Local Communities Vulnerability to climate change at Indawgyi Biosphere Reserve in Myanmar

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Abstract

The purpose of this study was to explore the vulnerability to climate change of local communities and to assess factors affecting the vulnerability of local communities to climate change in the Indawgyi Biosphere Reserve, Myanmar. Semi-structured questionnaires were distributed to 218 household heads from two different communities' villages in Indawgyi Biosphere Reserve, Myanmar. Households vulnerability index (HVI), descriptive statistics and chi-square tests were used in the analysis. The results showed that the majority of participants had low vulnerability (47.3 %), moderate vulnerable (46.3 %), and only 6.4 % of participants had a high vulnerability. Moreover, gender, education level, and employment status were found to be statistically associated with the vulnerability level. Even though most of the local communities' vulnerabilities to climate change was low and moderate level, some of them were found to be highly vulnerable. Therefore, enhancing the climate change resilience of rural livelihoods through community-based restoration should be conducted in the biosphere reserve in order to improve the local community's climate change adaptation programs.

Keywords: *Household' vulnerability, Climate change, Rural livelihoods, Household vulnerability index (HVI)*

1. Introduction

Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C (IPCC, 2018). Moreover, rural people are subject to multiple non-climatic stressors especially in developing countries, including underinvestment in agriculture, problems with land and natural resource policy, and processes of environmental degradation (Parry et al., 2007). The Asian Development Bank (2009) reported that Southeast Asia is expected to experience more climate change impacts than other regions because it is located in the world's most vulnerable regions, and has climatic hazards such as storms, sea-level rise, droughts, and heatwaves. However, there seems to be an inadequate capacity to cope with this problem (Zhuang, 2009). Agricultural productivities, biodiversity, forest harvests, and the availability of clean water will be negatively affected by climate variations. These negative impacts could slow down development in economic, affecting economic losses of 6.7% of gross domestic product (GDB) each year by 2100. It is over double the global average loss of 2.6% and threatens the livelihoods of lots of people (Zhuang et al., 2009).

Myanmar ranked second among the world's top 10 countries most affected by extreme weather events in the last 20 years, according to the Global Climate Risk Index by think-tank German watch (Kreft et al., 2016). According to natural disasters between 2002 and 2012, the three cyclones affected over 2.6 million people were occurred, which 2.4 million was affected only by cyclone Nargis in 2008, the worst damage in Myanmar's history. Moreover, floods affected over 500,000 people, and the two most massive earthquakes affected over 20,000 people have happened during these periods. Therefore, Myanmar ranked first as the most at-risk country in Asia pacific according to UN risk model (OCHA, 2012). This disruption to normal patterns of life may also be sudden, unexpected, and widespread. The local community needs shelter, food, clothing, medical assistance, and social care. In Myanmar, climate change prediction is expected to have negative impacts on the entire socio-economic functioning of the country. The Coastal, Central Dry and Northern Hilly areas of the country are most vulnerable to climate change impacts (NAPA, 2012). The developing countries are among the most vulnerable and face more severe consequences from the impact of climate change (Gohar et al., 2016). Regarding climate, local farmers in developing countries focus on changing rainfall patterns. Their consequences for water resources are considered to have the most significant potential impact on water supply. The degree of vulnerabilities is susceptible and able to increase farmers' resilience to climate change. It can also be used to conduct more research to prepare farmers' perception of climate change, farmer's vulnerability to climate change and expected changes in the future as Myanmar highly depends on rain-fed agriculture (SD21, 2012). Likewise, enhancing the climate change resilience of rural livelihoods through community-based restoration at the Indawgyi Lake watershed area in the Northern Hilly Region is one of the priority sectors: Agriculture, Early Warning Systems and Forest (NAPA, 2012).

