

Research Report

Climate change information and adaptation in Kuroshio Region's vulnerable island

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Abstract

Climate Change information and adaptation is a strong issue in the Kuroshio region- an area of rich marine biodiversity that starts from Eastern Philippines to Southern and Eastern Japan. Catanduanes, the region's forefront island is timely challenged as climatic shift is often predicted to become more apparent in a smaller island habitat. It includes case study with a framework on action theory of adaptation to climate change. The interview methods both individual and focused-group as well as document analysis from secondary data were also utilized. While it revealed that most people are aware of the climatic shift and some areas have undergone hazard-related management, most part of the island still hardly cope with regulations and establishments of adaptive procedures that suggests more political intervention and planning are to be employed.

1. Introduction

Climate change information has been recently boosted in many places due to campaigns on climate change which implies a need of adaptation. While it is generally transpiring in today's reports that most region cannot avoid climate change influence, small-island ecosystems (typhoon-path) are often pointed to be more affected by the changing climate, hence information and adaptation are definite concerns of its constituents. With reports of serious devastation in many Philippine provinces during climatic disturbances, Catanduanes Island must therefore keep on the eye of framing its people with climate change knowledge and on their means of adaptation to avoid or minimize impact of climatic adversities. It is only in evaluation of the people's knowledge, needs, priorities and their physical reliabilities that regulatory reforms and collaboration can be attained.

When information about climate change is accessible, one will almost always think adaptation, as these are highly connected. Information can therefore lead to the desire of knowing precautionary or readiness measures. The IPCC (2007b) has described the adaptation to be natural or human systems responding to climatic stimuli or its effects in order to lessen the danger of the climatic shift or make better counteractions; this realization can only be generally

recognized by people who are knowledgeable in the climatic phenomenon.

Informed populations can innovate series of adaptive techniques like strengthening private infrastructures or by personally deciding to use biodegradable materials. Community involvement can also be conducted when for instance the people anticipate that coastal erosion and flooding is a threat; therefore the development of mangrove protected area which is known to stabilize waves and storm surges is a must. Moreover, the area may not only be used against waves and erosion but may be utilized to conserve and restore marine organisms; which is another form of adaptation. The success of a conservation project can boost further information that indicates community collaboration can move to minimize the effect of climate change. However, the success of such community initiatives depends on how political establishments and figures, constituents and stockholders respond to their roles. The action theory of adaptation by Eisenack and Stecker (2012) will be connected later on this paper to show how informed players perform/manage for a successful conservation project (adaptive strategy).

Literature has it that in order for the adaptation to proceed, there should have considerations with strong sustainability paradigm, emergency services, health, coastal management and economic development (Davoudi et al.,

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2009; DCCEE, 2010; Gurran et al., 2012; Swart & Raes, 2007), a good adjustments of human systems (Eisenack & Stecker, 2010), collective and strategic response to climate change risks and impacts (Bennett, 1976; McNeely & Lazrus, 2014; Smithers & Smit, 1997) and high relationship to human cultural practices and imagination (Howard, 2013). As described, the imagination is implied to be modifications of information that drives people to think of the necessary measures.

In an island which is often battered by typhoons, the conditions mentioned above that would content adaptation is a challenge especially with the fact that it is relatively isolated, densely populated along coasts and plains, relatively fewer stockholders and has a depleting resources. Climate change information therefore may welcome motivation and realization for the people to voice out their needs or difficulties complying with climatic adaptation. These will be serving reinforcements for policy makers to renew regulations or to sustain on-going beneficial adaptive proceedings in the island.

Methods

The case study design was employed in this study with the purpose of analyzing the island's people on their climate change information and adaptive strategies which is influenced by series of island physical features and economic and political implementations. The study is accompanied by another satellite case study anchored on the action theory of adaptation. This is to give analytic premise how an environmental adaptive procedure (coastal conservation) could provide a successful model when collaborated by well-informed local government units, community involvement and stockholders both national and international. Further, secondary data was thoroughly described and analyzed to infer the present climate change adaptation of the island: both in information among the people and the physical, meteorological, political and cultural features of the island.

A preliminary survey was conducted in villages which are more prone to environmental change such as sea coasts, forest interior and lowland plains of respective municipalities (Virac, Gigmoto and Panganiban). A total of 28 sampled individuals were included in the focused group discussions (FGD). Three FGD were structured in three villages, each FGD comprised by 10:10:8 individuals respectively. Personal interviews were also reinforced to some of the FGD members who seemed to be hesitant to some issues when speaking in front of other respondents. Fifteen separate individual interviews (6:5:4) were also conducted in the areas until saturation point in the responses has been attained. Dialogue with the key informants (barangay captain or councilor) evaluated sampled respondents to be generally representative of the fishers, farmers, laborers, students and professional.

Semi structured interviews were directed focusing on the respondents awareness in the climate change such as "What is your idea of a climate change?", "Do you fell Catanduanes Island is vulnerable to climatic shifts?" and if you do, "what are sustainable management proceedings (including information dissemination) are already on progress?" and "What are the challenges/limitations that the island hardly copes with (including resistance among villagers to follow guidelines on adaptation)?". With current climatic issues, respondents were also asked to choose what they are standing to: "avoid the unmanageable" or "manage the unavoidable" (Kropp & Scholze, 2009) and later asked to describe why. Personal, family and local adaptations on climate change were likewise asked in both FGD and individual interviews in terms of dwelling, garbage treatment and energy but further utilized open ended questions or sometimes follow-up questions on other means of adaptations and knowledge on the changing climate. Purposive sampling of a qualitative study was used to ensure varied responses and welcome other perspectives of island people who are purposely represented in the community.

