

Climate Change Adaptation Activities in Selected Coastal Areas of Ilocos Sur

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Abstract – Climate change is a reality that is expected to have significant impacts on the most vulnerable population – the residents within coastal areas. They noticed an increase in the frequency of extreme events like coastal or tidal flooding, coastal soil erosion, saltwater intrusion, and intense typhoons. This study aimed to determine the respondents' profile and their knowledge and preparedness to climate change impacts. It assessed respondents' perception on the damages and impacts experienced from past climate hazards and events, and ascertained implementation of adaptation activities and policies. Data showed that respondents have adequate knowledge and preparation regarding climate change impacts. On the other hand, damages towards houses, boats, and motorcycles, loss in fishing income, and house members getting sick from water-borne illnesses were noted as impacts of typhoon and flooding, erosion, sea-level rise, and saltwater intrusion. The main adaptation activity in response to the impacts of climate change is the formation of the Barangay Disaster Risk Management Council (BDRMC), with calamity funds allocated per year primarily for coastal areas.

Keywords: climate change, adaptation activities, coastal areas

1. Introduction

Coastal ecosystems are vital to Southeast Asian countries because most countries in this region depend on fish and other aqua-marine products to sustain their economy and support their population. Many coasts undergo continual adjustment towards a dynamic equilibrium, often adopting different 'states' in response to varying wave energy and sediment supply (Woodroffe, 2003). Coasts reciprocate to modified circumstances apparent to the system, such as storm events or changes brought about by systems limitation that cannot be predicted based on external stimuli. This typical restlessness of coasts makes it difficult to distinguish the effects of a changing climate. For instance, most seashores worldwide manifested recent erosion, but sea-level rise is not consequently the primary culprit. Erosion can emanate from other variables, such as modified wind models (Pirazzoli et al., 2004; Regnaud et al., 2004). Trenberth et al. (2007), and Bindoff et al. (2007) observed several important climate change-related effects relevant to coastal zones.

Meanwhile, the Province of Ilocos Sur has a long stretch of coastal areas that communities are highly dependent on. Unfortunately, coastal areas are considered among one of the lowest sectors. Thus, the government has been concerned about the environmental problems confronting these ecosystems and their populations. With climate change, coastal ecosystems and associated populations are even more at risk. Most of the attendant effects of climate change, like sea-level rise (and subsequent saltwater intrusion) and sea surface temperature rise, emanate from the sea. Thus, while environmental externalities have been traced from the ridge to the reefs in the past, climate change has pushed the need to look at the ridge's reefs' effects. Coastal communities who rely on its resources have become more vulnerable and dependent on packets of support from various institutions.

This undertaking will serve as an input to policy and decision making that empowers stakeholders to implement appropriate action plans to mitigate the hazards and compounding impacts of climate change.

1.1. Objectives of the Study

This study aimed to determine the socio-economic profile of the respondents who are coastal residents, and assess their knowledge level on climate change impacts and their preparedness to deal with such impacts, assess their perception on the damages and impacts experienced from past climate hazards and events; and determine the adaptation activities being undertaken to address the hazards brought about by a changing climate.

1.2. Theoretical Framework

An archipelago with more than 7,000 islands, the Philippines has one of the world's longest shorelines. The National Statistical Coordination Board shows that it is 36,289 kilometers long. Geographers from the University of Sheffield have analyzed annual data from 1951 to 2013 and saw a slightly decreasing trend in the number of smaller cyclones (above 118 kilometers per hour) in the last two decades that hit land in the Philippines. However, more hazardous tropical cyclones (above 150 kilometers per hour) were shown to increase in recent years, with Luzon's northern island frequently affected by these weather events and associated rainfall. This is supported by the United Nations University (UNU) World Risk Report of 2014. The country is among the topmost susceptible nation to hydrometeorological dangers such as tropical cyclones, monsoon rains, seismic activity, and storm surges. Also, many large communities live in typhoon-prone regions and low-lying coastal zones. Moreover, the rising CO₂ concentrations have lowered ocean surface pH by 0.1 unit since 1750. Although to date, no significant impacts on coastal ecosystems have been identified. Recent trend analyses indicate that tropical cyclones have increased in intensity. Worldwide sea level swell at 1.7 ± 0.5 mm/yr through the 20th century, while global mean sea surface temperatures have risen about 0.6°C since 1950, with associated atmospheric warming in coastal areas (Bindoff et al., 2007).

