WAING, M.Sc.
College Research Coordinator

1/23/2020
Date Signed

EVARISTO A. ABELLA, Ph.D.
Dean, College of Arts and Science

01/23/20
Date signed

BIOGRAPHICAL SKETCH

The author is one of the four sons of Mr. Antonio M. Labuguen and Mrs. Susana A. Labuguen. He lives in San Jose City, Nueva Ecija with his parents. He is currently 19 years of old. He was born in Cabanatuan City, Nueva Ecija on June 21, 1999. He graduated pre-elementary at San Jose West Central School, elementary and high school at Core Gateway College Inc; San Jose City, Nueva Ecija in March 2011 and 2015, respectively. He is taking BS Environmental Science, major in Environmental Conservation and Management at Central Luzon State University. He is currently a member of CLSU Association of Future Environmental Scientists (CAFES).

ACKNOWLEDGMENT

The author would like to thank his family who helped and encouraged the author to finish this undergraduate thesis. Also, to his dearest panel Ms. Gella Patria Abella, Dr. Cesar V. Ortinero and Dr. Luzviminda S. Quitos.

The author would also like to thank the director of ICCEM, Dr. Annie Melinda Paz-Alberto and the staff Ma'am Elly, Sir Hans, Sir Tops, and Ma'am Kath for helping him throughout the study.

Grateful thanks are given to Neal, Che Lean, John Wayne, Cyril, Jessah, Liliane and Allaine for the encouragement they gave to the author.

And to the dearest adviser that did not give up, for the guidance, as well as for being the one who helped the author to finish this study.

Thank you very much to all and God Bless.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF EQUATIONS

LIST OF APPENDICES

LIST OF APPENDIX TABLES

ABSTRACT

LABUGUEN, ACE ANGELO A., Department of Environmental Science, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz Nueva Ecija Philippines, **February 2020, VULNERABILITY ASSESSMENT IN THE MUNICIPALITY OF MASINLOC, ZAMBALES**

Adviser: GELLA PATRIA L. ABELLA, Ph. D.

Natural hazard is very common in the Philippines. Flooding, typhoon, storm surge, tsunami and earthquake occur in the country. It can adversely affect a city or municipality, its residential properties, agricultural land, forest, marine ecosystem, commercial and industrial buildings, and most of all are human lives. This study aims to conduct the vulnerability assessment in the Municipality of Masinloc, Zambales. Specifically, to compute the sensitivity, exposure, and adaptive capacity index scores of the municipality, to compute the vulnerability index scores of the municipality, to generate sensitivity, exposure, adaptive capacity and vulnerability maps and to identify the priority areas in the municipality of Masinloc, Zambales. The study adopted the methodology of Espaldon et al. (2016) looking into three sectors that has been affected by the hazard, coastal to flood, storm surge and tsunami, agricultural sector to flood and forest sector to landslide. Maps were done using ArcGIS. The coastal sector of Barangay Bani obtained a high vulnerability index score of 0.76 to storm surge because of high sensitivity and exposure. Agricultural sector of Brgy. Collat also obtained a high vulnerability index score of 0.75 to flood due to high exposure, here were the top two areas that need to be prioritized in appropriate disaster risk reduction and management program.

Keywords: vulnerability assessment; sensitivity; exposure; adaptive capacity

LITERATURE CITED

Abella, G. P. (2016). *Systems Approach to Disaster Risk Reduction in Comprehensive Land Use Planning of San Jose City, Philippines,* Doctoral Dissertation, University of the Philippines Los Baños, Laguna, Philippines.

Acosta, L., & Galli, F. (2013). Crisis probability curves (CPCs): a model for assessing vulnerability thresholds across space and over time, *Journal of Environmental Science and Management, 16*(1), 36–49. http://journals.uplb.edu.ph/index.php/JESAM/article/view/961/884.

Adger, W. N., (2006). Vulnerability. *Global Environmental Change, 16*(3), 268–281. doi:10.1016/j.gloenvcha.2006.02.006

Birkmann, J. (Ed.) (2006). Measuring Vulnerability to Hazards of Natural Origin Towards Disaster- Resilient Societies, Tokyo, UNU Press.

Brooks, N., & Adger, N. (2004) in Lim, B. and Spanger- Siegfried, E. (Eds.): *Adaptation Policy Framework for Climate Change,* pp.165–182, Cambridge University Press, Cambridge, UK.