2. Catanduanes Island's Features

The island lies on the eastern Philippine seaboard at coordinates 13.5⁰- 14.1⁰ NL and 124.0⁰- 124.5⁰ EL (DENR-Catanduanes, 2009b) with the area 1,511.5 km² (Department of Science & Technology, 2010). It is separated from the Bicol peninsula by the Maqueda Channel and Lagonoy Gulf. In 2010 census, it is already home to 246, 300 human population (NSO, 2013) which generally inhabit its coastal boundaries. Catanduanes nestles on the latitude where final waves of North Equatorial Current encounter terrestrial soils for the first time and merge on the waters northwestward and becomes the Kuroshio Current- an oceanic current running from Eastern Philippines to Japan passing Taiwan. The sea current location is frequently visited by typhoons. Figure 1 shows the map of the Philippines with Catanduanes Island pointed by an arrow. Dark blue colored provinces (includes Catanduanes Island) are predicted to have the highest typhoon intensity (WFP, 2015).



Source: WFP, 2015

3.0 Results

Though there are variations with the responses of the people of the island when it comes to their perceptions and knowledge about the adverse effects of climate change in an island habitat, result show a generally informed population. Most responses about beliefs on climate change pertain to it as the change of atmospheric temperature (rising) and change of rains, typhoons and drought intensity. These responses are fairly similar to the fact that the ongoing changes in temperature which causes increased severity and unpredictability of extremes in weather and climates already reflects impact on productivity, economies and above all, on the livelihoods of the world's poorest and most vulnerable place (CCC, 2014). Human activities were hotly focused and blamed by respondents as the major cause of the phenomenon. The greenhouse gases (GHG's) is not a stranger term to the people as they know where it is coming (vehicles, factories, even appliances) although very few had actually specifically mentioned some GHG's (carbon dioxide, carbon monoxide, nitrous oxide). Some of them (fishers) admitted that they keep on going with gasoline and other fuels that sometimes accidentally spilled to the sea; however they cannot avoid it as there are no other means of fuel or that they have no funds of upgrading their boats with pollution control. Deforestation was also pointed out to aggravate the pollution (GHG's) as this lowers down tree population that absorb the hazardous gases. These responses are highly linked to reports of Warren et al. (2010) who mentioned that emission of GHG's and deforestation is actually naturally prevailing which underscores the need to limit greenhouse gas emissions by accelerating mitigation efforts and by protecting existing ecosystems from greenhouse-gas producing land use change processes such as deforestation. Many have also answered that it is the effect of other smaller pollutants produced indoor by individual or family groups and are unwarily accumulated in the atmosphere such as cigarette smoke, paints, varnishes, inks and home used fire. This is another good awareness as indoor pollution has been widely described by environmental scientists. Although people's responses were not specifically noted, for example they do not know that lead is a pollutant but mentioning paint conveys the message as well because paints contain lead. Schenck et al. (2010) states that air becomes a repository of gases if contained indoor, moisture and particles originating from occupants and materials which include biological contaminants, fibrous insulating materials, formaldehyde, lead, ozone, radon, volatile organic compounds and other emissions; particulate matter and smoke pollutants are also formed de novo from the mingling of various constituents in the indoor environment. Some answered that climate change is brought by illegal activities such as illegal logging and illegal

burning and also by poor waste management.

People knew that the island is vulnerable to storm surges, flooding and flashfloods due to typhoons. Majority answered an increasing intensity of typhoons and rise of sea level. Their responses are also reflected in literature which generally states that in some of the world's coastal region, an intensification of storm surges is expected by the end of this century in a massive increase of wave heights due to the changing climate (Weisse & Grabemann, 2007). On the other hand, one elderly has indicated that during his childhood, their coconut was some meters before the coastline, but today it is permanently submerged in sea water and has died. This response further supported by the fact that climate change is also expected to compound the overall vulnerability of urban areas and coastal plains through rising sea levels, more frequent and stronger weather events, and inland flooding, among other challenges (Eisenack et al., 2007; UN-HABITAT, 2008). Likewise, most responses on this matter have been paralleled to reports that in other coastal and island parts of the world, climate change has greatly contributed erosion and other weather related disturbances with implications for coastal infrastructure, homes, food security, biodiversity and hardships on mitigations (DECCW, 2009; IPCC, 2007a; PCCSPP, 2011; Steffen et al., 2009; WFP, 2015).

The size of the island is seen by many as an influential factor that they would often respond "If other bigger places are affected by the climate change, how much more for this small island?" Their awareness on island impact is in accordance with the thought that the island places are likely to suffer the most from the adverse effects and could even become uninhabitable with the advent of the effects of shifting climate (UNFCCC, 2005). The threat on drought is another issue that some people also foresee though they know that compared to some other provinces the island is still relatively wetter. Responses on drought caused by typhoons were also noted; this is unusual as many people may tend to associate typhoons to floods or landslides only. Asked "why typhoons can deliver droughts" few answered that forests were damaged, so water table have also been disturbed as well. Many believe that prolong drought may cause their livelihood to decline. That is actually a trend predicted by many authorities. Ramamasy & Baas (2007) have in fact indicated that increased carbon dioxide and other greenhouse gasses in the atmosphere have been suggested as causes of rainfall changes, which are in turn attributed to climate change and eventually more frequent droughts are expected. Surprisingly, some people are aware that their soil substrate (limestone in specific areas) can lead to sink hole and liquefactions with the constant concentration of acidic rains. This is also supported by the fact that sinkholes occur when acidic rainwater has eaten away so much of the underlying limestone bedrock beneath the soil that

the ground collapses (Rohrig, 2014). This sinkhole knowledge can be attributed to educational curriculum and campaigns of local government unit on the impacts of climate change.

