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Socio-Ecological Resilience Assessment: Initial Findings and Results in CALSANAG Balogo Sub-Watershed

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Abstract - Watersheds have a significant role to play in safeguarding vital ecosystem services against climate changes and extreme weather events. Thus, these protected areas are widely susceptible to such risks which will significantly affect human communities. This paper is an exploratory study conducted to assess the resilience of CALSANAG Balogo sub-watershed using the estimated Climate Disaster Resilience Index (CliDRI) and capital-based approach. The study used the five resilience-based dimensions; namely: the physical, social, economic, institutional, and natural in the survey conducted in which a total of 35 randomly selected respondents residing in Brgy. Balogo, Calatrava, Romblon were interviewed for the study. The questionnaire covered the five resilience-based dimensions and the 23 indicators selected based on the local context to gain an understanding of the level of resilience of its ecosystem. Results showed that Balogo exhibits above average resilience accumulating a score of 0.58 on a scale of 0-1. The resilience scores varied from 0.43 (average resilience) to 0.80 (high resilience). On the average, resilience levels in the community showed high levels in social dimension and low levels in the economic dimension. An analysis of the index values were also provided along with the suggested feasible policy recommendations that can provide insights to the appropriate adaptation actions that the community leaders, policymakers, and stakeholders can implement to improve climate and disaster resilience of Balogo.

Keywords - MODECERA research, climate disaster resilience, socio-ecological resilience

INTRODUCTION

Watersheds are areas of land that contain rivers and streams which all drain into a single larger body of water. It acts as a giant funnel that collects and directs all of the water that falls into it. Watersheds have significant roles to play like supplying drinking water, providing water for agriculture and manufacture, giving recreational opportunities, and serving as habitat for flora and fauna. With growing emphasis on climate change and the risks associated with it, watersheds provide practical contributions to climate change, to wit, its responses through safeguarding vital ecosystem services. Protected and well-managed watersheds will help reduce vulnerability to climate change and the impact of natural hazards and disasters with the ecosystem goods and services they provide (MacKinnon et al., 2011). However, these protected areas, in turn, are also susceptible to climate induced disasters which will significantly affect human communities.

According to the Global Assessment Report, both ecosystem decline and climate change have been identified as among the four fundamental drivers of risk to poverty and disaster (ISDR, 2009). By reducing the resilience of natural systems and human societies, ecosystem decline puts vulnerable communities at risk against the impact of climate change and increased risks of disaster. Furthermore, these impact of climate change and human activities put a lot of pressure on ecosystem structure and function resulting in reduced ecosystem services as well as lower resilience (Forslund et al., 2009). Thus, this global environmental change poses a serious threat to human well-being as humankind's future is directly dependent on the sustainability of ecosystems (WRI, 2000).

This puts national capacities for climate change adaptation and disaster risks reduction on the spotlight. In the Philippines, issues associated with climate change are arising with the sudden increase in mean temperature and rising sea levels observed over time (Lasco et al., 2008). It is among one of the countries which is most vulnerable to climate change due to its high exposure to the increasing incidence of extreme weather events. Thus, it is now faced with a challenge to enhance resilience and reduce the risk of climate change and disaster by providing resources for adaptive capacity.

Recently, the concept of climate resilience has gained wide interest. Resilience was first brought into focus by Holling (1973) as the ability of an ecosystem to absorb changes and still persist. Since then, resilience has gained several ecological definitions and even gained acceptance in hazard and disaster studies (Mayunga, 2007). In relation to hazard and

disaster, Timmerman (1981) characterizes resilience as a measure or part of the system's capacity to absorb and recover from hazardous event (Klein, 2003 cf. Mayunga, 2007). In other words, resilient communities should be organized with minimal effects of disaster and quick recovery response (Mayunga, 2007). Therefore, it is suggested that more resilient communities will experience less disaster impact and adapt faster to recover.

