



Enhancing Adaptive Capacity to Flooding of Households: Evidence from Lakeshore Communities of Pila, Laguna, Philippines

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Abstract

There is a need for households in flood-prone areas to strengthen their adaptive capacities to cope with the negative impacts of climate change. The main objective of this paper is to measure adaptive capacity to cope with the effects of flooding of households in lakeshore communities of Pila, Laguna, Philippines, a municipality with high vulnerability to climate change. The adaptive capacity index (ACI) was estimated by adapting the objective and subjective approaches to adaptive capacity measurements and using both equal and unequal weighting approaches to index estimation with household-level data. We also looked at the levels of adaptive capacity by income group and presented policy recommendations. Overall, the findings of this research suggest that there is a need to prioritize households with low adaptive capacities and be given necessary local government support. Results also suggest the use of appropriate weights for estimating the adaptive capacity index. There were statistically significant differences between the ACIs of households using equal and unequal weighting approaches. Since this study is case-specific, there is a need to conduct further studies using the three weighting approaches and determine how results vary across groups.

Keywords: adaptive capacity, flooding, household level index

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Introduction

Climate change is increasing the frequency and intensity of extreme weather and climate events that are affecting all countries (IPCC, 2014). Projections done by World Bank (2013) revealed that even with the current and planned policies to mitigate climate change, there is a good chance that the world will likely get warmer by more than 4 °C in the next century. This 4 °C increase in temperature exceeds the 1.5 °C threshold given by Small Island Developing States (SIDS) and least developing countries (LDCs). This is expected to bring devastating effects to their development. Southeast Asia in particular, has been considered as one of those at risk from the impacts of climate change. ADB (2009) estimated that by year 2100, Southeast Asia would suffer a 6.7% loss to gross domestic product (GDP) due to climate change, a significant threat to the region's economic growth.

The region's vulnerability to various climate related hazards is attributed to the fact that many Southeast Asian countries are located along coastlines, whose economic activities are concentrated in lakeshore areas, and have large and growing populations that are heavily dependent on natural resources for livelihood. The Philippines is particularly exposed to climate related shocks including cyclones and storms, flooding and drought. In the 2021 Global Climate Risk Index report, Philippines ranked fourth in the world in terms of most affected country by extreme weather events in the last two decades 2000-2019 (Eckstein *et al.*, 2021). The country's exposure to natural hazards, its dependence on climate-sensitive natural resources and vast coastlines has rendered it highly vulnerable to the impacts of climate change (Yusuf and Francisco, 2009).

Every year, an average of 20 cyclones enter the Philippine Area of Responsibility (<http://bagong.pagasa.dost.gov.ph>). Data showed that annual mean temperature in the country had increased by 0.1 °C per decade in the past 65 years (1951-2015) and that the country will continue to experience a rise in mean temperature in the next century. With changes in temperature, seasonal and spatial variations in rainfall across the country will also be experienced. Under high emission scenario for example, reductions in rainfall of up to 40% will be experienced across the country. Sea levels are also expected to increase by approximately 20 cm by end of the 21st century. This might worsen the storm surge hazards in the coastal communities. These projections suggest that the country will continue to experience the damaging effects of climate change. In the past decade, super typhoons including Ketsana and Parma in 2009, Washi in 2011, Bopha in 2012, Haiyan in 2013, Koppu in 2015, Haima in 2016, and Mangkhut in 2018, were recorded to have brought massive damages in the country (UNDRR, 2019). Between 2000 and 2016, the estimated socio-economic damages of natural disasters were about \$20 billion with an average total damage value of \$1.2 billion (Jha *et al.*, 2018). Looking at

specific areas, the Laguna Lake region is considered to be among the most vulnerable areas in the country in terms of natural disasters. It is exposed to flooding incidents over the years. Based on estimates done by ADB, World Bank and JICA in 2010, the cost of flooding damage reached up to PhP111 billion, which is roughly equivalent to 3-24% GDP of Metro Manila and Laguna Lake region (Global Footprint Network, 2013).

In recent years, studies on vulnerability and adaptive capacities, and resilience measurements have been mainstreamed to better understand the effects of climate change. In the context of climate change, IPCC (2001, p. 6) defines adaptive capacity as "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." Adaptive capacity is a component under the vulnerability framework, together with a system's sensitivity and exposure to climate variability (IPCC, 2001). Enhancement of adaptive capacity of a system translates to reducing the system's vulnerability and promoting its sustainable development (IPCC, 2001). Its critical role in reducing vulnerability is mainly attributed to it being characterized by human actions and by its ability to affect the biophysical and social elements of a system (Eakin and Luers, 2006). Ultimately, high adaptive capacity can reduce vulnerability. From the perspective of policymakers, the implications of increasing adaptive capacity and decreasing vulnerability are basically the same, considering that adaptive capacity is a factor that affects vulnerability.