Responses on the sustainable management proceedings currently on progress directed on some projects that are undergoing such as constructions of road/bridges and flood infrastructures, water systems, housing, evacuation centers and community preparedness initiatives, however most had answered that lot of efforts should be done by the government and of the people themselves to make the projects in full reality. The marine protected area conservation was a very popular answer; reasons for fish and other marine conservation are the usual responses when asked why the marine conservation should be done. Responses knowledge is parallel to statements of CDEH (2003) that states marine protected areas help protect important habitats and representative samples of marine life and can assist in restoring the productivity of the oceans and avoid further degradation. When it comes to accessibility of immediate information during inclement weather, most believe that national, regional and local advisories arrive on time through local media (television and battery operated radios). Moreover, impact of strong typhoons is sometimes blamed by people not on the typhoon itself but due to poor internet service and to the limited power source (electric current) which information on mass media largely depends. Further, many believe that the hazard maps are not properly informed and dispensed to the general population though they know that these are available in online sites.

“Manage the unavoidable” were answered by many as they know that climate change effect is already in the island. The responses is timely as it is widely acknowledged that climate change is now inevitable, and adaptation, through a range of technical, regulatory and behavioral changes, is one of the key methods available to the society for dealing with climate change (WMO, 2007). However, “the avoid the unmanageable” were also answered by some as they reason out that there are still more dangerous effect of climate change that could have not yet occurred; so minimizing the offensive human acts to the environment (such as illegal logging, illegal fishing or quarrying) should be stopped as much as possible. Anticipating the future effects have actually been described by Houghton (2011) and Howard (2013) who stated that the human activities together with the accompanying rapid industrial development, are leading to degradation of the environment on a very large scale and the language describing the effects of climate change is becoming often infused with dire predictions.

Most people answered that the sustainable management proceedings they have mentioned have their own limitations because many are not accessible to the general public or that it

is conducted not in the uniform circulation (For example, water systems are still not thoroughly built in some areas). They know that storm surges are serious threat to coastal villagers and the need of resettlements is a must, however many of these people remain on their coastal settlement as there is no other way of financing a house out of the area and that transferring may also mean an abandonment of their livelihood which already ran for many generations. Furthermore, most coastal people admit that some adaptations (like limiting exploitation of fingerlings of fish) are hard to employ as they are dependent on these daily activities. This is further supported by Soliman et al. (2009) who had actually reported overfishing of rabbitfish (*S. canaliculatus*) in the Bicol Region including important coasts of Catanduanes Island. Newman (2015) described that unregulated fishing are conducted in areas where there are no applicable conservation and management measures, this is likewise supported by respondents who initiated that regulations are not fully implemented or weakly regulated that is why they continue the routine as usual. On the other hand, some drought resistant crops are also not readily available or if available, people resist using it because of its long cultivation period and the fear that it is artificially modified; hence it may aggravate their body. This is in relation to Wieczorek (2003) who has mentioned that many individuals have conflicting and confusing statements regarding on their acceptance of using modified crops which would put them in great fear and anxiety. In connection, some vehicle owners may choose less friendly fuel because it is relatively more affordable while many village people choose on cutting trees for firewood. There are even some tree cutters who found livelihood by cutting and selling trees either fresh or turned into charcoal. They are aware that this can harm the environment but again, absence or limited opportunity for another job has been their big challenges. Consequently, many people tend to patronize nature exploitation products such as firewood/charcoal, fish fingerlings, crablets and other products because it is more affordable and has been carried by the culture they have been part of. Also, there are involved in sand and gravel collections and have been told by authorities to stop but have been returning to the work because it can give them easy money. Meanwhile the largest downtrend that people believe is the loss of natural resources especially biodiversity as terrestrial and aquatic organisms may finally succumb to the detrimental changes in the atmosphere. Some fisher respondents knew that sea current along the island's coasts drifts to Northern Region (mentioning Taiwan and Japan) and said that it is very important for the island's people to adapt and care for their resources as Northern Regions are partly dependent to the waters and currents drifting on its coasts.

Responses on a personal/family adaptation includes

concreting of the house to provide strong shelter, segregation of garbage and refusing them to be burned to minimize GHG's, reducing water and electric consumptions including purchasing of a solar panel to avoid overuse of non-renewable energy, becoming more vegetarian to keep body fresh and help conserve water, reusing/recycling used papers and other reusable materials to lessen cutting of trees, sending information through emails to minimize paper production, saving rain water, walking instead of riding in a less than 1 kilometer distance of transportation to minimize fuel combustion and greening the house backyard to provide more oxygen and fresh environment. These responses on dwelling, energy, vegetarian body and environmental reactions, forest utilizations and water and oxygen responses are virtually related in literature respectively (CEMBUREAU, 2007; Ekins-Daukes, 2009; Fox & Ward, 2008; Gill et al., 2007; Sarantis, 2002). This indicates of the information and willingness of the people to make their own ways to combat climate change though they often compare that this should be supported by the government.

Local community initiative adaptation includes concreting of sea wall/river dikes or building piles of sack of sands in the sea coasts/river banks if these have not been built, mangrove planting on the coasts, tree planting on the forests and idle lands, setting waste segregation containers in the public, implementing regulations on logging, and garbage burning, regulations of wildlife harvesting/hunting and minimizing water and electric consumptions in public infrastructures. They also know that one of the practices in climate change adaptation is to cultivate drought and flood resistant crop varieties yet they state that these are still generally not available in the market or not yet widely circulated by the government or other private institutions. Another challenge poses as they believe these varieties have usually longer cultivation time, generally less yield and limited accessibility among farmers. This coordinated effort by the local community has something to do with statements of Eisenack and Stecker (2012) who stressed that collaboration effort between various sectors of the community is important to thoroughly adapt with the changes. The community is relatively informed and willing to contribute to the adaptive strategies but their previous responses on the island's challenges do not just reflect on challenges that the provincial government may bear but also on their personal initiatives.