Increases in extreme sea levels due to rising mean sea level and changes in storm characteristics are of widespread concern. Meehl et al. (2007) found that models suggest both tropical and extra-tropical storm intensity will increase. This implies that other coastal impacts,

and not sea-level rise alone, affect tropical and mid-latitude coastal systems. Increases in tropical cyclone intensity over the past three decades are consistent with the observed changes (Emanuel, 2005; Webster et al., 2005). Changes in other storm characteristics are less specific, and the number of tropical and extra-tropical storms might even reduce. Similarly, future wave climate is uncertain, although extreme wave heights will likely increase with more intense storms (Meehl et al., 2007).

According to Dedekorkut-Howes et al. (2020), there are significant knowledge gaps in comparative analysis of adaptation strategies; they opined that coastal climate adaptation should embrace local characteristics using combined structural and non-structural measures to be effective. Nonetheless, climate change successively unsettles the natural human environment, especially coastal communities. This leads to a vulnerability that is intuitively framed in different ways; thus, disaster risk management is an imperative task that can enhance communities' resilience. More so, political interventions alignment and programs to address these susceptibilities require considerable discourse. Real-life implementation of ordinances can be construed appropriate at the local level or municipal (Islam et al., 2016; Ishtique et al., 2019).

Sensibility to an environmental event can be associated closely with one's cognizance about a particular situation sourced out from reliable information and government authorities Gubalane (2015). Being knowledgeable about a disaster does not warrant that a person is well equipped when hydrometeorological hazard strikes because logistics and infrastructure mobility would undoubtedly contribute in the process of preparation. Moreover, developing and strengthening the capabilities of susceptible and marginalized sectors to assuage, prepare, respond, and recover from the wrath of disasters is what the situation calls for. With the anticipated changes in weather patterns and sea-level rise associated with global climate change, researchers and policymakers will benefit from continuing to examine how Filipinos cope with and prepare for future disasters.



Figure 1. *Locale of the Study*

Methodology

2.1 Research Design

The descriptive-quantitative method of research with the aid of a questionnaire as the main data gathering instrument was utilized during the conduct of the study.

2.2. Subjects of the Study

The respondents composed of 163 household heads selected based on their geographic proximity to the coastal/beach area and creeks/rivers. It is presumed that they are more vulnerable to climate change impacts. This study was conducted in selected coastal barangays of Sinait (Pug-os), Cabugao (Salapasap), San Juan

(Solot-solot) and Magsingal (Alangan), Ilocos Sur from May-September, 2017 (Figure 1).

2.3. Data Gathering Tools

The study employed the use of survey questionnaire to determine the respondents' profile, their level of knowledge and preparedness in dealing with climate change impacts, assess perception on the damages and impacts experienced from past climatic hazards, and described adaptation activities being undertaken..

2.4. Ethical Considerations

This study passed through the ethical review committee of the university and complied with all the documentary requirements.

2.5. Data Gathering Procedure

The researcher prepared a questionnaire to acquire data along the climate change adaptation activities in selected coastal areas of Ilocos Sur.

The questionnaire was composed of four parts: the first is the profile of the respondents. The second part consists of the level of knowledge and preparedness on the impacts of climate change; followed by perception on the damages and impacts experienced from past climate hazards and events; as well as the adaptation activities undertaken.

2.6. Data Analysis

Collected data were statistically processed using frequency count, percentage, weighted mean, and bivariate correlation analysis using the Statistical Package for the Social Sciences.