Both ecosystems of the biosphere reserve, including wetlands habitats and livelihoods of the local community such as socio-economic activities, are affected by climate change impacts including increasing temperatures and rainfall variability, and others (MONREC, 2017). Assessing vulnerability to climate change is important for defining the risks posed by climate change and provides information for identifying measures to adapt to climate change impacts. It enables practitioners and decision-makers to identify the most vulnerable areas, sectors and social groups. In turn, this means climate change adaptation options targeted at specified contexts can be developed and implemented. Moreover, climate change-related research such as determinants of Household vulnerability to climate change is urgently needed in the Indawgyi Lake Biosphere Reserve in order to meet two main objectives of the biosphere reserve, to mitigate climate change and to support climate change adaptation programs, which are leading to fulfilling UN SDG goal 13 (MONREC, 2016). Thus, this research aims to assess the household's vulnerability to climate change in Indawgyi Lake Biosphere Reserve and to assess factors determining household vulnerabilities to climate change in Indawgyi Lake Biosphere Reserve.

2. Objectives

1. To explore vulnerability to climate change of local communities in Indawgyi Biosphere Reserve
2. To assess factors affecting the vulnerability of local communities to climate change in Indawgyi Biosphere Reserve

3. Materials and Methods

3.1 Theoretical background for the study

Vulnerability assessment is a central moment in adaptation activity to mitigate adverse climatic impacts (Corobov et al.,2013), and it can also be defined and approached in more than one way because vulnerability is a complex and multifaceted concept with social, economic, physical, and environmental dimensions (Adger et al., 2005). Moreover, Pearson et al. (2011) believe that, because of the different conceptualizations of vulnerability, there are different ways of assessing it and sometimes overlapping with each other. In this study, the starting point is that vulnerability is conceptualized as a state that exists before encountering a climatic shock (Gbetibouo et al., 2009). The analysis focuses on the drivers of the current adaptive capacity and susceptibility of the household to climate change-induced risks. The current adaptive capacity of households is depicted by human, physical, financial, natural and social capitals which they own. These capitals influence their vulnerability (Piya et al., 2012). In this study, we will use the Household Vulnerability Index (HVI) in order to understand the adaptive capacity of a household fully. The index will be computed from the five livelihood assets of a household based on the Sustainable Livelihood Framework. Regarding the strengths of HVI tool, it is a simple statistical tool which is easy to use and saves time and money. However, the HVI tool still has limitations because HVI does not have the costs of assets and services attached to adaptation measures. Moreover, the tool does not account for gender dimensions of vulnerability.

3.2 Study area

This study was conducted to explore vulnerability to climate change of local communities in Myanmar with particular reference to Indawgyi biosphere reserve in Mohnyin Township, Mohnyin District, Kachin State that has been most affected by climate variability (MONREC, 2017). Two communities' villages, namely Lon Ton and Lon Sant, were purposively selected as the research sites to examine the level of households' vulnerability to climate change.