3.1 The Case of the Agojo Point Fish Sanctuary and Marine Reserve (APFSMR)

The Agojo Point Fish Sanctuary and Marine Reserve coordinates at 124.0514 E Longitude, 13.6014 N Latitude with area coverage of approximately 3 km long and 1.5 km wide at

the peninsular region protruding into the northern waters of Lagonoy Gulf from the coastal areas of Barangay Agojo in the municipality of San Andres, Catanduanes. Fifty percent of the peninsula along the northern shoreline is a mangrove swamp. The remaining shoreline is a long stretch of white beach, while the interior is an area of farm and residential land. There are two coastal villages or *barangay* (Agojo & Tominawog) within the area with a combined population of about 25,000 people. Most of the barangay people including many people from the rest of San Andres rely heavily from the resources of marine and wetlands environment, which may eventually deplete the resources, hence this APFSMR has been established (Vargas & Asetre, 2011).

Vargas and Asetre (2011) noted that the oldest of the coastal resource management/ marine protected area establishment in Bicol Region is the Agojo Point Fish Sanctuary and Marine Reserve (APFSMR) also known as Agojo Marine Protected Area (AMPA) strategically located along the Lagonoy Gulf in the island province of Catanduanes. They have mentioned further that establishment of the MPA in 1993 has holistically addressed the management and conservation issues in the area, thus substantial recovery from the previously damaged conditions of the fragile coastal ecosystem has restored biodiversity of its natural resources and has significantly contributed to the enhancement of the quality of life of the stakeholders on the adjoining communities in the municipality of San Andres, Catanduanes.

The coastal parts of the area including all wetland and marine habitat heavily rely on erosion-resistant soil substrate (ERSS) as the ERSS retain earth debris such as soil minerals, rocks and organic particulates. This in turn shapes the coastal contour of the place while ensuring terrestrial environment not reclaimed from the sea. One of the most important uses of the ERSS is ensuring the aquatic habitat in place as this is used by organisms in their breeding and food foraging. In the area of rich biodiversity as in Agojo, ensuring ERSS is an important issue as many systems and people rely on its resources.

With the event of climatic shift, ERSS is bound to change. Intensifying typhoons usually battered villages of the area and directly results to loss of lands to the sea. Storm surges may become extreme as there is already no gradual deepening slope of the coasts as the soil has eroded. It then results biodiversity decline as well. Burrowing animals can be heavily destroyed while breathing tissues/organs of mangrove plants can be seriously suffocated. Siltation coming from weak soil sources can leach coral reefs, algal beds and mangrove forests (Aldea et al., 2014). As many people rely on the coastal resources, the situation comes even more severe.

Analyzing with the component of the case (Figure 2), the action theory on adaptation will be related with the following framework as described by Eisenack & Stecker (2012) that

states that boxes with rounded corners can be both actors and biophysical units, while operators are always actors. Operator, receptor and exposure unit are not necessarily identical (indicated by overlapping boxes). The straight arrow indicates a causal relation and the large arrow a teleological relation. Figure 2 shows the framework of the theory.

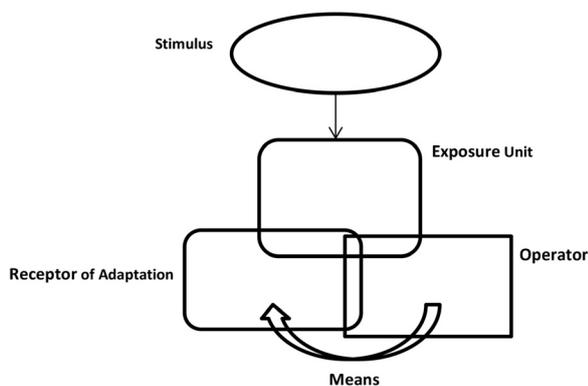


Fig. 2. Framework of the Action Theory on Adaptation.
 Source: Eisenack & Stecker (2012).

Describing the theory components, Eisenack and Stecker (2012) indicated with the following excerpts:

“The theory should begin with a “stimulus” as a change in biophysical (in particular meteorological) variables associated with climate change. In a very precise meaning, this has to be distinguished from weather events. It can refer to changed values of statistical parameters such as average intensity, frequency, or higher statistical momenta (e.g. variance). A stimulus is only relevant for adaptation when it influences an exposure unit. The latter term broadly refers to all those actors, social, technical or non-human systems that depend on climatic conditions, and are therefore exposed to stimuli (IPCC, 2001). The individual or collective actors that exercises the response is called the operator (a social entity)

while the actor or system that is the target of an adaptation (the purpose) is called the receptor. Receptors can be both biophysical entities (e.g. the crops of a farmer) and social systems (e.g. the farmer household), depending on the objective of analysis. It is further not required that the receptor of an adaptation is an exposure unit at the same time. Further, to implement the adaptation, the operator needs resources, called as means”. There are other variations and complexity as referred by Eisenack and Stecker (2012) but only those which are basic to this study were used.

As exposure can be a biophysical unit (not always an actor), this study will also utilize climate change effect (exposure units) in the physical attribution of the island which will further linked to government initiatives and communities as operators (always actors) to give necessary adaptive measures on the well-being of individuals as well as island biodiversity and natural resources. Moreover, while other studies focus on structural obstacles to local policy processes and on public participation for developing adaptation options (Brown et al., 2007), there should be concentration on assessing the perceptions that form the basis for local discourse (Eisenack et al., 2007).

In order to solve the current problems and the predicted maladies which climate change may bring, initiatives and collaborations from various stockholders have taken place to ensure that APFSMR remains functional with of course undisturbed ERSS. To date, there are no highly defined technological ways (aside from sea wall construction in some vicinity areas) to restore the integrity of the protected area, however other available adaptive means have been circulated and are currently on progress. The following shows the breakdown of the set of adaptation as described by Eisenack & Stecker (2012) (delimiting its adaptation types). The management intervention in APFSMR synthesized from the reports of Vargas and Asetre (2011) is described in table 1.

