Assessment of flood risk and adaptation efforts of the communities of Jabonga, Agusan del Norte, Philippines

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Abstract. Lake Mainit is an important ecosystem shared by the provinces of Agusan del Norte and Surigao del Norte. It is the fourth largest lake in the Philippines. It plays a vital role in the lakeshore communities considering that it brings lots of beneficial uses to local people. Because of some anthropogenic activities within its headwaters, flooding incidents in Jabonga become frequent. These brought risks to people's lives and properties. This study aimed to assess the awareness level of lakeshore communities in Jabonga and its adaptation efforts. The study reveals that the people in surveyed lakeshore communities are aware of the risks brought by frequent flooding to their lives and properties however, they still prefer to settle to this identified flood hazard areas. This entails that there is a need to enhance the existing flood risk management program to lessen the vulnerability of the people settling near the lake. This is to achieve sustainability on environmental and social developments.
Key Words: Lake Mainit, flood, Jabonga, awareness, ecosystem, Kalinawan River.

Introduction. Flood has become significant disaster around the world (Tingsanchali 2012). It is an indirect effect of localized anthropogenic activities. An increase of social and economic developments also cost natural disasters. This is due to population growth, changes in land patterns, unplanned urbanization and migration, environmental degradation, and global climate change.

To lessen the vulnerability of communities to future climate change, community based sustainable development and environmental management has to be implemented (Elasha et al 2005). An effective flood risk management takes place in a continuous cycle of planning, acting, reviewing, and adapting (Sayers et al 2013).

Lake Mainit is considered the fourth largest lake in the Philippines shared by Surigao del Norte and Agusan del Norte (Tumanda et al 2005). It receives inflows from 28 major and minor tributaries and discharges only to Kalinawan River. At heavy rainfall events, lake's water level increases and causes flood to lakeshore communities (Amora et al 2014).

This study assessed the level of risk of lakeshore communities through participatory approach. There were three (3) established sampling station of this study: Barangays Bunga, Poblacion, and Cuyago.

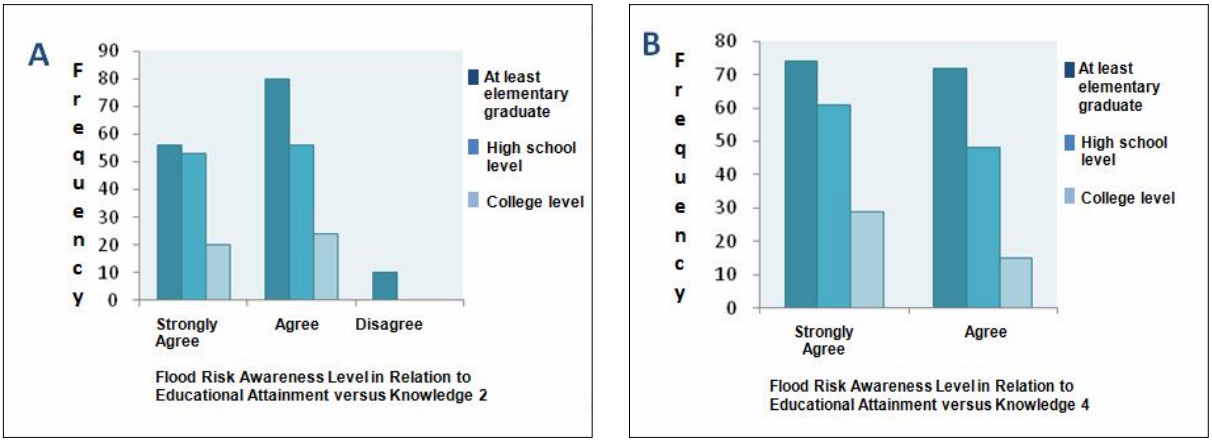
Material and Method. Random household interviews and Key Informant Interviews (KII) were conducted on April 2016. These methods were used to solicit resident's knowledge and attitudes towards flood risk. Qualitative and quantitative method were used to determine the awareness level. Chi-square test of independence was used to determine the significant associations between independent variables.