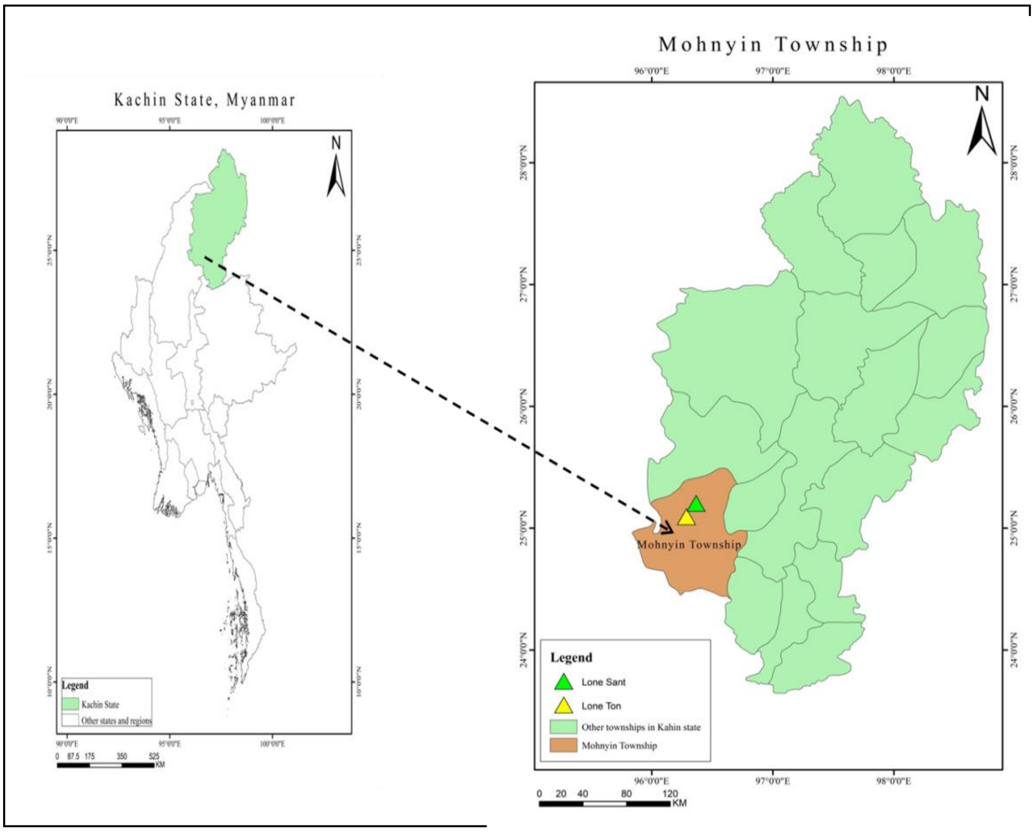

Figure 1 Study area map (MIMU, 2019)

3.3 Methods

In this study, a descriptive research design was used in order to explore the local communities' vulnerabilities to climate change and to assess the factors that affect the vulnerability of local communities in Indawgyi biosphere reserve. Since the study attempts to identify the level of local communities' vulnerability to climate change, a quantitative approach has been used in this study. In order to collect the quantitative data, a semi-structured questionnaire with close-ended questions was mainly used.

3.4 Sample size and data collection

The target population for this study was local farmers who have been living in the study area for more than 10 years. The inclusion criteria were the participants who are above 18 years old and can speak Myanmar language with the duration of living in the study area for more than 10 years. Additionally, exclusion criteria were the participants who are included in inclusion criteria but unable to give the information.

According to the administration unit, total households of selected villages are 479, which 229 households for Lone Ton village and 250 households for Lone Sant village (GAD, 2017; Bhandari et al., 2015). The sample size calculation was based on the 95% confidence level of Taro Yamane (1973) formula and a margin of error of 5% from 479 total household respondents of two selected villages. Of these total

479 households, 218 households were chosen for detailed investigation by using simple random sampling methods. Data collection was started from December 2019 to January 2020.

Data was collected by the researcher and one research assistant through face to face household interview questionnaires after getting approval from Mahidol University Central Institutional Review Board (MU-CIRB 2019/253.0110). Before data collection, pre-test questionnaires were done with 30 randomly participants selected from Indawgyi region. Cronbach's alpha tests were used to find the reliability of questionnaires. The reliability value at the first test was less than 0.5. The questionnaires were revised, and the second pre-test was done again. The value of Cronbach's alpha in the second pre-test was 0.618, which is acceptable moderate reliability (Perry, 2004). For the protection of human subjects, the investigator carefully explained the aim of the study, how to answer the questions, and the survey protocol through the informed consent form and participant information sheet. They also are informed that the answers to each respondent would be kept anonymous and confidential.

3.5 Data analysis

The first phase of the analysis included calculation of household vulnerability through Household vulnerability index (HVI) which is developed by Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN) in order to explore the local community vulnerability (Sibanda et al., 2008; Nkondze et al., 2013; Ncube et al., 2016). The HVI assesses "external" vulnerability that is introduced by a defined shock or shocks, e.g. climate risks, and others, and "internal" vulnerability or inability of such a household to withstand shocks in general. It is based on the Sustainable Livelihoods Framework (SLF) developed by the Department for International Development (DFID, 2000). It uses Fuzzy logic to assess a household's access to (1) natural assets such as land, soil and water; (2) physical assets such as livestock and equipment; (3) financial assets such as savings, salaries, remittances or pensions; (4) human capital assets such as farm labor, gender composition and dependents; and (5) social assets such as information, community support, extended families and formal or informal social welfare support. More than 15 variables (called dimensions) were assessed together, and a statistical score was calculated for each household. The Score will then categorize households into the low (coping level household/ CLH), medium (Acute level household/ ALH) and high vulnerable (Emergency level household/ELH) (FANRPAN, 2011; Chineka et al., 2016).