Table 1. The Management Intervention in APFSMR.

Adaptation	Operator	Receptor	Exposure Unit	Means
Surveillance (Patrol Boats) and construction of a watch house	Local & Public Government, RP-Japan Increase Food Production Program)	Fishing regulators/ implementors (Bantay dagat, etc.)	Fishing regulators/ implementors (Bantay dagat, etc.)	Administrative Acts
Extensive Mangrove Reforestation	Catanduanes Youth Clubs, BFAR Regional Administration	Youth Volunteers, Barangay people, Nature Advocates	APFSMR's Mangrove Area	Investments, contracts, scientific projects
Seaweed seedlings distribution to Municipal Fishery and Aquatic Resource Management Council (MFARMC) members operating a seaweed farm project	BFAR Regional Administration	Members of the MFARMC	APFSMR's seaweed area	Regional approval, investments, partnerships and linkages

Procurement of Funds from US Embassy and Women's Club and DENR	Local and Public Government	APFSMR's Implementors	APFSMR's Implementors	Funds, Private support
Scientific studies about the ecology of the area (soil, water, flora and fauna, etc.)	Catanduanes State University	Natural & Social Departments, Teachers, Researchers	APFSMR's physical and biological features	Funds, linkages, research collaborations
Coastal clean-up advocacy campaign	San Andres Vocational High School, CSU	Students, Teachers	Students, Teachers	Collaboration, institutional partnerships

Source: Vargas & Asetre (2011) (A synthesis)

The various components of the action theory on adaptation have been widely used by the stockholders involved in the management of the APFSMR. It ensured the ERSS in place that led to the recovery of the mangrove cover (although it has recorded some loss in the first few years) by the end of 2003 at 147 ha or 166 rebound hectares from 1995 (Aldea et al., 2015), thus ensuring biodiversity stock. It is now considered as one of the most successful environmental initiatives in the island of Catanduanes mitigating for the adverse effects of climate change.

The barriers could have appeared however. For instance when means are not available or insufficient, this could have led to stagnation of the programs. When exposure units are not properly targeted by the operator, poor results are to be expected as no proper evaluation are conducted by the doers (operator). Likewise, the response of the receptors could have been resulted unsuccessfully even when all best practices are dispensed by the operators when physical and natural forces come amidst the proceedings.

Administrative acts may also serve a barrier. This comes when political structures of the area are weakly established and managed. Regulating and passing these acts to become law will require lot of time, investments and series of public

talks. In some cases, absence of operators may pose a great challenge especially if operators are potential source of funds and authority.

4. Climate Change Related Adaptation in Catanduanes Island

(Provincial, Regional, National and private activities and collaborations)

Several issues should be assessed to identify key urban activity sectors which are deemed crucial to support the island's resilience to projected climate change impacts while also looking into the valuation of possible damages (UN-HABITAT, 2008). In an adaptive community, different sectors have their own participatory activities in identifying vulnerability and project necessary for mitigating measures. National and Provincial government and private stockholders usually collaborate with the proceedings while strategic planning and various implementation of mitigating programs developed and dispensed to the concerned parties. Table 2 shows the following issues and adaptive strategies in Catanduanes Island.

Table 2. Issues and Strategies.

Issues	Adaptive Strategies	Remarks
Housing	<ul style="list-style-type: none"> * A Multi million peso housing project in one barangay provided by the Housing and Urban Development Coordinating Council (HUDCC) collaborated by PagIBIG or the Home Development Mutual Fund (HDMF) (Calleja, 2011). This strategy may serve as models for future housing projects. * House models are especially designed concrete structures capable of withstanding super typhoon gusts (300 kph winds) and 8.0 magnitude earthquakes and equipped by solar generator and rain collector systems. * The project includes technology using green designs, introduced new approaches in renewable energy applications and waste management initiatives to achieve ecological integrity in mass housing projects; and, pioneer sustainable homeowner livelihood programs with the available low energy cost (Catanduanes Tribune, 2012). 	<ul style="list-style-type: none"> * Catanduanes has the least housing programs in the region (Bicol Periodico, 2013). * The inclusion of rain collector system is another adaptive approach for household water concern.