Existing literature suggests that adaptive capacity assessments can be dichotomized between objective and perception-based approaches. Some studies which used objective approaches focused on macro-level assessments (Adger, 2006; Brooks *et al.*, 2005; Vincent, 2007). There have been attempts to measure adaptive capacity at local and case-specific levels (Arias *et al.*, 2014; Ballaran *et al.*, 2014; Defiesta and Rapera, 2014; Eakin and Bojórquez-Tapia, 2008; Vincent, 2007). The adaptive capacity assessments at the national level are mostly using asset-based approach framework which rely heavily on assets and capitals. These studies make use of aggregate proxy data to accommodate comparisons across countries. However, the use of national level assessment indicators is prone to oversimplification of a much more complex reality. Although the assessments at the national level facilitate comparison across countries with the aim of influencing policies at the international levels, these studies had to deal with data and conceptual problems to characterize adaptive capacity (Vincent, 2007). Full understanding of adaptive capacity means including some intangible processes such as "decision-making and governance, fostering of innovation, experimentation and opportunity exploitation, and the structure of institutions and entitlements" (Jones *et al.*, 2010,

p. 1). Furthermore, a framework for adaptive capacity assessment in the local context is vital so it can be supported in broader contexts. Aside from the context-specific assessments, measuring perception also offers an alternative approach to measuring adaptive capacity of households to flooding.

As an alternative approach to measuring adaptive capacity, there are existing studies that explored the perception of households and communities of their own adaptive capacity (Brown *et al.*, 2010; Elrick *et al.*, 2017; Grunblatt & Alessa, 2017; Lockwood *et al.*, 2015; Nguyen & James, 2013). These studies aimed to capture the perception of the households of their adaptive capacity to climate hazards. Elrick-Barr *et al.* (2017) pointed out that even though there are available studies on quantitative measures to adaptive capacity, there is a gap in capturing the perception of households of their capacity needs. Nguyen & James (2013) conducted a study on resilience of households to floods. To operationalize resilience measurement, they used a “subjective well-being approach” to measure resilience of households to floods. With the aid of survey questionnaire, the study made use of ten statements that reflected the subjective assessments of households related to their well-being. The study used factor analysis using the principal components method to analyze the data. Result showed that the first component included the questions related to securing food, income, health, safe evacuation during flood season and recovery after floods.

Our research study gained insights from the existing literature on the theories and methodologies used in measuring adaptive capacity. Specifically, this research study aimed to: (1) assess the adaptive capacity of households from lakeshore communities by using both equal and unequal weighting approaches; (2) look at the levels of adaptive capacity by income group in lakeshore communities of Pila, Laguna; and (3) present policy recommendations relating to adaptive capacity to flooding of households.

Materials and Methods

Study Area

This research was conducted in the five lakeshore communities of the Municipality of Pila, Laguna which is 80 km away from Metro Manila, in the eastern part of Laguna Lake region. The Municipality of Pila has a total area of 3,428 ha and about 300 ha are affected by water rise in Laguna Lake from 10.5 m to 12.5 m (Lasco *et al.*, 2005). This brings devastating effects to households in the lakeshore areas. With added pressures such as increase in built-up areas, percentage of flooded areas is expected to increase. The five lakeshore communities of Pila have moderate to high susceptibility to flooding (DENR, 2018, Figure 1). Key

informant interviews¹ with the Municipal Agriculturist and with the community leaders, officers-in-charge of the agriculture, disaster risk manager were conducted in the five lakeshore communities to gather information on how their community prepare, respond to and learn from climate-related shocks. Socio-demographic and socio-economic conditions of the communities as well as the incidence of climate related shocks and community practices when prompted with shocks were collected. Information from qualitative interviews was useful in designing the questionnaire for the household survey and to identifying priority areas.

Based on the initial interview with the municipal agriculturist, the five lakeshore barangays – Aplaya, Bagong Pook, Linga, Pinagbayanan, and Tubuan –

- 1 Number of key informant interviews: Municipal Agriculturist (1), Pinagbayanan (4), Aplaya (3), Linga (3), Bagong Pook (2), Tubuan (2)

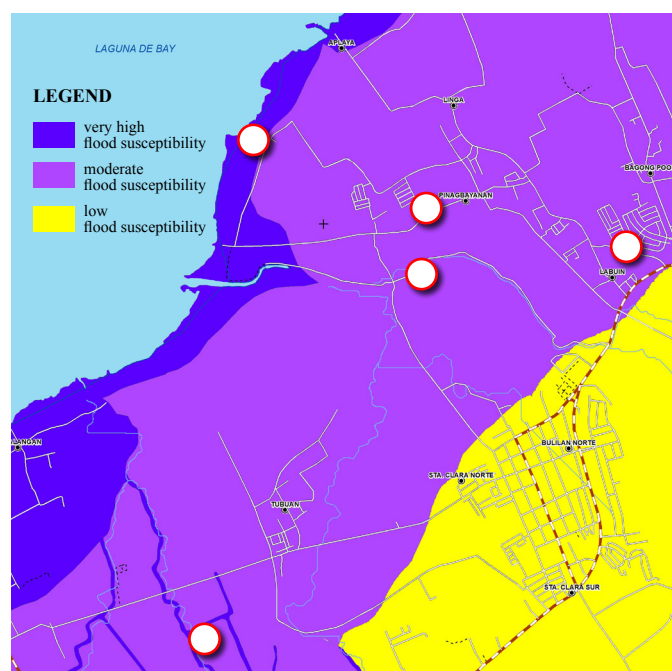


Figure 1. Geohazard map of Pila, Laguna, Philippines showing the five lakeshore communities (white dots)