Topographic and elevation map was used to identify areas vulnerable to flood in terms of height. The map was generated from National Aeronautics and Space Administration (NASA) in 90 m resolution Shuttle Radar Topography Mission (SRTM) developed by Floodmap.net. Flood hazard map from Department of Environment and Natural Resources – Mines and Geosciences Bureau (2015) was used to show areas that are highly susceptible to flood.

Available rainfall data for the years 2014 to 2015 from Local Disater Risk Reduction Management Office of Jabonga were gathered to identify the trend of rainfall events in Jabonga.

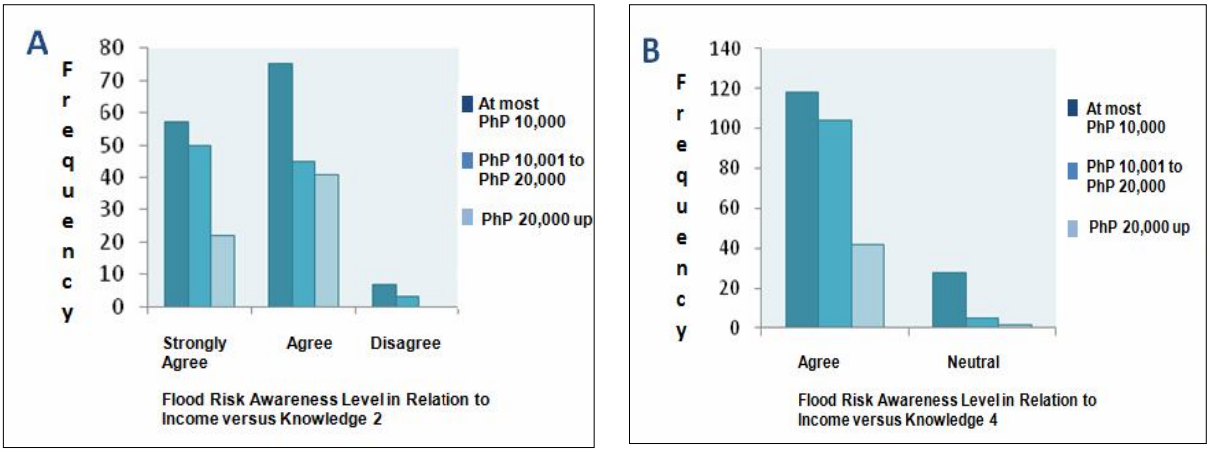
Results and Discussion

Awareness level based on educational attainment and income versus knowledge and attitude. Across barangays, awareness level among respondents differs based on educational attainment versus knowledge. Residents are aware that the frequent flooding of Jabonga is caused by the degradation of the environment and of the Lake Mainit itself (Figure 1A). Fifty-three point fifty-one percent (53.51%) agree, 43.14% strongly agree, and 3.34% disagree. The critical value is 9.49 and the chi-square test statistic is 12.21. The p-value is 0.015, therefore there is no relationship on awareness level between educational attainment and knowledge. Respondents in all levels of education are aware that frequent flooding will give risk to people (Figure 1B). The critical value is 5.99 and the chi-square test statistic is 3. 25. The p-value 0.019.



Figures 1A and B: Distribution of flood risk awareness level in relation to educational attainment versus knowledge 2 (frequent flooding is caused by the degredation of the environment and of the Lake Mainit itself) and distribution of flood risk awareness level in relation to educational attainment versus knowledge 4 (frequent flooding will give risk to people).

Awareness levels across barangays vary based on income versus knowledge 2 (frequent flooding is caused by the degradation of environment and Lake Mainit itself) (Figure 2A). The critical value is 9.49 and the chi-square test statistic is 8.51. The p-value is 0.075, therefore there is a relationship on awareness level among respondents between income and knowledge 2 (frequent flooding is caused by the degredation of the environment and Lake Mainit itself). Respondents who are earning below PhP20,000.00 a month are mostly depending on lake as their source of income. Respondents in all ranges of income are aware that flooding will give risks to people (Figure 2B). The critical value is 5.99 and the chi-square test statistic is 7.34. The p-value is 0.025, thus there is no relationship between awareness level in relation to income and knowledge 4 (frequent flooding will give risk to people).