Climate change information and adaptation in Kuroshio Region's vulnerable island

<p>Water System</p>	<p>* Implementation of water systems is currently on progress.</p> <p>*Recent funds for municipalities are given</p> <p>* Million funds provided by the Local Water Utilities Administration (LWUA) to establish water system in many areas or upgrade water systems in the areas with existing water systems (Calleja, 2011).</p> <p>* The Water Supply, Sanitation and Hygiene (CPWASH), engaged in a project of potable water establishments with the Department of Agrarian Reform (DAR) which campaigns awareness and appreciation on the relationship of water, health and poverty that are closely linked to each other.</p> <p>* The said project is the first-in-the-province prototype potable water sanitation system that with iron removal filter, bio-sand filter, and rainwater collector and biogas digester will be constructed. Some barangays were the recipient of the the pioneering projects (Calleja, 2014; Catanduanes Tribune, 2013a; 2014).</p>	<p>* In 2012, it was reported that Cholera outbreak occurred in one barangay which resulted in 18 deaths and hospitalized about 3,000 others (Calleja, 2014) which was eventually blamed on bacteria in the water source where folks take their drinking water. This could have been avoided with the presence of water systems.</p>
<p>Bridges and Roads Rehabilitation</p>	<p>* Recent rehabilitation and improvement programs of parts of Catanduanes Circumferential Road are on-going.</p> <p>* The government has sought Foreign Aid for the Japanese-funded P2.6-billion Catanduanes Circumferential Road Improvement (Philippine News Agency, 2013) which covers many road sections and bridges. Currently, several projects of road rehabilitation are parts of that huge road program.</p>	<p>* The collapse of Bato Bridge in 1998 (Super Typhoon Loleng/Babs) has made three municipalities isolated for about 3 months.</p>
<p>Sea Wall/ Flood Control Establishment and Repair</p>	<p>* There have been recent project in flood control (sea walls and river dikes) as stated by the Provincial Disaster Risk Reduction and Management Office (PDRRMO) (Catanduanes Tribune, 2016).</p> <p>* In 2013, the Catanduanes had appealed to National government for rehabilitation (inclusion for typhoon Yolanda affected areas) that sought to augment the Calamity Fund. A damage report prepared by the Department of Public Works and Highways (DPWH); with validation, assessed funds were figured (Catanduanes Tribune, 2015b).</p>	<p>* It is a common view that after a strong typhoon in the island, many sea walls and river dikes are destroyed.</p>
<p>Evacuation Centers</p>	<p>* KALAHI-CIDSS program, a foreign stockholder had also taken its part in the construction of evacuation center-barangay hall which has recently constructed in one barangay (Catanduanes Tribune, 2015d).</p> <p>*A DILG Project (DILG-LISTO) Project has procured Disaster Risk and Response (DRR) facilities which include construction of evacuation facility, drainage canal project and municipal evacuation center in selected towns as well as procurement of speed boat and evacuation center in other areas (Catanduanes Tribune, 2015a).</p> <p>* For the purpose of reducing the risks of storm surges, the Provincial Disaster Risk Reduction and Management Office (PDRRMO) invested infrastructure projects across the province from 2014 to 2015 that included construction of 7 multi-purpose evacuation centers (Catanduanes Tribune, 2016). In far villages, barangay halls are usually made into evacuation centers during typhoons. This matter should be carefully studied by authorities as many barangay locations in the province are located within flood and/or landslide prone areas. Barangay halls may be used as evacuation centers especially for those least populated barangays; however, the building integrity should be assessed thoroughly to avoid further damage to life and property.</p>	<p>* The value of evacuation centers during adverse climatic condition (typhoons) is highly advantageous. Many people whose dwellings are not concrete materials may be provided with safety and security by evacuation centers. Even those people who have competitive house foundation may shelter in the evacuation centers when their houses may become vulnerable to secondary effects such as floods and landslides.</p>

<p>Disaster preparedness Information and Activities</p>	<p>* In 2015, the Department of the Interior and Local Government (DILG) developed a Disaster Preparedness Manual for the community information.</p> <p>* The provincial government discusses with municipal leaders, the Disaster Risk Reduction and Management (DRRM) officers and the local Department of Interior and Local Government (DILG) officers for a provincial convergence action planning to identify roles and responsibilities and create convergence plan among stockholders in the province.</p> <p>* Also, the Local Government Units (LGU's) initiates the installation of signage or markers in identified hazard and danger zones; institutionalization of the implementation of Pre-emptive and Forced Evacuation; and, the purchase, installation and maintenance of water level and rain gauge stations. The DILG had a dialogue for the appreciation on the preparedness manuals among Civil Society Organizations (CSOs), the private sector, LRIs and the media (Catanduanes Tribune, 2015a).</p>	<p>While material culture is the physical adaptive responses made to counteract forces inflicted by changing winds, precipitation and solar radiations, it is an important trend that political responses of the community come up first before any technological applications.</p>
<p>Biodiversity and Agriculture/ Aquaculture Management</p>	<p>* Marine Protected Areas (MPAs) are recently implemented in some areas.</p> <p>* The establishment of the fish sanctuary and marine reserve (FSMR) at the Virac coastal barangays of Marilima and Batag as well as at the Takot barrier reef (Catanduanes Tribune, 2013c).</p> <p>* The BFAR and World Wildlife Fund had some fundings provided in coastal conservation (Catanduanes Tribune, 2013b).</p> <p>* The Catanduanes Watershed Forest Reserve was (CWFS) proclaimed (DENR-Catanduanes, 2009a). The DENR has initiated a management program for reviving the Catanduanes Forests, thus the Catanduanes Watershed Forest Reserve 5-year Management Plan (2010 ? 2014) was born in 2009.</p> <p>* The DENR-5 (2015) seeks to expand the Catanduanes Watershed Forest Reserve (CWFR) from 26,000 hectares (ha) to 48,831 ha. The CWFR is a protected area. Penalties apply to those who commit prohibited acts including hunting, destroying, disturbing or mere possession of any plants or animals or products derived therefrom without permit from the Management Board (DENR-5 May 14).</p> <p>* The DENR-Catanduanes (2016) created a Protected Areas and Wildlife Bureau (PAWB) which aims to guard and maintain protected areas and wildlife resources development, biodiversity conservation and coastal and marine resources management while its Mines and Geosciences Bureau (MGB) released hazard maps of places susceptibility to flood, liquefaction, landslide and ground subsidence and?ground?settlement.</p> <p>* Evaluation for climate change resistant rice is being conducted by agricultural institution (Barba et al., 2014).</p> <p>* The Department of Agriculture- 5 (2011) is initiating shift or innovation in the following aquaculture/agriculture practices. It states that in increased drought, diversification of livelihoods; introduction of drought resistant varieties; adjustment in cropping cycle, improved soil and water management; community grain storage and fodder cultivation, likewise in increased salinity, cultivation of salt resistant varieties; cultivating maize and fodder grass during dry season; rainwater harvesting in miniponds; coastal banks and embankments are encouraged. Moreover, for sea level rise, sluice gates to balance agriculture and fisheries; no tillage farming; re- agro forestation; flood early warning system; emergency shelters for human and livestock and for shift in seasons, adjust timing of farm operations; introduction of short cycle varieties, irrigation, rainwater harvesting.</p> <p>* Trainings for climate change among Catanduanes farmers have also being conducted. The trainings on Climate Change Adaptation are participated by Agriculture Extension Workers (AEWs) and farmers (Department of Agriculture- 5, 2014).</p> <p>* The Department of Agriculture Region 5 (2016) through its Regional Field Office is already implementing Rice Seed Buffer Stocking System as one of the important measures towards food sufficiency and as pro-active response to calamities and unforeseen climatic events.</p>	<p>As climate change interfere in creating imbalance to water supply, erosion, rise of temperature, etc., organisms eventually hardly cope and many of them either die out or leave for other places less vulnerable to shifts.</p> <p>*Island Biodiversity is high as reflected in the literature (Aldea et al., 2014, 2015; Masagca et al., 2010; Vargas & Asetre, 2011; Viron, 2006).</p> <p>*Human induced activities such as overfishing and coastal forests clearings continue (Aldea et al., 2015).</p> <p>* Another MPA was established in one municipality, however, villagers are considering the site already inactive as reefs experienced significant leaching and siltation caused by natural and human induced activities.</p>