However, the succeeding action will be how to measure the level of resilience of socio-ecological systems, particularly in the Philippine context. This is where the project, Monitoring and Detection of Ecosystems Changes for Enhancing Resilience and Adaptation in the Philippines or MODECERA, a long-term monitoring system in eight selected watersheds across the country, comes in. It aimed to enhance resilience and adaptation of agriculture, marine, and natural resources sector through the promotion of science and technology based management and policy decisions. In addition, the project includes examination of climate change and disaster resilience in terms of studying the capacity of linked social and ecological systems in absorbing shocks yet still persisting. There is a need to develop an indicator system for generating a climate and disaster resilience index, using a capital based approach. With this, an in-depth understanding of the social system and its capabilities to cope and adapt to climate change and natural disasters will be done.

This study is an attempt to identify the general level of resiliency of Balogo sub-watershed using the estimated Climate Disaster Resilience Index (CliDRI) through a Balanced Weighted Approach while considering the five resilience-based dimensions: natural, physical, social, economic and institutional. The study also determined possible policy implications which can provide insights into adaptation actions for the community leaders, policymakers, and stakeholders to improve climate and disaster resilience of Balogo.

METHODOLOGY

Study Site

There are eight (8) selected watersheds across the Philippines under the MODECERA project. One of these is the CALSANAG Watershed Forest Reserve located in Romblon. It is the only existing watershed in Tablas Island covering an area of 2,670 hectares (6,597.7 acres) along the municipalities of Calatrava, San Andres, and San Agustin. Previously proposed as CALSANAG Protected Landscape, it was re-established as

CALSANAG WFR under Proclamation No. 2186 signed on April 29, 1982 upon the Marcos administration.

The Balogo sub-watershed was selected as sample of the whole watershed, where the monitoring sites of MODECERA across ecosystems were established. Balogo is situated in the southern part of the municipality of Calatrava which has an abundant forest area of the watershed. It is the biggest among the seven (7) barangays with a total area of 2,603.60 hectares or 30.03% of the total land area of Calatrava. It is divided into six (6) *sitios* with a total population of 1,700 (as of 2015) mainly engaged in rice production, copra, and fisheries (PSA, 2016).

Sampling Design

This exploratory study used quantitative research methods through a survey carried out in October and November 2016. The survey questionnaire was used to obtain information about households' profile as well as their physical, social, economic, institutional and natural characteristics. A total of 35 interviewees residing in Balogo were randomly selected.

Data Analysis

The study was guided by an earlier work of the Climate and Disaster Resilience Initiative (CDRI) in 2008-2009 which developed the Climate Disaster Resilience Index (CliDRI) and was also used by Pulhin (2016) in the analysis of disaster resilience in Tacloban, Leyte after the onslaught of Super Typhoon Yolanda or internationally known as Haiyan. The CliDRI measures climate disaster resilience by considering five (5) resilience-based dimensions namely, physical, social, natural, economic, and institutional. For each dimension, a total of 23 indicators were identified and collected through the survey, and secondary data gathered (Figure 1).