Figures 2A and B: Distribution of flood risk awareness level to income versus knowledge 2 (frequent flooding is caused by the degredation of the environment and of the Lake Mainit itself) and distribution of flood risk awareness level to income versus knowledge 4 (frequent flooding will give risk to people).

Respondents' awareness level on flood risks in relation to income and attitude 3 (people living near lakeshore areas should be informed for the risk posed by flooding to their lives and property) vary (Figure 3). The critical value is 5.99 and the chi-square test statistic is 5.46. The p-value is 0.065, therefore there is a relationship between awareness level between income and attitude 3 (people living near lakeshore areas should be informed for the risk posed by flooding to their lives and property). Residents in all ranges of income mostly agreed that they should know for the possible risks flooding may brought to their lives and properties

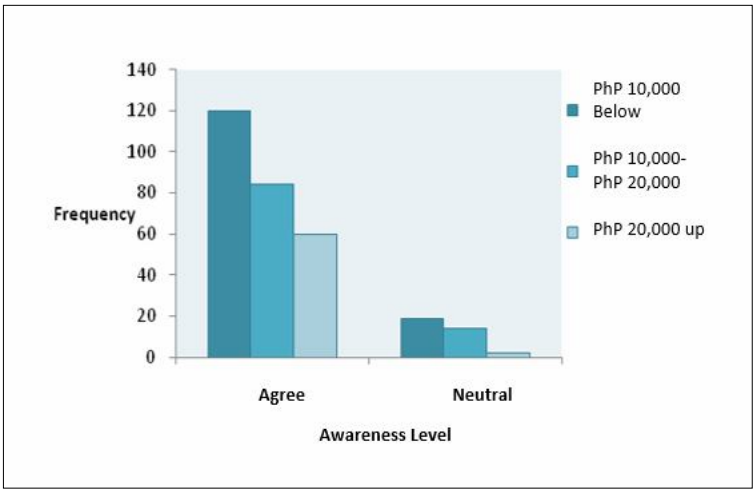


Figure 3. Distribution of flood risk awareness level in relation to income versus attitude 3 (people living near lakeshore areas should be informed for the risk posed by flooding to their lives and property).

Topography and elevation. Jabonga is the third class municipality in the province of Agusan del Norte and lies within the grid of 90 degrees 18 minutes to 9 degrees 23 minutes north latitude and 125 degrees 43 minutes east longitude. It is bounded by Kitacharao and Surigao del Norte to the north; Butuan bay to the west; Tubay and Santiago to the south; and Surigao del Sur to the east. It has a total land area of 29,300 hectares of plain to rolling hilly lands. Its surrounding areas ranges an elevation of 83 to 751 meters (Figure 4A). Most of its lakeshore communities ranges from 83 to 167 meters covering Barangays Bunga, San Pabo, Poblacion, Colorado, Cuyago, and Baleguian (LMDA 2016).

Based on Figure 4B, these lakeshore areas are considered to be highly susceptible to flood. Flood of less than 1 meter occurs roughly at 24 times a year at an estimated flood heights reached to 3.6 meters (LMHPP 2009). Flooding in Jabonga is influenced by the increase of lake water level during peak flows. Lake Mainit has an average annual flow approximately 81 cubic meters per second with evaporation and other losses approaching to 11 cu. m. per second annually, while its only outlet is Kalinawan River with an estimated discharge of 70 cu. m. per second (LMHPP 2009).

There have been identified factors that contribute to the frequent flooding incidents in Jabonga according to Mascarinas (2012). Mining and illegal logging activities at Lake Mainit's nearby areas caused siltation in the river that channels water from lake to sea. It was supported by Reuters (2014) that on January 17, 2014, Jabonganons evacuated due to flooding.