2. Results and Discussion

2.1. Socio-Economic Profile of the Coastal Residents

Most of the respondents belonged to the age range between 36-40, while the least constituted the 25-30 age bracket. Males posted the highest percentage compared to their female counterparts. Further, most of the respondents are high school graduates while few obtained vocational studies. In terms of occupation, a more significant part of the respondents is into fishing, while two are retired government workers.

It is further revealed that almost half of the respondents have a monthly income ranging from P500-P3,000, while the least had above P12,000 monthly income. The result is consistent with the Philippine Statistics Authority (PSA, 2015) that the poverty incidence among fishers is high (39.20%). The majority of the respondents have households with four to six members, while others have one to three members.

The respondents' distance to the nearest creek and river is within 1-200 meters, while a few are located within 201-400 meters. On the other hand, the most significant percentage had their house located within 1-200 meters of the coastal/beach area. A small number indicated that their house is located within 601-800 m. It can be noted that in the country, the easement or setback from the shoreline high-water mark is currently at 20 meters. The data manifests that the current easement or setback area is not followed or strictly

implemented by the local government units concerned. Hence, there is no implementation of a sound zoning ordinance. In other Pacific countries, the easement is from 50 m to 200 m (Burgonio, 2013). The delineation of the easement is consistent with Presidential Decree No. 1067, Section 24, or the Philippines' Water Code.

The roof is the most critical protection of a house from the intermittent rain and the strong winds brought about by typhoons. The most common type of roofing material used by a larger part of respondents is galvanized iron. According to Salazar (2011), corrugated G.I. roofing is the cheapest, cost-economical for the low-end economy but deteriorate and corrode the fastest, if not painted properly. When oxidation process occurs, it is impossible to prevent corrosion. Replacing the whole sheet is the best way to address the problem, thus entails additional family expenses.

Television appeared to be the most familiar source of information on climate change, followed by radio, and some indicated access to the World Wide Web through Internet access. Various studies have shown that the public gathers much of its knowledge about science from the mass media (Wilson, 2000), with television and daily newspapers being the primary sources of information (Project for Excellence in Journalism, 2006; NSF, 2004)

2.2. Level of Knowledge of Households on Climate Change Impacts

The level of knowledge of the respondents on the impacts of climate change is adequate. Specifically, the respondents have adequate knowledge of coastal/tidal flooding, particularly on permanent seawater inundation of inland areas, reduced fishery production, and contamination of water source. Moreover, the respondents are fully knowledgeable about health-related sickness due to water-borne diseases and damage to crops. The results showed that coastal area inhabitants appear to be aware of the hazards of climate change they face, possibly partly due to a high frequency of exposure in the recent past. This is consistent with the work of Esteban et al. (2013) Anh et al. (2017) that awareness is location-specific and depends on a variety of factors such as education, culture, and

the policies of local administration and national governments.

Meanwhile, it is noted that respondents have adequate knowledge on coastal erosion explicitly on the following items: can be caused either by sea-level rise or by removal of geologic materials that make up the shoreline; sea-level rise exacerbates erosion; change in climate and increase in human activity toward the coasts has turned coastal erosion into a more severe problem, and coastal erosion is derived from numerous causes, but wind and current are particularly significant. They are also fully knowledgeable on increased cost for maintenance of coastal erosion mitigating measures. The result signifies that sea-level rise is evident, resulting in coastal erosion. This coincides with the findings by Rietbroek et al. (2016) that relative sea-level rise in the western seaboard of the country is one of the highest.

Further, respondents have signified adequate knowledge on saltwater intrusion, specifically on the movement of saline water into freshwater aquifers, and high levels of salt in agricultural soil suppress plant growth and crop yields significantly reduced while fully knowledgeable on the item "cause of contamination of fresh drinking water sources." Conversely, it appeared that respondents have inadequate knowledge that over-pumping of groundwater is the primary cause of saltwater intrusion. The data negates the findings of Masciopinto (2006); Mjemah et al. (2009); Van Camp et al. (2014) which stated that accelerated withdrawal of water from the ground near coastal aquifers diminishes the flow of freshwater to the sea resulting to depression of water table causing the seawater to encroach the land, and find its way to the wells thus, deterioration of groundwater quality happens.