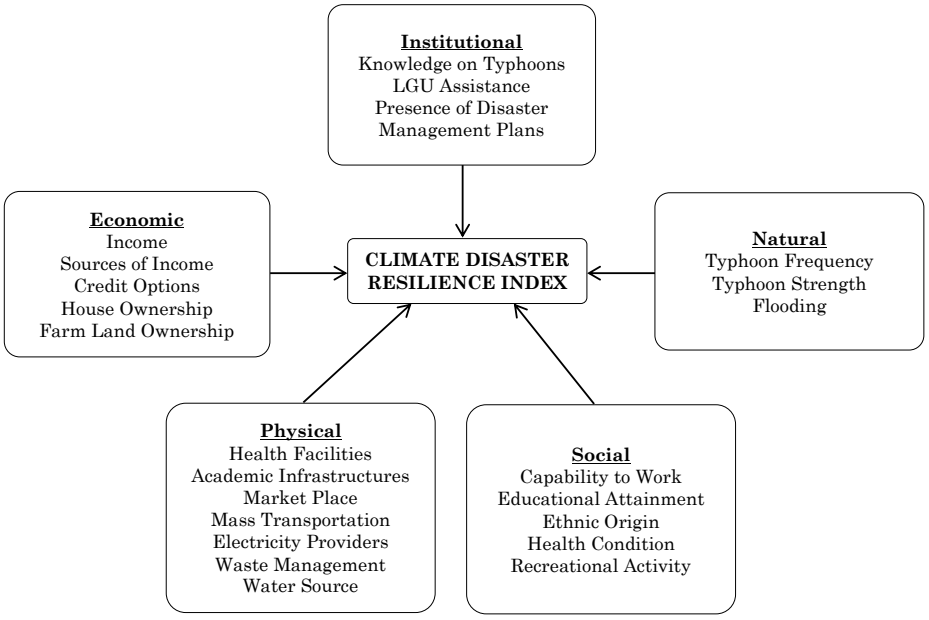

Figure 1. Climate Disaster Resilience Index Indicators per Dimension

Ratings applied were based on the rubric developed by past studies. Using a Balanced Weighted Approach (BWA), the index was computed by equally dividing the different weights of the indicators and sub-indicators which were given as,

Equation 1. Indicator weight, $\mathbf{w_{I_i} = \frac{1}{n_j}}$ and Sub-indicator weight, $\mathbf{w_{S_{ij}} = \frac{1}{n_k}}$

The weights of the different dimensions were also equal. Since there were five (5) resilience-based dimensions, the weights ($\mathbf{w_{d_i}}$) for each of these dimensions were equal to $\mathbf{w_{d_i} = 0.20}$,

Equation 2. CliDRI = f (Physical, P; Social, S; Economic, E; Institutional, I; Natural, N)

Equation 3. CliDRI = $(P \cdot w_{d_1}) + (S \cdot w_{d_2}) + (E \cdot w_{d_3}) + (I \cdot w_{d_4}) + (N \cdot w_{d_5})$

Equation 4. CliDRI = (0.20P) + (0.20S) + (0.20E) + (0.20I) + (0.20N)

The index value lies between 0 to 1 which was not to be taken as absolute values, but only as an indication of resilience of the system being evaluated. Higher CliDRI values would mean higher preparedness to cope with climate change and disasters. Likewise, actions to be taken to ameliorate resilience levels should be recommended based on Pulhin (2016) measures based on index values (see Table 1).

Table 1. Level of resilience based on the index value and recommended action (Pulhin, 2016)

Index Value	Level of Resilience	Recommended Action
0.00 - 0.20	low	Must be addressed urgently and should be highly prioritized or be given high level of efforts; needs more frequent monitoring and evaluation
0.21 - 0.40	below average	May need immediate attention and should be prioritized; requires improvement and regular monitoring and evaluation
0.41 - 0.50	average	May not need immediate attention but level of efforts should be improved, monitored and evaluated
0.51 - 0.60	above average	Already receiving attention and acceptable level of efforts but need to be continuously improved, monitored and evaluated
0.61 - 1.00	high	Should be sustained and need continuous monitoring and evaluation; may need improvement at some point

RESULTS AND DISCUSSIONS

Demographic Profile of the Respondents

Table 2 presents the result of the survey conducted. Most (51%) of the respondents belong to the senior adult group with ages 51 years and above while 49% comprised the adult group with ages 20-50 years. Fifty-one percent (51%) of the respondents were males while the remaining 49% were females. Majority (80%) of the respondents were married. The highest educational attainment was vocational study with six (6) percentage share. Sixty percent (60%) of the respondents have reached elementary level. Some have reached high school and college, 17% and 14% respectively.

In addition, most (69%) of the respondents have one to six children. Meanwhile, 31% come from families with more than six children. In the survey, farming was indicated as the major source of income of the

respondents with 80%. It was followed by those who were engaged in services (e.g. laborers and vendors) at 11%, six percent have their own business, and three percent are fishermen.