The model computed the sum of the weighted variables across all dimensions to give the particular households total vulnerability to climate change as follows:

$$Vhhi = \sum_{j=1}^{m} Xwj \Big/ \sum_{j=1}^{m} wj$$

Where,

j = dimension of impact

m = specific dimensions of impact

w = corresponding weighted vulnerability

Vhhi = sum of the weighted vulnerabilities across all dimensions and this gave a particular household total vulnerability to climate change.

Descriptive statistics such as frequency, percentage, and others, cross-tabulation, chi-square tests were used as the second phase of analysis in order to examine the factors affecting the level of local communities' vulnerability to climate change. All statistical analysis was conducted by using Statistical Package for the Social Science (SPSS) version 22 and Microsoft Excel.

4. Results and Discussion

From the results of table 1, we can say that the selected samples were heterogeneous in their socio-demographic characteristics. It was observed during the field survey that most of the participants were male (55.5%) whereas the rest were female (44.5%). Additionally, age group of 55 years old and above were found to be major (41.3 %), indicating that majority of participants were in the old generation, followed by middle age group 41-54 (23.4%), new generation's age group 18-30 (18.3%) and early middle age group 31-40 (17%) respectively. It is evident from the information presented in table 1 that most of the households surveyed were being married (77.5%), and the second largest group is 14.2 % of participants with a single status. Moreover, it was also observed that the majority of respondents were not more than the middle school education level, showing low emphasis on education in the old generation. In terms of employment status, the majority was basically engaged in self-employed (45.4%) and employed (35.3%), which means that 80% of participants had a job during field investigation.

Table 1 The characteristics of the sample group

n=218

Item	Number (%)	Item	Number (%)
Gender		**Education level**	
Male	121 (55.5)	No formal education	34 (15.6)
Female	97 (44.5)	Primary school	79 (36.2)
Age group		Middle school	53 (24.3)
18-30	40 (18.3)	High school	48 (22)
31-40	37 (17)	Graduate	4 (1.8)
41-54	51 (23.4)	**Employment Status**	
55 and above	90 (41.3)	Employed	77 (35.3)
Marital status		Self-employed	99 (45.4)
Single	31 (14.2)	Unemployed	33 (15.1)
Married	169 (77.5)	Pensioner	9 (4.1)
Divorced	3 (1.4)		
Widowed	15 (6.9)		

Source: Primary survey, 2019

Level of vulnerability to climate change was calculated by using Households Vulnerability index (HVI) and categorized into three levels according to FANRPAN (2011). The results revealed that majority of participants had low vulnerable (47.3 %) and moderate vulnerable (46.3 %). About 6.4 % of participants had a high vulnerable, indicating the adaptive capacity of households in emergency level were very low. Among Low vulnerable group, households with being male (51.2%), 55 years old and above (41.1%), married (46.2%), primary school (50.6%), and self-employed (60.6%) were found to be common. Respondents who are being male (47.1%), 55 years old and above (47.8%), married (46.7%), and primary school (41.8%) and employed (54.5%) were dominated in moderate vulnerable group. However, participants with female (12.4%), 55 years old and above (11.1%), married (7.1%), primary school (7.6%), and unemployed (27.3%) were found to be in high vulnerable. Detailed information of the number and percentage of participants by level of vulnerability to climate change were shown in Table 2.