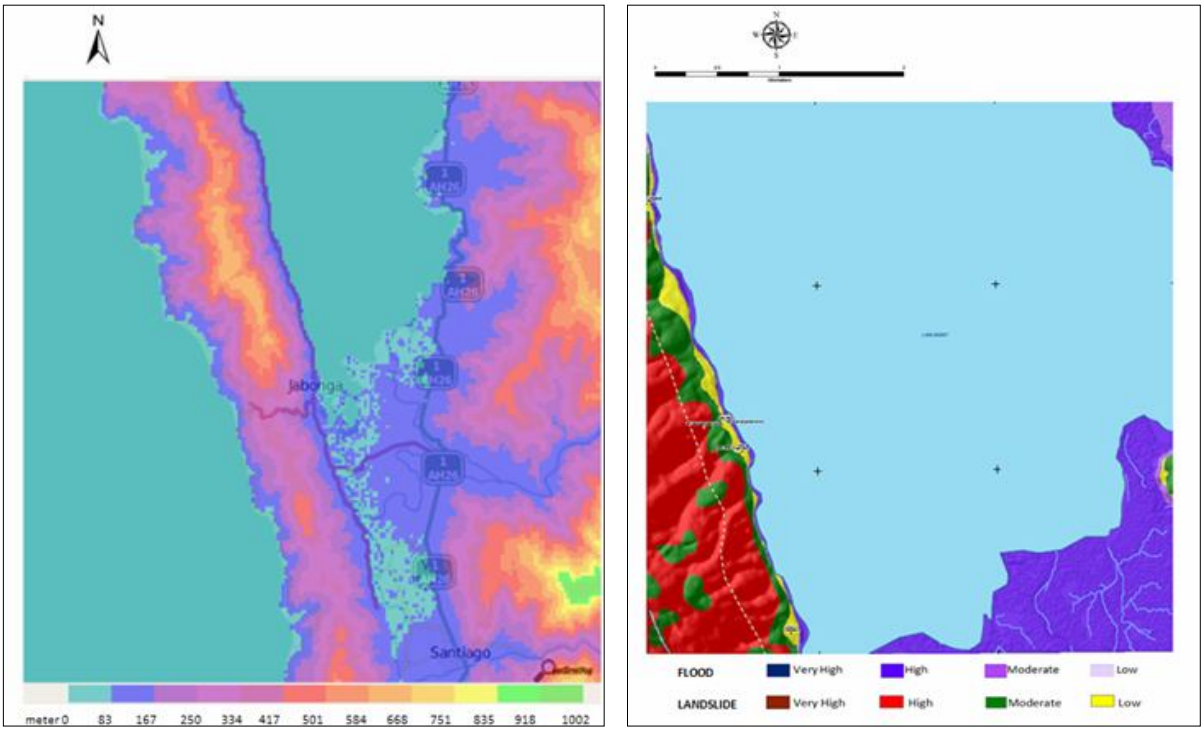
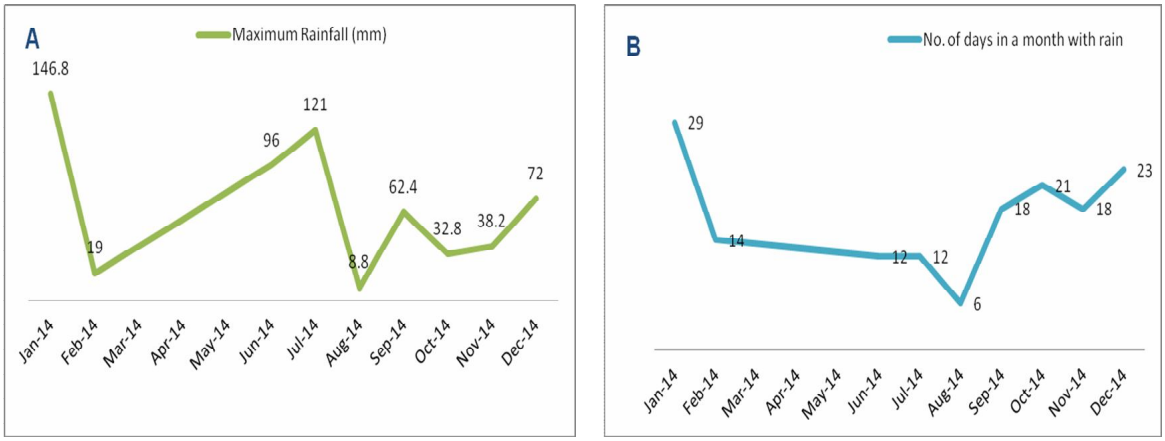