Table 2. Demographic profile of household survey respondents (in percent)

	(N)	(%)
Total	**35**	**100**
Age		
20-50 years	17	49
>51 years	18	51
Sex		
Male	18	51
Female	17	49
Civil Status		
Single	1	3
Married	28	80
Widowed	3	9
Live in	3	9
Education		
Elementary	21	60
High School	6	17
College	5	14
Vocational	2	6
Ethnic Origin		
Native	32	91
Immigrant	3	9
Number of Children		
1-6 children	24	69
>6 children	11	31
Main Source of Income		
Farming	28	80
Fishing	1	3
Services (e.g. laborer, vendor)	4	11
Business	2	6

Resilience Score Results

Figure 2 shows the estimated resilience for Balogo. Generally, the social dimension index has the highest score with 0.80, followed by institutional (0.63), natural (0.54), physical (0.50), and economic (0.43) as shown in Table 3. Overall score ranges from 0.43 to 0.80 indicating low to high levels of resilience. The social dimension demonstrates the highest resilience while the economic dimension shows the lowest resilience. This demonstrates a strong social structure existing within the community and a weak economic structure that indicates lack of economic growth in Balogo. In general, Balogo scored 0.58 in the CliDRI which shows an above average level of resilience further indicating that the community should maintain and further continue efforts in enhancing the resiliency of its socio-ecological systems.

Table 3. Scores of the five resilience-based dimensions

Resilience Dimension	Resilience Index	Level of Resilience
Physical	0.50	Average
Social	0.80	High
Economic	0.43	Average
Institutional	0.63	High
Natural	0.54	Above Average
OVERALL	**0.58**	**Above Average**

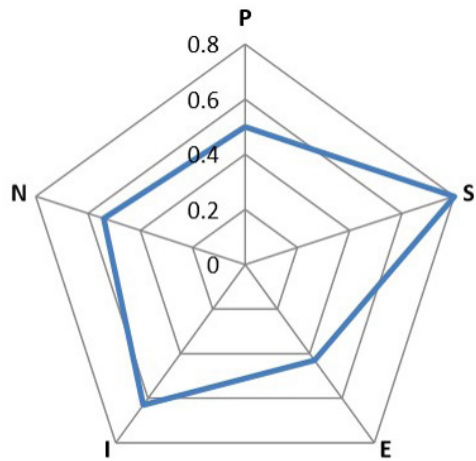

Figure 2. Radar graph of resilience score per dimension of Balogo

Resilience Score Analysis

An analysis of the dynamics of these natural and human systems was made possible by breaking down socio-ecological factors into dimensions, namely: physical, social, economic, natural and institutional (Uy et al., 2012). Since the elements of these natural and human systems were interdependent, the analysis required a focus on interdependencies (Berkes & Folkes, 1994). Furthermore, these physical, social, economic, natural and institutional systems were also mutually dependent. Once the physical or ecological system starts deteriorating in a watershed ecosystem, fewer resources flow from it and soon the people dependent on the natural capital of the ecosystem will be impoverished. Damage to the functional operation of the ecosystem will likely result in damage to the social system and the management institutions based on it. Resiliency scores per dimension were examined to explain their corresponding resiliency levels which would eventually serve as key to possible policy implications.

The social dimension got the highest estimated resiliency index attributed to the sub-indicator – ethnic origin. The ethnic origin indicates that there exists a strong social cohesion in the community. Most of the respondents were native of Balogo; thus, resulting in strong social cohesion. For a community to establish and implement rules, build trust, and decrease dependence on external connections for information and capital, cooperation and network are considered as good bases for self-organization and necessary for interactions of the residents (Ifejika Speranza, 2010). Thus, social capital is crucial for building and sustaining resilience as the actors play a significant role in the interaction process. Aside from social cohesion, social capital is measured through the number and types of groups in which an actor is a member, the degree of participation in groups and networks, trust, and lastly, reciprocity (Ifejika Speranza et al., 2014).

Moreover, social conditions in Balogo were likewise high due to the accessibility of both pre-school and elementary schools which contributed to better education in the community. Educational attainment is found to be the strongest predictor of awareness for climate change across regions representing 90% of the world's population (Lee, et al., 2015). Education predicts greater awareness of climate change, and knowledge of threats and potential opportunities are helpful in times of crisis. Also, health facilities, particularly the barangay health center, were also significantly accessible to the residents which helped raise awareness on health and wellness. Alongside education, healthcare was most cited as a good variable in community development. Maintaining good health and hygiene is an

important indicator of resilience with assurance on adequate ecological resources, particularly an access to clean water supply.