It could also be gleaned from the data that respondents are fully knowledgeable about frequent and intense typhoons. Respondents have indicated that they are fully knowledgeable on frequent/intense typhoons would result in the reduction of fishers' income, an increase of vector-borne diseases, and damage to property in low-lying coastal settlements. The result concurs with the findings of Shaffril et al. (2011) that unstable weather conditions caused by climate change will limit the number of days spent on the sea. Besides,

climate change will also affect fishermen's health; they will be frequently exposed to diseases such as fever, flu, and cough resulting in lesser time for them to go out to the sea. As a result, this lowers their income. Besides, the respondents have adequate knowledge of the increase of environmental pollution and water supply contamination, and a decline in crop production.

2.3. Level of Preparedness of Households on the Impacts of Climate Change

The result manifests that the level of preparedness of households about climate change impacts is adequate. When taken singly, respondents are fully prepared for frequent/intense typhoons and adequately prepared for coastal or tidal flooding, coastal soil erosion, and saltwater intrusion. These impacts seem to take place in the area of study with each passing year. Thus, remedial actions must be carried out to adapt to climate and weather uncertainties. Bollentino et al. (2018) noted that most Filipinos believed that they are self-reliant in preparing for a disaster, during the onslaught of a disaster, and in the disasters outcome. Most Filipinos cited their experience with the previous/past disasters as their reason for being prepared for future disasters. Similarly, many Filipinos believed their local government is well-prepared to deal with disasters and felt that the national government is well-prepared to cope with disasters.

Further, having a stockpile of water and food that will last for at least three days or the so-called "72-hour rule", availability of first aid kits in homes and a sound evacuation plan can be a positive safeguard to the effects of natural disasters. (Hooffman & Mattarak, 2017). This also concurs with Shreve and Kelman (2014), van der Keur et al. (2016) which noted that precautionary actions undertaken by households prior to the occurrence of a disaster can significantly prevent havoc to life and property.

2.4. Perception on the Damages/Impacts of Climate Change (% Incidence)

The results indicate that a large part of the respondents perceived that damage to the house (90.0%), loss of income brought about by work disruption (86.0%), damaged/loss of appliances and loss of fishing income (82.0%), and loss of livestock to be the most significant typhoon and flooding impacts. On the other hand, damage to assets (fishing boats, motorcycles) (70.0%), loss in agriculture production (78.0%), and loss in aquaculture production (74.0%) were recognized as the least impacts of typhoon and flooding. It can be noted that a great number of household heads are fishermen. Frequent and intense typhoons prohibit fishers from sailing out to sea. One strategy to augment their income could be livelihood diversification. Also, the provision of credit and training to beef-up alternative sources of livelihoods may be considered towards this end.

Concerning erosion and sea-level rise impacts, damage to assets (fishing boats, motorcycles) (88.0%), loss in fishing income (85.0%), and income loss due to work stoppage (84.0%) were considered the leading effects. On the contrary, damaged/loss of appliances (77.0%), loss in aquaculture production (77.0%), damage to house (76.0%), loss of livestock (76.0%), and loss in crop production (72.0%) were regarded as secondary effects.

Moreover, the respondents noted that their household members got sick from water-borne diseases (84.0%) as the significant effect of saltwater intrusion, followed by household members experiencing lack of portable water for domestic uses (83.0%), they got sick from other gastrointestinal maladies (81.0%), typhoid (81.0%), and loss in agricultural production. The result signifies that a strengthened healthcare system is imperative to address this concern.

Kibria (2014) theorized that the leading risk to coastal communities worldwide and the most disastrous aftermath of climate change is sea-level rise. It causes serious damage to biodiversity; encroachment of saltwater in groundwater aquifers; destruction of assets; salinization of crop lands; and coastal facilities used in aquaculture. In addition, low-lying coastal areas are prone to

flooding; increased bacterial outbreak; and proliferation of mosquitoes tolerant to salinity.