5.0 Challenges in the Adaptation Implementation

While the government is doing its share to prepare the population adaptation through various means; meteorological,

physical, economic and biodiversity features of the island still strive and make barriers to implementation. Table 3 shows these challenges.

Table 3. Challenges in the Adaptation Implementation

Challenges	Remarks
Information Technology	<p>*Internet connection is generally unstable in many parts of the island.</p> <p>* There is a request for the National Telecommunication Commission to look into the poor internet service of a big telecommunications company in Catanduanes (Catanduanes Tribune 2015c).</p> <p>*The slow broadband connection in Catanduanes results in the delayed of a number of the government transactions (DENR-Catanduanes-Annual Report, 2014; Catanduanes Tribune, 2015e).</p>
Geography	<p>* The location of the island facing the Pacific Ocean makes it a typhoon land fall area.</p> <p>* Most typhoons move in a general Northwest direction which may threat the island as most of them develop below the islands latitude.</p> <p>* Some people may observe about the southward movement of tropical cyclones to Mindanao as a result of strong typhoons such as Bopha which made landfall in Mindanao. However, tropical cyclone climatology from 1950-2010 does not suggest such a trend. Instead, there is high inter-decadal variability in cyclone frequency (WFP, 2015).</p> <p>*Island's location has an important pragmatic frame that initiates adaptive measures (Lyth et al., 2015). It is therefore important to understand the geography of adaptation, whether it be the scale at which the issue is explored and the adaptation responses developed, or the characteristics of the "place" that determine vulnerability, risk and adaptive options (Adger et al. 2005; Hallegatte & Corfee-Morlot, 2011; Juhola et al. 2011; Lyth et al., 2015; McEvoy et al., 2013).</p> <p>* The scenario is also predicted to become even more diverting as the WFO (2015) predicted that typhoon risk remains high particularly in the north of the country (including Catanduanes Island) which has historically been the most frequently affected region. Recently, there have been diverse reports that many island's barangay centers are prone to floods, soil erosion and landslides (PCW, 2015; Philippine Information Agency, 2005; Philstar Global, 2012).</p>
Topography	<p>* It is noted that the vulnerability and suitability aspects in terms of the provincial framework on Disaster Risk Reduction and Climate Change Adaptation (DRR-CCA) including the slope characteristics of land should be taken into considerations, being location-specific. It is noted that NEDA facilitated the formulation of the provincial DRR-CCA framework. Generally, the slope characteristics maybe summarized, as follows: 49% or 740.635 km² – rolling to hilly; 9% or 438.335 km² – steep hills /mountains, and 7% or 105.805 km² very steep/mountainous (PCIP, Catanduanes, 2013).</p> <p>* This description may not only impact on crops but on physical conditions of the island as portions of these lands are used for settlements which could be prone to secondary natural disasters such as landslides or liquefactions brought by typhoons. The remaining percentages are usually coastal plains which are eventually becoming prone to floods and storm surges.</p>
Human Development	<p>* Adaptive responses will be best practice when large proportion of the population is living higher above the general poverty index as many other practices may not be followed with an empty stomach.</p> <p>* In 2009, the province ranked 1st in the Human Development Index with HDI Value of 0.630 (NCSB, 2009) and have the lowest poverty (2003) incidence among all provinces in Bicol Region (Monge et al., 2007).</p> <p>* However, it should be noted that the province is still lagged behind the national average of 0.633 (NSCB, 2009). The statistics is a better results of Human Development the island compared the Bicol Region's yet a challenge arise on how it would alleviate poverty further to overcome the very small national average margin and points even better beyond.</p>