The institutional setting of Balogo was the most likely to contribute to its resilience. This was supported by the efforts of the local government unit in assuming their responsibilities in disaster response. The sub-indicators showed that there was coordination and efficient information dissemination between the municipal leaders and the residents, particularly in disaster preparedness and assistance which are crucial for resilience. This confirms that the presence of local institutions, as one of the most cited factors, enhances adaptive capacity of social-ecological systems. There are two ways in which institutions can aid adaptive capacity: one is through improvement of sustainable resource use and the other is through creation of networks within and between institutions (Adger, 2003; Tompkins and Adger, 2004; Folke et al., 2005). With the aid of sustainable use policies, communities become more resilient due to conservation of natural resources and their supporting ecosystem processes (Adger, 2003; Tompkins and Adger, 2004; Folke et al., 2004). Moreover, local institutions promote communication between people and groups which allow them to effectively adapt management strategies and be more flexible during times of crisis (Berkes et al., 2002; Ford et al., 2006). Also, establishing strong network of relations between the community and the government officials, particularly those in charge of disaster planning, reduces the negative impact of climate change and disaster risks. In addition, Beichler et al. (2014) suggested a normative assumption that multilevel governance structures can positively influence adaptive capacity further enhancing the resilience of a socio-ecological system. The actions of community leaders, policymakers, stakeholders, and the residents as well as the relations between them greatly affect the governance state of the system. All these in turn make a more sustainable contribution to lessen vulnerability and strengthen adaptation against climate change and disaster risks.

The natural dimension also showed high scores among the five dimensions. This is linked to the low environmental disturbance due to fewer typhoons and extreme events occurring in the community. It also showed that there was low vulnerability of households to changes in climate conditions, such as increasing precipitation of rainfall and rising of water levels in Balogo River. The CALSANAG Watershed plays a big part in protecting the community from extreme events thus, resulting in less threats to residents from climate change. Often overlooked, biophysical factors affect and constrain social processes and in time, adaptive capacity. Annual rainfall and annual temperature, among others, are all directly correlated to improve forest conditions, and these

result in stronger institutions (Tucker et al., 2007). This applied to Balogo where low environmental disturbance was experienced by the residents mainly because of the protected forest cover managed with strong and effective institutions. Consequently once the forest ecosystem is neglected, the community dependent on its natural capital will be greatly affected. As a result, the institutions will suffer the damage of this dysfunctional operation of the natural ecosystem.

In addition, Balogo's physical structure also contributes to the assertion of community's resilience. One obvious reason for this is its proximity and accessibility to health facilities and academic infrastructures. National level studies consider increased access to healthcare, higher literacy rates, and even increased per capita income as a good predictor variable of community development. It is observed that health and education indicators are the best predictors of total deaths after a disaster (Brooks et al., 2005). Thus, these studies claim that analysis on adaptive capacity should consider factors concerning the overall health, educational, and even economic development of a community. Looking at specific variables, water and sanitation account for its strong physical resilience because majority of the households have access to water either from the Balogo River Network or the public water system. There is a need to highlight the ability of communities to cope with changes in water resource availability and water quality, particularly in the face of calamities and limited resources due to growing population (Fazey et al., 2007). In countries like the sub-Saharan Africa, one of the main problems brought upon by climate change is the worsening water supply situation that the region likely suffers from due to prolonged dry periods and severe rainfall (Holling et al., 1998; Alcamo et al., 2007). Without the accessible public water supply, Balogo residents will likely be in for serious consequences. Households will not have enough stored water for their consumption, and even the agricultural crops will be destroyed due to lack of water. In addition, access to transportation and means of communication also play a big part in physical dimension since most of the households own a transport vehicle (e.g. motorcycle) which give access to markets and market information easier.