frequently experience flooding. Three of these lakeshore barangays– Aplaya, Bagong Pook, and Tubuan – were identified as among the most vulnerable barangays in Pila, Laguna for the agriculture sector (Ballaran *et al.*, 2014). The households in these communities are engaged in fishing activities and farming. The dominant crops grown are rice and vegetables. Few households are also engaged in livestock-raising, while some work outside the communities and are employed in some private

companies or are working outside the country. In terms of climate-related shocks, these lakeshore communities often experience flood events due to typhoons. Strong typhoons in the past caused houses near the lake to be submerged in flood waters and forced households to evacuate. Across communities, information dissemination drives to advise their constituents to prepare for calamities are conducted as soon as there is news about typhoons. Community officials are also assigned to monitor the households. The presence of evacuation centers and clinics are also indicative of the community preparedness to respond to natural disasters. Some communities also have emergency boats which can be used to help households evacuate in case their house is submerged in floods.

This study focused on households located in *purok* or *sitio* which are often submerged in floods. From the household population, the Slovin's formula was used to determine the sample size. The population size was the total number of households in *puroks* often affected by floods. The sample size in each barangay was proportional

to the total household population affected by floods. A total of 185 respondents out of 2008 households located in *purok* or *sitio* which are often submerged in floods were chosen using the simple random sampling method. Primary data was collected through household surveys in the five lakeshore communities (Table 1). Most of the respondents were male (66%) and fall under the age of 31 to 50 (61%), with Brgy. Bagong Pook having the highest percentage (84%) of respondents falling into this range. The respondents' age ranged from 21 to 66 years old, with an average age of 45 years old. Majority of the respondents are married (82%), with 8% single, 7% widowed/er and 3% separated. More than half of the respondents (56%) have a household size ranging from four to six, 24% had household size of at most three members, and the remaining 20% of respondents comprised of seven to 15 household members.

Average household size across all sites is five, with a range of one to 15 household members. Dependency ratio, computed by dividing the number of non-working household members by the number of working household

Table 1. Socio-demographic characteristics of respondents

ITEM	PINAGBAYANAN	APLAYA	LINGA	BAGONG POOK	TUBUAN	ALL SITES
Age (%)						
At most 30	11.9	12.2	6.7	4	13	10.8
31-50	54.8	46.9	73.3	84	63	60.5
51 and above	33.3	40.8	20	12	24.1	28.6
Ave. (years)	46	46	46	43	45	45
Std. error	1.97	1.72	2.82	2.117	1.7	0.89
Range	25-66	22-65	29-66	21-60	21-66	21-66
Gender (%)						
Male	54.8	83.7	53.3	72	59.3	65.9
Female	45.2	16.3	46.7	28	40.7	34.1
Marital Status (%)						
Single	4.8	8.2	13.3	4	11.1	8.1
Married	81	85.7	80	84	79.6	82.2
Widowed/er	11.9	6.1	6.7	4	5.6	7
Separated	2.4	0		8	3.7	2.7
Household size (%)						
3 and below	16.7	16.3	26.7	8	44.4	24.3
4 to 6	64.3	65.3	53.3	76	33.3	56.2
7 to 15	21.4	18.4	20	16	22.2	20
Ave.	5	5	5	5	5	5
Std. error	0.34	0.26	0.45	0.39	0.34	0.16
Range	2-15	1-9	2-8	3-11	1-14	1-15
Dependency ratio	3	3	2	3	3	3
No. of observations	42	49	15	25	54	185

members, is three in most sites except Brgy. Linga with dependency ratio of two.

Estimation of Adaptive Capacity Index (ACI)

The first step in developing the ACI was the selection of component indicators (Figure 2). The adaptive capacity of a given household in this research was defined as:

$$AC = f(E_i, P_i, H_i, Pe_i)$$

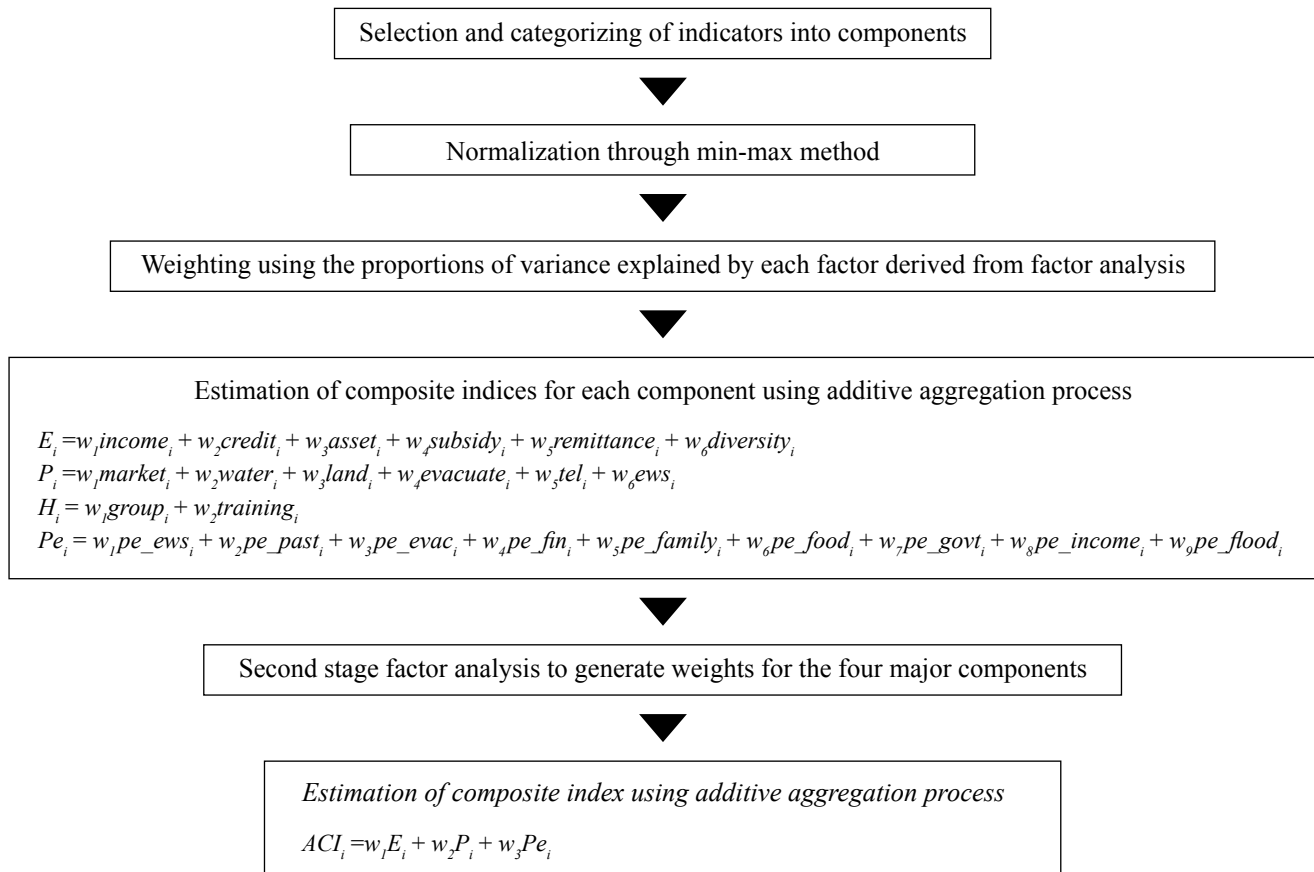
where AC = adaptive capacity, E_i = economic resources, P_i = physical resources, H_i = human resources, and Pe_i = perception of households of their adaptive capacity.

Each component (E_i , P_i , H_i , and Pe_i) was comprised of selected indicators (Appendix A). Some indicators used in this research study were tailored from studies measuring adaptive capacity at the household level (Defiesta & Rapera, 2014; Eakin & Bojórquez-Tapia, 2008; Nguyen & James, 2013). The studies done by Defiesta and Rapera (2014) and Eakin and Leurs (2008) categorized their variables into the sustainable livelihoods framework. The sustainable livelihoods

framework revolves around five main capitals - human, financial, physical, natural, and social capital - that capture the complexities of poor people's livelihoods, as well as the challenges and opportunities they are subjected to. The sustainable livelihoods approach is also used in vulnerability and impact assessments under the context of climate change (Defiesta & Rapera, 2014). In this research, the indicators were classified into three capitals – economic, physical, and human resources. There were six indicators under the economic resources (E_i) component, namely: monthly household income, credit amount, value of asset, government subsidy, remittances, and diversity of income sources. The physical resources (P_i) component, on the other hand, was composed of the following indicators: distance to market, access to potable water, landholding, access to evacuation place, telecommunication, and early warning system. Human resources (H_i) component was comprised of group membership and training.