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change, 15*(2), 151–163. doi. org/10.1016/j.gloenvcha.2004.12.006

Cardona, O. D., Van-Aalst, M. K., Birkmann, J., Fordham, M., McGregor, G., Perez, R. S., ... & Sinh, B. T. (2012). Determinants of risk: exposure and vulnerability. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, 2,* 65-108.

Champati ray, P., Dimri, S., Lakhera, R., & Sati, S. (2007). Fuzzy based methods for landslide hazard assessment in active seismic zone of Himalaya. *Landslides,* 4, 101–110. doi.org/10.1007/s10346-006-0068-6

Clark, C., (1987). Deforestation and Floods. *Environmental Conservation, 14*(1), 67. doi:10.1017/s0376892900011127

Crossett, K. M., Culliton, T. J., Wiley, P. C., & Goodspeed, T. R. (2004). Population trends along the coastal United States: 1980–2008. Coastal Trends Report Series, National Oceanic and Atmospheric Administration/National Ocean Service/Management and Budget Office/Special Projects, Silver Spring, Maryland.

Daag, A. S., Tungol, N., Peralta, M., & Cruz, O. (2006). Landslide and Flash flood Critical Rainfall Threshold Determination and Hazard Mapping: Terminal Report of the

Study in Panaon Island, Southern Leyte and Surigao City. Department of Science and Technology, Philippines.

Dewan, A., Monirul, M., Islam, M., Kumamoto, T., & Nishigaki, M. (2007). Evaluating flood hazard for land-use planning in greater Dhaka of Bangladesh using remote sensing and GIS techniques. *Water Resource Management 21*(9), 1601–1612. doi.org/10. 1007/s11269-006-9116

Feng, M., McPhaden, M. J., Xie, S. P., Hafner, J. (2013). La Niña forces unprecedented Leeuwin Current warming in 2011. Scientific Report. 3.

Fuchs, S., Birkmann, J., & Glade, T. (2012). Vulnerability assessment in natural hazard and risk analysis: Current approaches and future challenges. *Journal of Natural Hazard, 64*(3), 1969-1975. doi.org/10.1007/S11069-012-0352-9d

Gaillard, J. C. (2010). Vulnerability, capacity and resilience: Perspectives for climate and development policy, *Journal of International Development, 22,* 218-232. doi.org/10.1002/jid.1675

Google Earth Pro. (2019). https://www.google.com/earth/

Hoeurn, C. (2013). Rural Households' Vulnerability Assessment to Climate Variability The Case of Peang Lvea Commune, Odongk District, Kampong Speu Province, Cambodia, *Mekong Institute Research Working Paper Series No. 1*, 1-30.

Hufschmidt, G., & Glade, T. (2010). Vulnerability analysis in geomorphic risk assessment. *Geomorphological hazards and disaster prevention,* 233–243. doi.org/ 10.1017/CBO9780511807527.019

Intergovernmental Panel on Climate Change. (2001). Climate change 2001: impacts, adaptation and vulnerability, *Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change,* In J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White (eds). Cambridge, UK, and New York, USA, Cambridge University Press, 2001. No. of pages: 1032.

Intergovernmental Panel on Climate Change. (2014). Annex II: Glossary. In: Climate Change 2014. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Synthesis Report. K. J. Mach, S. Planton, & C. von Stechow, (Eds.). (pp. 117-130). IPCC, Geneva, Switzerland. Retrieved from https://www.ipcc.ch

Kazakis, N., Kougias, I., & Patsialis, T. (2015). Assessment of flood hazard areas at a regional scale using an index-based approach and analytical hierarchy process:

Application in Rhodope–Evros region, Greece. *Science of The Total Environment.* 538, 555–563. doi.org/10.1016/j.scitotenv.2015.08.055

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change, 47*(4), 325–352. doi.org/10.1023/A:10056278 28199

Kongko, W. (2005). Mangrove as a tsunami reduction and its application. APEC-EqTAP seminar on Earthquake and Tsunami Disatser Reduction, Jakarta.

Kuruppu, N., & Liverman, D. (2011). Mental preparation for climate adaptation: the role of cognition and culture in enhancing adaptive capacity of water management in Kiribati. *Global Environmental Change, 21*(2), 657–669, doi: 10.1016/j.gloenvcha. 2010.12.002.

Liu, J. G., Dietz, T., & Carpenter, S. R. (2007). Complexity of coupled human and natural systems. *Science, 317*(5844), 1513–1516. doi.org/10.1126/science.1144004

Mazda, Y., Wolanski, E., & Ridd, P.V. (2007). The Role of Physical Processes in Mangrove Environments. *Manual for the Preservation and Utilization of Mangrove Ecosystem,* Terrapub, Tokyo, 598.