Figure 4. (A) Elevation map of Jabonga, and (B) Flood hazard map of Jabonga.

Rainfall. Based on the data from the Local Disaster Risk Reduction Management Office (LDRRMO) of Jabonga, the maximum rainfall for the year 2014 is 146.8 mm with 29 days of rain that falls on the month of January (Figure 5A). The minumum rainfall is 8.8 mm with 6 days of rain within the month of August. In the same scenario, the maximum rainfall for the year 2015 fall on January at 136.8 mm for only 18 days of rain (Figure 6A). The minimum rainfall is 3.88 mm for 25 days of rain that falls in the month of December. For the year 2015, the average rainfalll is 33.725 mm.

According to Koppen and Geiger climate classification, the climate in Jabonga is classified as (Af) Tropical Rainforest Climate (Climate-Date.Org 2016). It has a significant rainfall throughout the year. Even in the driest month (August), there is still a lot of rain. Its average annual rainfall is 3.522 mm with an average temperature of 26.1^{o}C.



Figures 5. A - maximum rainfall of year 2014; B - number of days in a month of year 2014 with rain.

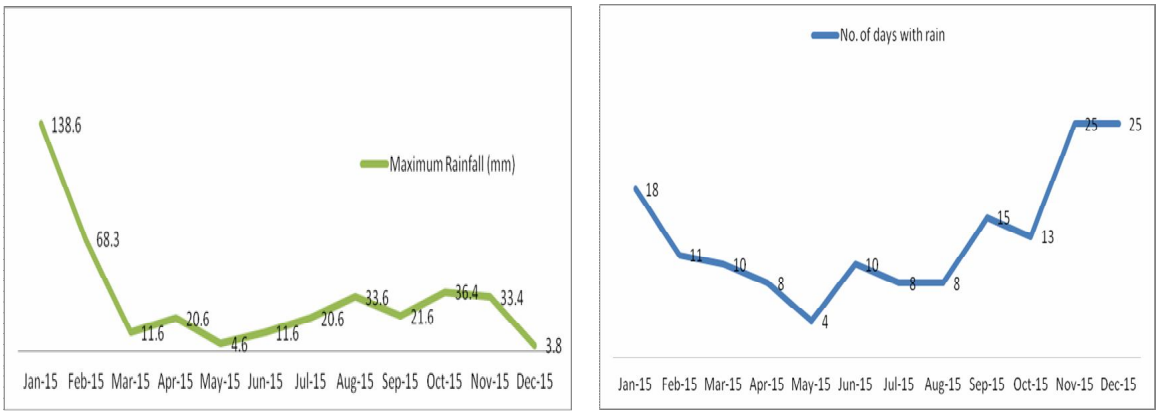


Figure 6. A - maximum rainfall in the year 2015; B - number of days in a month of 2015 with rain.

Management implications. As cited by Sayers et al (2013) complete flood risk management efforts require a cycle of planning, acting, reviewing, and adapting. Respondents are aware of the flood risks to their lives and properties, however their knowledge and attitudes vary. Local Government Units of Jabonga has also extended its efforts in reaching out those vulnerable communities through Municipal Disaster Risk Reduction Management Office (MDRRMO). This is a great challenge in the managing flood risks. Lakeshore areas in Jabonga are identified to be flood hazard area and there are residentials are found within this area. Legal and institutional frameworks should be strictly implemented to lessen the vulnerability of these lakeshore residents. Crafting regulations on the land usage is vital to reduce further proliferation of settlements to this identified flood prone areas.