The perception component was added to include context-specific elements to this research. Subjective assessments of households can provide insights into how they deal with flooding. The indicators under the perception

Figure 2. Process in estimating the adaptive capacity index



component were tailored from the study done by Nguyen and James (2013) where they used a subjective approach to measure the resilience of households to floods. Respondents were asked to rate statements related to their adaptive capacities. Each statement used a 5-point Likert scale ($1 = \text{strongly disagree}$, $2 = \text{disagree}$, $3 = \text{neither agree nor disagree}$, $4 = \text{agree}$, $5 = \text{strongly agree}$). This can be potentially useful to add insights to the objective approach of measuring adaptive capacities of households and what factors will affect their capacity to adapt to future shocks based on their subjective assessments. The statements aimed to capture the perception of household of their adaptive capacity in terms of their confidence to prepare for flooding given their access to early warning information and their past experiences. The statements were used to gauge the confidence of households in their ability to secure a place to evacuate, income, food, and presence of people and institutions to rely to in case they need help. There was also a statement that captured the confidence of households to recover from a flooding event. The questionnaire was pre-tested to test the appropriateness of questions and determine if the questions need further refinement. The computed Cronbach's alpha coefficient was 0.79, which means that there was internal consistency in the questions used related to perception of households.

Given that the indicators have different measurement units, the data set was normalized prior to calculating the ACI to make sure that the variables were at least comparable (OECD, 2008). This research used the min-max normalization which resulted in each indicator having range of [0,1]. The following equation was used to normalize variables which have positive influence on ACI:

On the other hand, for those variables with negative influence on ACI:

where $y = 1$ if indicator; $y = 0$ if indicator for all observations

$$y = \frac{Max\{X_i\} - X_i}{Max\{X_i\} - Min\{X_i\}}$$

To estimate adaptive capacity, it was necessary to estimate separately E_i , P_i , H_i , and Pe_i before estimating the ACI. After normalization, each component was estimated by assigning weights to the variables. In addition, available literature suggests that there are three methods used to assign weights to indicators: use of equal weights

(i.e., Arias *et al.*, 2014; Ballaran *et al.*, 2014); through expert judgment facilitated through AHP (i.e., Defiesta & Rapera, 2014); and through statistical methods such as principal components analysis or factor analysis (i.e., Gbetibouo *et al.*, 2010; Tambo & Wünscher, 2017). This study used both the equal weights and unequal weights. The ACI for both approaches was estimated using the formula:

$$ACI = w_1 E_i + w_2 P_i + w_3 H_i + w_4 Pe_i$$

where ACI = weighted sum of the factors; w_1, w_2, w_3, w_4 = weights of the components; E_i = estimated value of economic resources; P_i = estimated value of physical resources; H_i = estimated value of human resources; Pe_i = estimated value of perception.

In the equal weighting approach, it was assumed that the indicators contributed equally to the components. Hence, the weights of the components were the average of all the variables. Consequently, the weight of the ACI was the average of the four components. In the unequal approach, factor analysis for each component was conducted to generate weights for the indicators. The weights of each indicator were the proportion of variance explained by each factor. Each component was a weighted average of all the indicators. The value of ACI was estimated by conducting a factor analysis using the estimated values of the four major components. Similar to the process used to estimate the four components, the weights were the proportion of variance explained by each factor and the ACI was estimated using the aggregation method.

The computed ACIs were compared to the levels of adaptive capacity that fall within 0-1, with 0 being the lowest value of adaptive capacity (Appendix B). Low adaptive capacity level meant a household had low scores in the four main components. Households with low levels of ACI had to identify the factors that contributed to low capacity in order to raise their ACI level. On the other end, it was helpful to identify the factors that contributed to the high levels of adaptive capacity of those households with high levels of ACI.

Results and Discussion

The graphical representation of results of the estimation of the four main components – using equal and unequal weighting approaches by income classification – is illustrated in Figure 3. The figures suggest levels of economic, human, and perception were at consistent levels of classification. It is worth noting that perception levels were high. The respondents had high scores for the statements related to their perceived capacity. The main takeaway from this is the fact that households are confident that they had available people to turn to when they faced climate shocks. In particular, they were confident that they had social safety nets or social circles which they could turn to in case they needed help. These