Messner, F., & Meyer, V., (2005). Flood damage, vulnerability and risk perception challenges for flood damage research, 1-19.

Miles, M. B., & Huberman, A. M. (1994). Qualitative Data Analysis: A Methods Source Book. London, Sage.

Morss, R. E., Wilhelmi, O., Meehl, G. A., & Dilling, L. (2011). Improving societal outcomes of extreme weather in a changing climate. *Integrated Perspective Annual Revision in Environment Resource, 36,* 1–25.

Municipal Environment and Natural Resources. (2010). Retrieved from Comprehensive Land Use Plan of the municipality of Masinloc, Zambales.

Olga, V. W., & Donald, A. W. (2002). Assessing vulnerability to agricultural drought: A Nebraska case study. *Natural Hazards, 25*(1), 37–58. doi.org/10.1023/A:1013388814894

Ouma, Y., & Tateishi, R., (2014). Urban flood vulnerability and risk mapping using integrated multi-parametric AHP and GIS: methodological overview and case study assessment. *Water 6*(6), 1515–1545. dx.doi.org/10.3390/w6061515.

Orense, R. P. (2004). Slope failures triggered by heavy rainfall. *Philippine Engineering Journal, 25*(2), 73-90.

Papathoma, M., Dominey-Howes, D., Zong, Y., & Smith, D. (2003). Assessing tsunami vulnerability, an example from Herakleio, Crete. *Natural Hazards and Earth System Sciences, 3*, 377 – 389.

Paz-Alberto, A. M., de Dios, M. J. J., Alberto, R. P. & De Guzman, C. H. E. A. (2018). Climate change impacts and vulnerability assessment of selected municipalities and agroecosystems to support development of resilient communities and livelihoods in Nueva Ecija, Philippines. *American Journal of Climate Change,* 7, 295-335. doi.org/10.4236/ajcc.2018.72019

Penning-rowsell, E. C., Ramsbottom, D., & Surendran, S. (2005). Estimating injury and loss of life in floods: A deterministic framework estimating injury and loss of life in floods: a deterministic framework. *Natural Hazard, 36*, 43-64. doi.org/ 10.1007/s11069-004-4538-7

Raaijmakers, R., Krywkow, J., & van der Veen, A., (2008). Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Natural Hazards, 46*(3), 307–322.

Ranjan, A. K., Vallisree, S., & Singh, R. K. (2016). Role of geographic information system and remote sensing in monitoring and management of urban and watershed environment: Overview. *Journal of Remote Sensing & GIS, 7*(2), 1-14.

Sharma, U., & Patwardhan, A. (2008). An empirical approach to assessing generic adaptive capacity to tropical cyclone risk in coastal districts of India, *Mitigation and Adaptation Strategies to Global Change, 13,* 819-831.

Shrestha, A., (2005). Vulnerability Assessment of Weather Disasters in Syangja District, Nepal: A Case Study in Putalibazaar Municipality Case Study in Putalibazaar Municipality; Advances Institute on Vulnerability to Global Environmental Change; START and Department of Hydrology: Kathmandu, Nepal.

Spalding, M., McIvor, A., Tonneijck, F. H., Tol, S., & van Eijk, P. (2014). Mangroves for coastal defence. Guidelines for coastal managers & policy makers. Published by Wetlands International and The Nature Conservancy. Pp 42.

Tanaka, N., Sasaki, Y., Mowjood, M. I. M., Jinadasa, K. B. S. N., Homchuen, S. (2007). Coastal vegetation structures and their functions in tsunami protection: Experience

of the recent indian ocean tsunami. *Landscape and Ecological Engineering 3*(1), 33-45. doi.org/10.1007/s11355-006-0013-9

Tehrany, M., Shafapour, P., Biswajeet, J., & Mustafa, N. (2014). Flood susceptibility mapping using a novel ensemble weights-of-evidence and support vector machine models in GIS. *Journal of Hydrology,* 512, 332–343. doi.org/10.1016/j.jhydrol. 2014.03.008

Thieken, A. H., Muller, M., Kreibich, H., & Merz, B., (2005). Flood damage and influencing factors: New insights from the August 2002 flood in Germany. *Water Resources Research 41*(12), 1-16. doi.org/10.1029/2005WR004177

Wang, G., & Sassa, K., (2001). Factors affecting rainfall-induced flowslides in laboratory flume tests. *Geotechnique, 51*(7), 587–599.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). At risk, natural hazards, people's vulnerability and disasters. *Journal of Homeland Security and Emergency Management, 2*(2), 1-7.