Table 2 Level of vulnerability to climate change by HVI Range **n=218**

	Level of vulnerability to climate change			
HVI score range	**0-47, CLH (%)**	**47.1-63.7, ALH (%)**	**63.71-100, ELH (%)**	**Total (%)**
Vulnerable Households	**103 (47.3)**	**101 (46.3)**	**14 (6.4)**	**218 (100)**
Gender				
Male	62 (51.2)	57 (47.1)	2 (1.7)	121 (55.5)
Female	41 (42.3)	44 (45.4)	12 (12.4)	97 (44.5)
Age				
18-30	22 (55)	15 (37.5)	3 (7.5)	40 (18.3)
31-40	16 (43.2)	21 (56.8)	0	37 (17)
41-54	28 (54.9)	22 (43.1)	1 (2)	51 (23.4)
55 and above	37 (41.1)	43 (47.8)	10 (11.1)	90 (41.3)
Marital Status				

Single	19 (61.3)	10 (32.3)	2 (6.5)	31 (14.2)
Married	78 (46.2)	79 (46.7)	12 (7.1)	169 (77.5)
Divorced	0	3 (100)	0	3 (1.4)
Widowed	6 (40)	9 (60)	0	15 (6.9)
Education level				
No formal education	16 (47.1)	18 (52.9)	0	34 (15.6)
Primary school	40 (50.6)	33 (41.8)	6 (7.6)	79 (36.2)
Middle school	29 (54.7)	20 (37.7)	4 (7.5)	53 (24.3)
High school	14 (29.2)	30 (62.5)	4 (8.3)	48 (22)
Graduate	4 (100)	0	0	4 (1.8)
Employment status				
Employed	33 (42.9)	42 (54.5)	2 (2.6)	77 (35.3)
Self-employed	60 (60.6)	36 (36.4)	3 (3)	99 (45.4)
Unemployed	4 (12.1)	20 (60.6)	9 (27.3)	33 (15.1)
Pensioner	6 (66.7)	3 (33.3)	0	9 (4.1)

Source: Primary survey, 2019

The chi-squared test of independence was performed to examine the relationship between socio-demographic factors and vulnerability level and the results are shown in the table 3. A p-value of <0.05 was considered to be statistically significant. The relation between gender and vulnerability level was significant $X^2(2, N=218) = 10.584$, $p = 0.005$. Female were more likely than male to be able to vulnerable. But there was no significant association between age and vulnerability level, $X^2(6, N=218) = 10.789$, $p=0.095$. Similarly, association between marital status and vulnerability level was not significant, $X^2(6, N=218) = 7.999$, $p=0.238$. Therefore, the null hypothesis that there is no interaction between two independent variables; age and marital status and dependent variables; level of vulnerability to climate change was failed to reject the null hypothesis and concluded that there was no significant association. However, both education level and employment status were found to be statistically significant association with vulnerability level at $X^2(8, N=218) = 15.564$, $p = 0.049$ and $X^2(6, N=218) = 44.859$, $p = <0.001$ respectively. Since we get a p-Value less than the significance level of 0.05, we reject the null hypothesis and conclude that there was significant association with vulnerability level.

Table 3 Association between socio-demographic factors and vulnerability level

n=218

Socio-demographic factors	CLH (%)	HVI score ALH (%)	ELH (%)	Chi-square (df)	P-value
Gender					
Male	62 (51.2)	57 (47.1)	2 (1.7)	10.584 (2)	0.005**
Female	41 (42.3)	44 (45.4)	12 (12.4)		
Age					
18-30	22 (55)	15 (37.5)	3 (7.5)	10.789 (6)	0.095
31-40	16 (43.2)	21 (56.8)	0 (0)		
41-54	28 (54.9)	22 (43.1)	1 (2)		
55 and above	37 (41.1)	43 (47.8)	10 (11.1)		
Marital Status					
Single	19 (61.3)	10 (32.3)	2 (6.5)	7.999 (6)	0.238
Married	78 (46.2)	79 (46.7)	12 (7.1)		
Divorced	0 (0)	3 (100)	0 (0)		
Widowed	6 (40)	9 (60)	0 (0)		
Education level					
No formal education	16 (47.1)	18 (52.9)	0 (0)	15.564 (8)	0.049*
Primary school	40 (50.6)	33 (41.8)	6 (7.6)		