<p>Accessibility to Safe Water</p>	<p>* Water Systems are not yet fully implemented especially in farther municipalities.</p> <p>* Catanduanes ranked two in safe water accessibility (93.8%) while it ranked three in the number of sanitary toilets (67%) (Monge et al., 2007) in the Bicol Region. While the figure can reflect of a higher safety water access and a relatively average value in accessibility to sanitary toilets across the Bicol Region, it is still posing challenge as the less privileged households involved are still large numbers (2,664 for safe water; 14,083 for sanitary toilets) and should never be disregarded in order to attain higher development.</p>
<p>Basic Education Dropouts</p>	<p>* As education plays a distinct role to make people well informed of the effect of climate change beginning on their earlier age, education is therefore given a weight on adaptive challenge.</p> <p>* Catanduanes Island had a 0.50 and 4.02 percent dropout in elementary and high school levels (DEPED-5, 2013). While these are generally lower values compared to other provinces in the Bicol Region, a challenge remains as it still involves higher dropout rates compared to other Philippine provinces.</p> <p>* Poverty is the underlying common factor that triggered most of the learners to drop out from school, in both elementary and secondary levels. Many were forced into child labor, while others succumbed to illness. Another risk factor identified among drop outs was the distance of the learner's home from the school, followed by transfer of residence. In the secondary level, early marriage/pregnancy was also common, and so with domestic problems as primary causes of dropping out (DEPED-5, 2013). These situations is even predicted to be affected by changing stocks of natural resources as the climatic conditions deviate through times.</p>
<p>Housing and Relocation</p>	<p>* Challenges come as LGU's may not readily find/won fund sources from housing agencies, government banks, local appropriations for housing, bond flotation, calamity funds, and non-government organizations like Habitat for Humanity and Gawad Kalinga as there are other provinces also evaluated for it by the government/private organizations.</p> <p>*Private funds from private institutions may be hardly implemented/won due to the anticipated meteorological conditions of the island.</p> <p>* Relocation is a better option for families living in squatter's area or in areas prone to disasters. But some relocation projects established posed problems on limited supply of public water area and public toilets. In 2013, a relocation site was one of the several areas hard hit by a diarrhea outbreak that affected half of the original households (Catanduanes Tribune, 2015d).</p>
<p>Mining & Quarrying</p>	<p>* The soils data in Catanduanes includes important minerals such as coal, copper, gold and phosphate. Limestone and silica are abundant. Other minerals include manganese, black sand, marble and clay (DENR-Catanduanes, 2009a).</p> <p>* This has attracted mining and quarrying enthusiasts which also add challenges to natural terrain of the island as those extracted places become more vulnerable to landslides, flashfloods and liquefaction. This is not only a challenge of the island as small scale illegal mining operations and treasure hunting is rampant across the region. Currently, there are protests from anti-mining and environmental groups (NEDA, 2011).</p>
<p>Biodiversity Exploitation</p>	<p>*Environmental effort is still limited when it comes to restrictions or total prohibition of juvenile fish excessive fishing. Soliman et al. (2009) indicated that <i>Siganid</i> overfishing is a serious problem in Lagonoy Gulf which is a maritime part of Southern Catanduanes, although most coastal part of the island has been heavily fishing it as well.</p> <p>* Dynamite fishing has declined for the past years, the results are still prevailing as damaged coral reefs are not easily recovered in some areas (Catanduanes Tribune, 2013a).</p> <p>*Vargas and Asetre (2011) stated that the sudden decline in the island's mangrove area coverage in 1995 indicated degradation of coastal resources and the construction of fish ponds and other anthropogenic activities such as uncontrolled gathering or cutting of economically important trees for fuels occurred.</p> <p>* Very recently, the Catanduanes Tribune (2014) had reported findings that at least 8 fishponds in northern towns were illegally built within mangrove forests and swamplands.</p> <p>* Catanduanes Island has one of the two clumps of rainforests remained in the Bicol region (Fragada, as cited by Arguelles, 2011). However, forest clearing and indiscriminate hunting of forest wildlife may have been the reason why the endemic Catanduanes bleeding heart pigeon is considered nearing to extinction by avian authorities (Hume & Walters, 2012).</p> <p>* Illegal logging has been a primary problem for the past years and continues to threat forest life a organisms when siltation ran off from denuded mountains to the sea. Illegal and destructive fishing activities in the form of improvised battery operated gadgets, use of cyanide or pesticide that are poisoning the river and creeks and other forms of non- traditional fishing destroy the natural production cycle of fresh water fishes and shrimps throughout the year (DENR-Catanduanes, 2009a).</p>

6.0 Conclusions and Recommendations

While most people of Catanduanes Island are informed on the general climatic knowledge, cases of abandoning their information do prevail in the presence of declining resources or due to absence or weak regulations; for instance some people resist information on adaptation because implementing it may mean a decrease on their livelihood harvest. Political means sometimes hardly imposes rules and regulations due to law enforcement issue such as lack of manpower and coordination among stockholders. This reflects of a higher need of environmental laws and implementation in a large uniformity and circulations.

It has to be noted that government must excel more in distributing the technological resources and lead more effective adaptive measures as well as sustain the information campaign. The infrastructures recently built and are currently building can resist the adversity of the incoming climatic shift but it should be evenly provided to the general populations especially to remote villages where technological trends and mass media are usually limited. Adaptation challenges may appear in information dissemination as well as on physical, meteorological, economic, political and biodiversity aspects of the island.

Barriers are always part of information and adaptive measures because they challenge the integrity of the process. Limitations of adaptation among stockholders and the general population influenced by the challenges can be strongly overcome however if the challenges are properly evaluated as in the case of the APFSMR- that is if thorough and comprehensive information is provided on the players. Various means in planning an environmental initiative/ program are all connected; hence absence or insufficiency of one may lead to imbalance of the system's action. Further, the information and adaptation development of the island may become a contribution to the development of Kuroshio Region, where rich natural resources may shrink due to natural and anthropogenic influences with the effects of the changing climate. As noted, adaptation is collaborated by many players, thus the Kuroshio Region may sustain its abundant resources if every one of its corners overcome the challenge brought by the climate change.

The island people are already struggling with the effects of soil erosion, floods, landslides and biodiversity loss that results in the pressure of the accessibility of potable water, dwellings, food, infrastructures, etc. As these problems already penetrated the island's community, adaptations with the sense of urgency has to be engaged. As typhoons and other calamities evolve, the government's adaptation must have to be counteractive.

Information may not only be focused on the knowledge

and perception during calm times; it may be extended on the information ("what to do" readiness) and training of the people when climatic disturbance is already occurring which could pose danger and instability.

Enhancement of the local and national government units partnerships as well as foreign institutions and private organizations may be extended for more funds and programs. This may mark development of other programs and projects that are currently limited (internet and other multi-media, energy, housing, bridges, marine reserve, etc.) with the general populations. Furthermore, more studies on information and adaptation across the coastal communities of the Kuroshio Region may be conducted to empower consensus and stability of the Region's people and natural resources.

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