2.5. Adaptation Activities

People need not merely suffer the climate conditions they face but can change their practices, institutions, or technology to take maximum advantage of the opportunities the climate presents and limit the harms they suffer from. Through such adaptations, people and societies (like ecosystems) adjust to the average climate conditions and the variability of conditions they have experienced in the recent past. When habits, livelihoods, capital stock, and management practices are finely tuned to current climate conditions, the direct effect of many types of change in these conditions, mainly if the change occurs rapidly, is more likely to be harmful and disruptive than beneficial. Nevertheless, just as societies adapt to the present climate, they can also adapt to changes in it.

The respondents were further asked to describe their adaptation activities and policies undertaken in response to the impacts of climate change. The study results demonstrated that respondents applied multitude adaptation measures in response to the impacts of climate change. The result indicates that the most common adaptation activities were the presence of the Barangay Disaster Risk Management Council (BDRMC) with calamity funds allocated per year in the coastal areas ((90.0%), planting of mangrove tree species and fruit-bearing trees (85.0%), regular conduct of Information, Education and Communication (IEC) campaigns (82.0%) and maintenance of enhancement of Marine Protected Areas (MPA's) and mangrove areas (80.0%). It can be inferred from the result that the presence of BDRMC in every barangay is stipulated under Section 12 of RA 10121, otherwise known as the Philippine Disaster Risk Reduction and Management Act of 2010, that sets the direction, coordination, implementation and development of disaster risk management programs in respective geographical location.

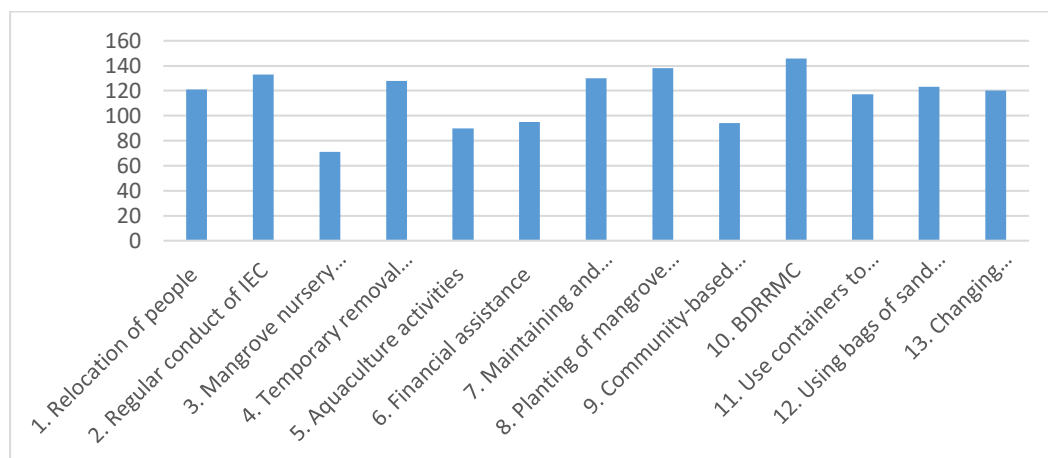


Figure 2. Adaptation Activities Undertaken

Conversely, the establishment of a mangrove nursery and selling of mangrove seedlings (44.0%) was regarded by the respondents as the least adaptation option. Considering the present state of mangrove forests, which have dramatically decreased (FAO, 2007; Long and Giri, 2011) since the start of the century, there is a need to reforest. However, first, mangrove nurseries must be established since they serve as sources of planting materials for different mangrove species. Further, nurseries would mean a sustainable livelihood source for coastal communities because of continuous demand for propagules (Sinohin & Bacongus, 2000). A mangrove nursery is a place for raising and tending seedlings until they are ready for permanent planting. Also, the establishment of mangrove nurseries are in conjunction with the National Greening Program (NGP) of the government to rehabilitate and regenerate the coastal and mangrove ecosystems.