Lastly, the economic setting of Balogo is least likely to contribute to its resilience for it has scored the lowest among the other indices. This is due to high poverty incidence in the area because few households have resources necessary for their livelihood and have access to credit and financial institutions. Aside from rice farming, vegetable growing and fishing, there were no other available livelihood which could have provided supplemental income to the residents. This is supported by Adger (2000) who highlighted the nature of economic growth and the

stability and distribution of income among populations as one key factor of the economic aspects of resilience. This is seen in Balogo where most households in the community depend on a narrow range of natural resources which increases the variance of income and further decreases stability of their livelihood. A livelihood is sustainable when it is able to cope with and recover from stresses and shocks, maintain its capabilities and assets without undermining natural resources (Ifejika Speranza et al., 2014). Few case studies and analyses examining vulnerability also suggest that access to capital and increased development result in enhanced adaptive capacity (Ziervogel and Bharwani, 2006; Brooks et al., 2007). This gives individuals more alternatives to adapt their consumption of natural resources that reduces the impacts of climate shocks on their livelihood activities. Communities could also raise their adaptive capacity through diversification of livelihood strategies by increasing the range of their livelihood practices (Howden et al., 2007).

CONCLUSION

Due to constant changes in the climate, ecosystems must be able to persist and adapt to the different circumstances of external forces (Uy et al., 2012). In socio-ecological systems, a community's response to arising conditions usually defines the nature and composition of its adaptation measures (Jodha, 1998). Aside from natural processes, the health and resilience of ecosystems are also highly affected by social, political and economic actors (Connell, 2010). Thus, there is a need to examine the human-environment interactions and the ways to enhance ecosystem resilience.

This study attempted to use an approach to assess resilience considering the ecosystem alongside the external forces influencing it. The five dimensions – physical, natural, social, economic, and institutional – were significant in estimating resilience. Initial findings indicated that Balogo exhibits above average resilience accumulating a score of 0.58 on a scale of 0-1. Social dimension indicated high levels of resilience while economic dimension got the lowest scores. This further demonstrated a strong social structure existing within the community but a weak economic structure that illustrated the lack of economic growth in Balogo. There is a need to maintain and further continue its efforts in enhancing the resiliency of its socio-ecological systems.

The methodology offered in this study made use of these capital based framework and an indicator system for estimating resilience of watershed areas. Also, the indicators used are generally available at the

DENR, LGU, and PSA which could be helpful if this indicator system will be adopted in monitoring climate and disaster resilience. However, this climate disaster resilience assessment is still in its development stage. The data collected through survey, secondary sources, and subjective observations were inadequate and sometimes, incomplete. Thus, it is crucial to validate the results of the analysis by incorporating the perception of community and leaders in estimating resiliency.

From the resilience analysis of each dimension, possible policy recommendations are suggested to encourage the government, municipal leaders, and policymakers to strengthen their engagements and orient their efforts in a way that current and future potential risks are considered. After all, the goal of CliDRI is to raise awareness on the existing and future ecosystem risks on climate related disasters.

POLICY RECOMMENDATIONS

Findings show that resilience levels in Balogo in each dimension were concentrated on average-to-high. Both the economic and physical dimension achieved an average resilience level which indicates that there is a deficiency in the economic structure and the physical state of the community. These need to be addressed and be highly prioritized to further increase resiliency levels. The other three dimensions reflect above average to high resilience levels. This suggests that efforts to enhance resilience levels in the natural, social and institutional dimensions should be continuously improved, monitored, and evaluated to maintain such resilience levels. Based on these results, decision-makers should provide assistance to stakeholders in their efforts to enhance the resilience of their community.

In general, the economic dimension has the lowest resiliency index. This weak link can be addressed by extending diverse livelihood opportunities in the community to widen employment and income levels to promote economic resilience. The present employment rate is high but there is low income earning opportunities. The local government should focus on the entrepreneurial development by offering better access to financial services.

The low physical index, on the other hand, is also in need of assistance. Access to basic services of the community such as water supply, sanitation, and solid waste management all call for significant improvement to increase resiliency levels of the watershed. This could be done through effective participatory, community-based improvement

techniques with the help of community leaders and policymakers. Better coordination is needed for making resiliency efforts more effective.

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