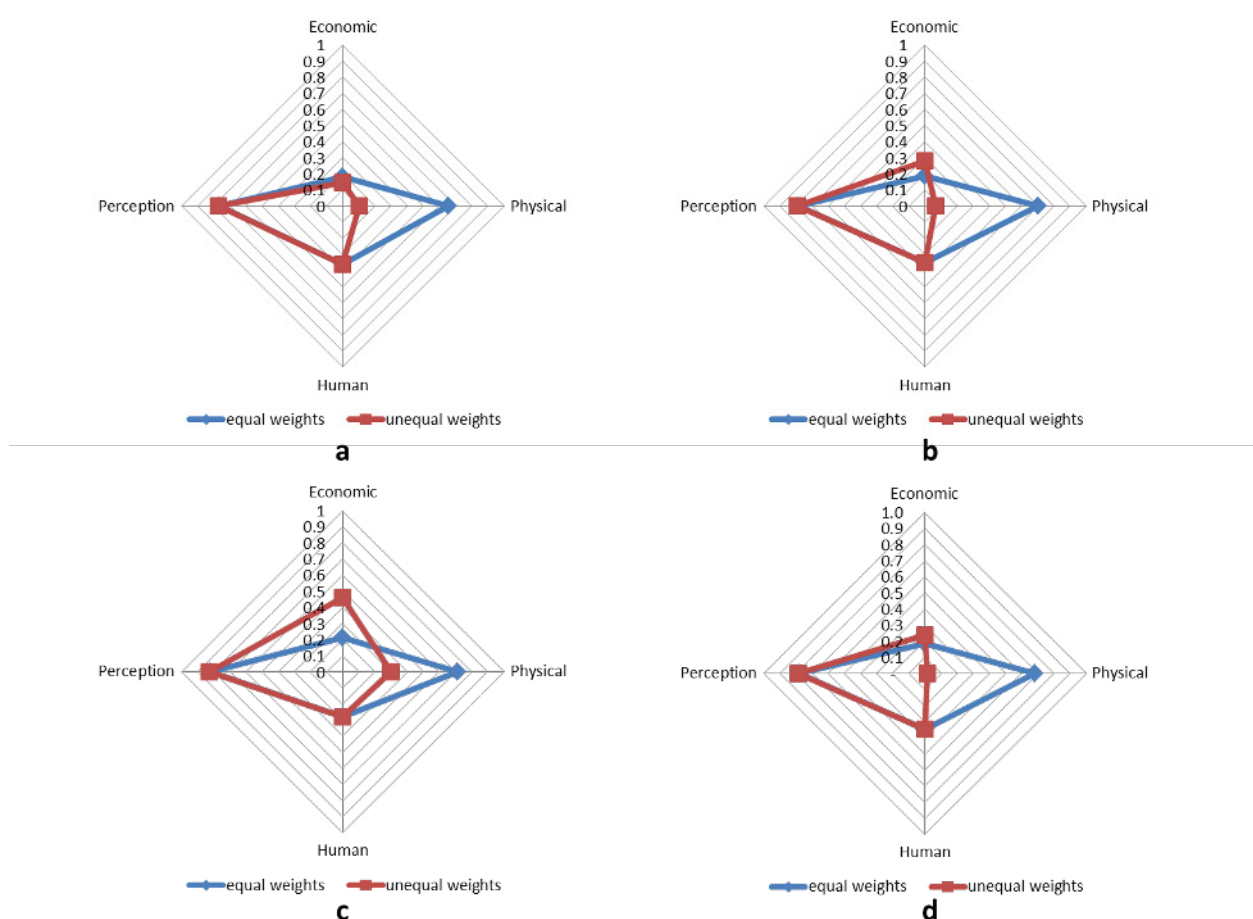
statements made reference to the availability of social circles such as the confidence of households in getting government support in case help was needed. The households were also in agreement to statements that included access of households to help from friends and family members (see Appendix A). Results also showed that the households in the lakeshore communities were also confident in their ability to secure food and be prepared in case there was flood. In contrast, households had lower agreements to having access to other sources of income in case their primary source of income was affected by extreme floods. This might be an indication that households do not have a financial safety net for unexpected events such as flooding. Households' income sources were easily affected by climatic events. There is not much variability in terms of income source of households because most of the household sources of income were locally stationed. The households also did not quite agree when asked if they were confident that they could recover fast from flooding. The results from the perception component relate to that of Nguyen and James' (2013) study. Ability to secure income and food when flooding occurs also affect household perception

about their vulnerability. Availability of social networks add to the confidence of households in securing food and income.

The economic component was at low levels, regardless of the weighting approach used. Looking at the data collected, majority (85%) of respondents belonged to poor and low income classifications. The income of the respondents from the lakeshore communities under this study was below the poverty threshold. Poor and low income households had only at most two income sources and had higher dependency ratios compared to lower middle income households. In addition, only 35% of households received government subsidy; a small proportion (8%) of them received remittances from relatives working abroad; and half had availed credit from sources such as microfinance, informal credit, and relatives.

Variables under the physical resources suggest that the local officials failed to reach out to all its constituents to disseminate information on occurrence of climate shocks and availability of evacuation place. Only 67%

Figure 3. Adaptive capacity components by weighting technique: **a** poor households, **b** low income households, **c** middle income households, **d** all households



of households reported to have access to early warnings prior to occurrence of climate shock and 89% reported to have access to a place to evacuate despite the presence of evacuation place in each community. Evacuation place must be made available to those households that need to evacuate if they need to. Moreover, low levels of human resources provided an indication that the households did not belong to any community organizations and had no access to training related to disaster management.

This study also looked into two weighting approaches used in estimating an index. The objective was to determine if the weighting approach had an effect on the estimated components, and consequently on the prioritization of interventions by policymakers. First, it was determined if there were differences in the estimated components used in this study when using both weighting approaches. Results showed that there were statistically significant differences between means of economic, physical, and perception (Table 2). The striking difference in means was observed with the physical resources. Using the equal weighting, physical resources component was 0.680, which was significantly higher than the 0.017 using the unequal weighting approach.