The respondents further disclosed that in addition to the preceding adaptation strategies, they also actively took part in activities such as tree planting, coastal clean-up, *Oplan Dalus* and initiated activities like recycling non-biodegradable waste and avoided burning of plastic waste materials. Other coastal communities can also adapt these activities to minimize the causes and mitigate climate change effects.

Preparedness on the Impacts of Climate Change

It can be inferred from the result that the respondents' level of knowledge is directly related to their level of preparedness on the different climate change hazards such as coastal or tidal flooding, coastal soil erosion, saltwater intrusion, and frequent/intense typhoon. Please refer to Table 1. Climate and or disaster risk awareness, which denotes the extent of common knowledge about disaster risks, and the factors that lead to disasters, influence the actions taken individually or collectively to address exposure and vulnerability to hazards. Awareness is a very crucial element for a society to adapt to flood risk effectively. As stated by Shen (2009), awareness is diminished when the provision of appropriate information is minimal or when memories of past experiences or events are diminished. Awareness can generally be uplifted through efforts centered on local issues that contain simple solutions to reduce flood risk, and are repeated regularly (Poortinga et al., 2011).

2.6. Relationship Between the Respondents Level of Knowledge and Level of

Table 1. Correlation Between the Respondents Level of Knowledge and Level of Preparedness on the Impacts of Climate Change

Knowledge	Preparedness				Overall
	Coastal or Tidal Flooding	Coastal Soil Erosion	Saltwater Intrusion	Frequent/Intense Typhoon	
Coastal or Tidal Flooding	.623**	.625**	.609**	.437**	.693**
Coastal Soil Erosion	.602**	.576**	.441**	.145	.527**
Saltwater Intrusion	.581**	.513**	.531**	.142	.529**
Frequent/Intense Typhoon	.277**	.084	.018	.498**	.297**
Overall	.671**	.573**	.506**	.393**	.654**

2.7. Relationship Between the Respondents Level of Knowledge and Level of Preparedness on the Impacts of Climate Change, and Adaptation Activities

Table 2 reveals that the respondents' level of knowledge and level of preparedness is not significantly related to the different adaptation

Table 2. Correlation Between the Respondents Level of Knowledge and Adaptation Activities

Knowledge	r-value	Adaptation	
		r-prob	Decision
Coastal or Tidal Flooding	.002	.976	Do not Reject Ho
Coastal Soil Erosion	.000	.998	Do not Reject Ho
Saltwater Intrusion	.002	.984	Do not Reject Ho
Frequent/Intense Typhoon	.008	.915	Do not Reject Ho
Overall	.004	.957	Do not Reject Ho
Preparedness			
Coastal or Tidal Flooding	.002	.981	Do not Reject Ho
Coastal Soil Erosion	.005	.953	Do not Reject Ho
Saltwater Intrusion	.005	.949	Do not Reject Ho
Frequent/Intense Typhoon	.006	.942	Do not Reject Ho
Overall	.004	.957	Do not Reject Ho

activities undertaken to respond to the changing climate. While adaptation is to reduce exposure

and vulnerability, and enhance resilience by responding to disaster risks, it is also a process in all stages of hazards to help enhance the people's ability to reduce and mitigate the imminent threat.

3. Conclusions and Recommendations

The coastal residents are adequately knowledgeable and prepared on climate change impacts, such as coastal/tidal flooding, coastal soil erosion, saltwater intrusion, and frequent/intense typhoons. They experienced socio-economic impacts brought about by the changing climate. As such, different adaptation strategies were undertaken to cushion their compounded impacts.

It is recommended that best practices on climate change adaptation strategies be documented appropriately and replicated by other local government units vulnerable to climate change. In support of the Enhanced National Greening Program of the government, each of the coastal barangays with natural and rehabilitated mangrove areas should establish their seedling nursery for easier sourcing of planting materials.

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