Middle school	29 (54.7)	20 (37.7)	4 (7.5)		
High school	14 (29.2)	30 (62.5)	4 (8.3)		
Graduate	4 (100)	0 (0)	0 (0)		
Employment status					
Employed	33 (42.9)	42 (54.5)	2 (2.6)	44.859 (6)	<0.001***
Self-employed	60 (60.6)	36 (36.4)	3 (3)		
Unemployed	4 (12.1)	20 (60.6)	9 (27.3)		
Pensioner	6 (66.7)	3 (33.3)	0 (0)		

*p-value<0.05, **P-value<0.01, ***P-value<0.001

Implications of the study

Even though not many in number, some households were in an emergency situation, the majority of households in study area would need external assistance in case of an external shock. In order to help these households, government should consider appropriate strategies and action plans. These strategies should include enhancing the local education system because the education level in a household affects the vulnerability status of households. This education strategy would also help households to cope with the shock. Moreover, it has been shown by the study that employment also affects vulnerability. Therefore, the resilience of communities to climate change can also be increased by providing employment opportunities in the development of climate change adaptation plans.

5. Conclusion

Regarding the findings from this research, 14 (6.4 %) of the households surveyed were highly vulnerable, which means they are in the emergency level and need intensive care situation in terms of climate change impacts. Furthermore, 101 (46.3 %) of the households were found to be moderately vulnerable whereas the majority of households, which is 103 (47.3%), was able to cope with the climate change even though they were also vulnerable. Although the majority of HVI results were at a moderate and low level, authorities should concern about the low adaptive capacity of local community households which is not ready to withstand the future climate risks. Therefore, the government urgently needs to implement climate change adaptation programs in the Indawgyi biosphere reserve in order to improve the local community's resilience to climate change. Moreover, the level of vulnerability was also found to be influenced by some socio-demographic characteristics such as gender, education level, and employment status in households. Finally, future research should be more focused on adaption strategies, the community's awareness, preparedness, resilience and recovery for climate change-related risks because this study only covered the vulnerability of households to climate change.

Table 3 Association between socio-demographic factors and vulnerability level

n=218

Socio-demographic factors	CLH (%)	HVI score ALH (%)	ELH (%)	Chi-square (df)	P-value
Gender					
Male	62 (51.2)	57 (47.1)	2 (1.7)	10.584 (2)	0.005**
Female	41 (42.3)	44 (45.4)	12 (12.4)		
Age					
18-30	22 (55)	15 (37.5)	3 (7.5)	10.789 (6)	0.095
31-40	16 (43.2)	21 (56.8)	0 (0)		
41-54	28 (54.9)	22 (43.1)	1 (2)		
55 and above	37 (41.1)	43 (47.8)	10 (11.1)		
Marital Status					
Single	19 (61.3)	10 (32.3)	2 (6.5)	7.999 (6)	0.238
Married	78 (46.2)	79 (46.7)	12 (7.1)		
Divorced	0 (0)	3 (100)	0 (0)		
Widowed	6 (40)	9 (60)	0 (0)		
Education level					
No formal education	16 (47.1)	18 (52.9)	0 (0)	15.564 (8)	0.049*
Primary school	40 (50.6)	33 (41.8)	6 (7.6)		

Middle school	29 (54.7)	20 (37.7)	4 (7.5)		
High school	14 (29.2)	30 (62.5)	4 (8.3)		
Graduate	4 (100)	0 (0)	0 (0)		
Employment status					
Employed	33 (42.9)	42 (54.5)	2 (2.6)	44.859 (6)	<0.001***
Self-employed	60 (60.6)	36 (36.4)	3 (3)		
Unemployed	4 (12.1)	20 (60.6)	9 (27.3)		
Pensioner	6 (66.7)	3 (33.3)	0 (0)		

*p-value<0.05, **P-value<0.01, ***P-value<0.001

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