The economic resources were at low levels with 0.185 and 0.239 for equal and unequal weighting, respectively. The difference in these values was also statistically significant. The same case was observed for the

Table 2. Effect of weighting techniques to components of household adaptive capacity

Component	Component value		t-test statistic
	Equal weight	Unequal weight	
Economic	0.185	0.239	(2.24)**
Physical	0.680	0.017	15.95**
Human	0.346	0.346	0.00 ^{ns}
Perception	0.782	0.786	(0.22)**

** significant at $\alpha = 0.05$

^{ns} = not significant

perception levels. The estimated perception level using equal weights was 0.782; and 0.786 using the unequal weights. Furthermore, the levels of human resources yielded the same results because there were only two variables under this component. When the weights were normalized using unequal approach, it resulted in 0.50 for each variable, which was the same as the equal weighting approach.

The economic resources were at low levels with 0.185

and 0.239 for equal and unequal weighting, respectively. The difference in these values was also statistically significant. The same case was observed for the perception levels. The estimated perception level using equal weights was 0.782; and 0.786 using the unequal weights. Furthermore, the levels of human resources yielded the same results because there were only two variables under this component. When the weights were normalized using unequal approach, it resulted in 0.50 for each variable, which was the same as the equal weighting approach.

The estimated ACIs are presented in Figure 4. Similar to the results for the estimation of the main components, the figure shows differences in the ACIs using equal and unequal weighting approaches. Equal weighting approach suggests that all households have at most a moderate level of adaptive capacity (0.498), while the unequal weighting approach showed households had low levels of ACI (0.361). Data was further segregated into different levels of income which generated different results. Poor households had higher ACI when equal weighting approach was used (0.490) compared to the unequal weighting approach (0.296). For low income households, the computed ACI (0.507) was moderate when the equal weighting approach was used, and low (0.391) when the unequal weighting approach was used. For lower middle income households, the ACI was consistent at moderate levels, with 0.506 for equal weighting approach and 0.517 for unequal weighting approach.

In the research study, although the ACI classification of poor income households were at the same level of index classification, the difference was statistically significant. The differences between the scores for poor ($t = 8.30$)

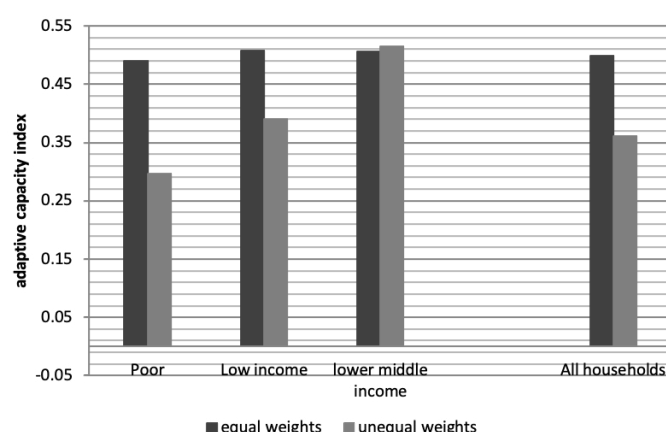


Figure 4. Adaptive capacity index by income classification

and low income ($t = 4.32$) households were statistically significant (Table 3). On the other end, there was no statistically significant difference between ACIs of lower middle income households.

The above discussion on weights implies that the use

of weighting approaches has significant effect on the estimation of index. The study done by Tambo and Wünsch (2016) which estimated resilience index

Table 3. Effect of weighting techniques on adaptive capacity of households by income group

Income classification	Adaptive Capacity Index (ACI)		t-test statistic
	Equal weight	Unequal weight	
Poor	0.490	0.296	8.30**
Low income	0.507	0.391	4.32**
Lower middle income	0.506	0.515	(0.19) ^{ns}
All households	0.498	0.361	7.91**

** significant at $\alpha = 0.05$

^{ns} = not significant

of farmers to climate shocks also used both equal and unequal weighting approaches. When equal weights were used, the results suggested that the farm households were moderately resilient. However, the same respondents were not resilient when unequal weighting approach was used. There were significant differences in the estimated resilience indices. If these results are compared to existing studies using AHP for weights (i.e., Defiesta & Rapera, 2014), there can be found some striking contrast. In Defiesta and Rapera's (2014) study, economic component ('Financial resources') scored the highest weight among all the resources. Having good financial resources implies that a certain household has the financial capacity for adaptation to risks brought by climate change.

Conclusions

The objective of this study was to assess the adaptive capacity of households in lakeshore communities susceptible to flooding. We postulated that the way households respond to climate shocks depend on the available resources that they have, and on their confidence in their ability to adapt to these climate shocks. Results suggest that the adaptive capacity levels of households from the lakeshore communities are at low levels. This means that households have low ability to adjust to climate shocks such as flooding. This further implies that their adaptive capacity has to improve so they can adjust to and cope with flooding. Looking at the components, perception levels were consistently high. The perception component in this study served as the subjective assessment of households of their adaptive capacity. The respondents had high scores to the statements related to their perceived capacity. However, even though the

perception levels were high, the mean ACIs were at low levels. Using the unequal weights approach showed that economic and physical resources components had comparable weights with the perception component.