Intellectual and social capitals can support better management approach (ESSC 2007). In-depth Information, Education, and Communication (IEC) to communities is an essential part in attaining social sustainability. Settling up mitigating measures like installation of additional flood hazard signages and lake water level gauges can help prevent loss of life and damage of properties when flood occurs.

Continuous tree planting program at Lake Mainit watershed should be done in order to maintain the integrity of the watersheds. In this end, trees can help absorb water thus help prevent flooding.

Conclusions. Most of the Jabonganons are aware of the risks brought by flooding to their lives and properties. The local government also has existing strategies to extend their aid to the affected communities in times of flooding. Since there were portions of the studied communities which are located at lower elevation and are considered to be flood prone, there is a need to enhance the existing flood risk management strategies

like in-depth information drives to the residents. The residents should be well informed based on records like January is the expected flood peak month. Continuous awareness drives should be done to minimize the settling of the residents at lakeshore areas. Additional flood warning signages should be installed at lakeshore areas to better inform the public for the consequences of settling near the lake. Installation of censored flood gauge is necessary to easily identify the lake water level and the possibility of flood occurrence. Moreover, using flood prone areas for human activities put risk to lives and property, thus, a review of land use is necessary. Local ordinances should be made and enforce to prohibit proliferation settlements near the flood prone areas.

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References

Amora A. M., Santillan J. R., Santillan M. M., 2014 The development of a hydrologic model for water level forecasting in the Philippines' deepest lake. 3rd Philippine Geomatics Symposium 2014 (PhilGEOS 2014), pp. 1-4.

Climate-Data.Org. 2016 Available at: https://en.climate-data.org/region/1902/. Accessed: November, 2016.

Department of Environment and Natural Resources – Mines and Geosciences Bureau. Flood hazard map, 2015.

Elasha B. O., Elhassan N. G., Ahmed H., Zakieldin S., 2005 Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan. AIACC Working Paper No.17, pp. 1-26.

ESSC-PWG Report: Partnership building towards sustainable management of Lake Mainit. Lake Mainit Development Alliance, Agusan del Norte and Surigao del Norte. February 2007, pp. 1-10.

Lake Mainit Hydro Power Project. IEER. May 2009. ES1-7.

Lake Mainit Development Alliance (LDMA), 2016 Municipality of Jabonga. Available at: https://jabongaagusan.wordpress.com/about/. Accessed: November, 2016.

Local Disaster Risk Reduction Management Office (LDRRMO) of Jabonga. Annual Rainfall Data Year 2014 and 2015.

Mascarinas E., 2012 Logging, mining blamed for recent flood in Jabonga. Mindanews. Available at: http://www.mindanews.com/top-stories/2012/02/21/logging-mining-blamed-for-recent-flood-in-jabonga/. Accessed: February, 2012.

Reuters, 2014 Residents who evacuated their homes due to flooding, gather outside their makeshift tents in an indoor basketball gym in Jabonga, Agusan del Norte. Available at: http://news.trust.org//item/20140117072728-ehttw?view=print. Accessed: December, 2014.

Sayers P., Li Y., Galloway E., Penning R., Shen F., Wen K., Chen Y., Le Quesne T., 2013 Flood risk management: a strategic approach. Asian Development Bank, GWP, UMESCO, and WWF-UK. Available at: https://www.adb.org/sites/default/files/publication/30246/flood-risk-management.pdf. Accessed: November, 2016.

Tingsanchali T., 2012 Urban flood management. Procedia Engineering 32:25-37.

Tumanda M. Jr., Roa E. C., Gorospe J. G., Daitia M. T., Dejarme S. M., Gaid R. D., 2005 Limnological and water quality assessment of Lake Mainit. Mindanao State University at Naawan, pp. 1-53.

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