The results of this study found that most of the households in lakeshore communities in the Municipality of Pila have low levels of ACI, specifically with regard to economic, physical, and human resources. This suggests that certain resources are needed to increase their adaptive capacities. At the barangay level, the following actions that community officials can undertake are recommended: (1) have an inventory of all households in the community, with information on the household members, contact numbers, and status of household dwelling in case they need to be evacuated when there is extreme flood; (2) reach out to all constituents to make sure they have access to information on occurrence of climate shock and help them prepare; (3) make sure that evacuation centers are functional and ready in case typhoons or monsoon rains are expected to cause flooding; (4) conduct capacity building activities for households related to adaptation and mitigation practices needed for climate related shocks; (5) prioritize those households with low levels of adaptive capacities in case the community is expected to experience extreme flooding; (6) be updated on information related to climate related risks, possible flooding, and evacuation; secure emergency funds to be used in case there are unanticipated emergencies such as flooding; and (7) invest in infrastructure improvements in the community especially on the construction of proper sewage system. For the local government of Pila, the following actions are recommended: (1) provide livelihood assistance to households belonging to poor income classification; (2) conduct capacity building activities for local community leaders related to disaster management; (3) make sure that the community organizations are accessible to all constituents; and (4) invest in infrastructure improvements in lakeshore communities especially on the construction and improvements of sewage system and evacuation centers.

The results of this study further suggest that weighting approach may have implications on the recommendations which will be used by the policymakers. If this research study only offered the results of the equal weighting approach, priority will be given to economic and human resources. On other end, if the study only offered the results of the unequal weighting approach, priority will be given to households' access to physical resources. The methodology in this study also provided ways on how to estimate the adaptive capacity levels using household level data. Other flood-prone municipalities could map AC levels of households in similar areas. By using this assessment, local governments can identify the levels of adaptive capacities of households and the factors affecting it. Local governments can also identify the households with low levels of adaptive capacity and can prioritize them in case an extreme flood is anticipated.

The study also recognizes that the index measurement has limitations. The selection of indicators can be disputed as subjective. Some indicators were tailored from existing studies which also aim to measure capacities to cope with climate change and variability. Studies for other flood-prone areas to validate and examine the variables used in this study will provide a significant improvement in assessing adaptive capacity at the household level. Further studies are also recommended to validate the adaptive capacity levels using the three approaches to using weights for the variables and to determine how results would vary across groups.

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APPENDIX A

Indicators used for estimation of household adaptive capacity

Component	Indicators	Description	Relationship with adaptive capacity
Economic (E_i)	Monthly household income	Monthly household income from all sources (PhP)	+
	Credit amount	Value of credit received the previous year	+
	Value of asset	Total value of productive assets (PhP)	+
	Government subsidy	Total amount of transfers received monthly from institutional sources (PhP)	+
	Remittances	Monthly remittances received from household members (PhP)	+
	Diversity of income sources	Total number of income sources (count)	+
Physical (P_i)	Distance to market	Distance to the nearest market (km)	-
	Access to potable water	Household has access to potable water (dummy)	+
	Landholding	Area of permanent dwelling of household (m^2)	+
	Access to evacuation place	Access to evacuation place (dummy)	+
	Telecommunication	Ownership of telecommunication devices (dummy)	+
	Early warning system	Household receives information from village officials about climate shocks prior to its occurrence (dummy)	+

APPENDIX A
Indicators used for estimation of household adaptive capacity

Component	Indicators	Description	Relationship with adaptive capacity
Human (H_i)	Group membership	A household member belongs to a group/ association (dummy)	+
	Trainings	Number of trainings/seminars attended related to disaster management (count)	+
Perception (Pe_i)	I am confident that our household can have access to early warning information during extreme floods		+
	Given our past experience, I am confident to say that our household are better prepared for future flooding/ climate related shocks		+
	I am confident that our household can find a safe place to evacuate to if there is an extreme flood event in the future		+
	I am confident that our household can have access to financial support from formal sources during extreme floods		+
	I am confident that our household can rely on the support of family and friends in case we'll need it		+
	I am confident that our household has enough food to eat during a flood event		+
	I am confident that our household can rely on government support in case we'll need help		+
	During extreme floods, in case our primary source of income is affected, our household can resort to other sources of income		+
	I am confident that our household can recover fast from flooding		+

APPENDIX B
Levels of adaptive capacity and their corresponding values

Component	Indicators	Description
Low	0.00-0.50	A household has low ability to adjust to climate shocks such as flooding.
Moderate	0.50-0.79	A household has capacity to adapt but there is still a need to identify the factors that can be targeted to raise their level of adaptive capacity.
High	0.80-1.00	A household has high chance of coping with the pressures of environmental stresses (flooding).

Source: Arias *et al.* (2014)