Adaptive Strategies in Coping with Climate Variability: Experience of Philippine Traditional Indigenous Fishers

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Variation in climate is a natural phenomenon extending over almost all time scales, from seasonal to yearly changes and spatial ranging from regional to global. Climate variability is not often observed as compared to weather that varies on a daily basis. Common drivers of climate variability include *El Niño* and *La Niña* events, volcanic eruptions and sunspots. However, this year-to-year variation known as climate variability can escalate into long-term continuous transformation commonly referred to as climate change. In many literatures, climate change is, in many ways from a simple *"any change in the long-term climatology, regardless of its cause"*, to a more specific *"rapid change in climate that can be linked directly or indirectly to anthropogenic activities"*. Climate change is a natural phenomenon, most often extending decades or geological timescales (Roessig *et al.*, 2004, Baede *et al.*, 2001). However, anthropogenic activities that led to increased greenhouse gas concentration in the atmosphere (IPCC, 1996; Gribbin, 1998 in Roessig *et al.*, 2004; Sarmiento and Gruber, 2002; Baede *et al.*, 2001) drive the change in climate to occur more rapidly. Compared to year-to-year climate variability, climate change is slow and gradual, and therefore is difficult to remark on without scientific evidence.

Impacts of Climate Variability and Climate Change on Philippine Fisheries

Efforts to study the impacts of climate variability are emerging fast not only in the Philippines but in other countries as well, and in different fields of sciences including fisheries, specifically the direct and indirect impacts to fisheries. On one hand, biological and ecological impacts could be direct such as alteration of growth, physiology, behavior development, reproductive capacity, mortality, and distribution of aquatic species that further lead to changes in productivity, community structure, and ecosystem composition. On the other hand, socio-economic impacts could be the indirect effects of climate variability on fisheries. One of the natural resources leaned on by Filipinos for livelihood and source of their dietary protein is the fisheries resources, and fisheries play a vital role to Philippine economy by providing employment and income to rural areas and coastal communities. With many coastal communities that abound the country, mainly dependent on fisheries for livelihood and sustenance, any changes that negatively affect fisheries would be detrimental to the socio-economic conditions of the communities.

Philippine Fisheries

Many Southeast Asian countries including the Philippines are dependent on fisheries resources to improve their socio-economic conditions. The Philippines is rich in aquatic resources ranging from commercially-important to threatened and endangered species (Barut, 2003), and the scientific reports of Carpenter and Springer (2005) indicated that the country is the center of marine biodiversity in the world. The people of the Philippines, known as Filipinos, are dependent on marine fisheries resources for their livelihoods and source of dietary protein. The Philippines, as the 6th top fish producing country in the world, 9th in aquaculture, and 3rd in marine plants (BFAR, 2010), embraces rich fishing grounds teeming with fisheries resources that supply food to the whole country. Fish and fishery products provide about 70% of the protein requirements of about 1.6 million Filipinos. Being an archipelagic country with over 2.2 million km^2 of highly productive seas, fishing has been a major source of livelihood for almost 70% of communities located in coastal areas. The fisheries sector is therefore vital to the Philippine economy providing employment and income especially to rural areas and coastal communities. It was known in 2009, that the country's fisheries sector employed a total of 1,614,368 fishing operators nationwide of which the municipal fisheries sector accounted for the majority (85.0%) while the commercial and aquaculture sectors only accounted for 1.0% and 14.0% of the operators, respectively. The fisheries sector also contributed to approximately 2.2% (170.3 billion USD) to the country's GDP and export earnings of about 452 million USD (BFAR, 2009).

Climate Variability and Traditional Knowledge

Traditional knowledge, also referred to as indigenous or traditional ecological knowledge, local knowledge, farmers' knowledge, folk knowledge, and indigenous science (Nakashima *et al.*, 2012; Berkes *et al.*, 1995), is the accumulated knowledge retained by indigenous people throughout generations that is passed to each generation thereafter. Traditional ecological knowledge actually guides the current generation in countless ways, on how

to interact with the environment and pass on the practices that affect their daily lives.

Indigenous knowledge covers a wide range of ideas including livelihood, community structure, rituals and traditions, and most importantly, survival strategies. The use of traditional knowledge in science has been recognized as significant (Trosper and Parrotta, 2012) although study on traditional knowledge is considerably new to climate science. However, it has already proven its significance to other fields of sciences such as in social sciences, traditional medicine, agriculture and forestry, and resource management as well as studies in impact assessment and biodiversity conservation (Gadgil *et al*., 1993, Alexander *et al*., 2011).

Recent studies on the impacts of climate variability seem to indicate that indigenous people are among the most vulnerable, in view of their community structure, education, population size, lack of recognized and social rights, and lack of access on information that contribute to their sensitivity. Their high dependence on natural resources for livelihood and sustenance added to their high sensitivity to any changes that affect the natural resources. Being highly vulnerable, indigenous people are therefore not mere victims to the impacts of climate variability since their high sensitivity to climate vulnerability makes them persist in the same environment amidst increasing climate variability due to the skills and adaptive strategies that they have developed. Traditional ecological knowledge has been proven to be essential to the economic and cultural survival of indigenous people. In climate science, traditional ecological knowledge has also been shown to be potentially useful in understanding the impacts of climate variability on the environment across spatial and temporal scales for organisms, habitat, and ecosystem (Nabhan, 2010) and can also provide significant short- and medium-term climate and weather patterns forecasting (Parrotta and Agnoletti, 2012). Nevertheless, the skills and adaptive strategies developed by indigenous people could be of importance to climate science, especially in developing adaptation strategies to climate change. This suggests the potential of traditional ecological knowledge in climate change assessment and adaptation (Salick and Ross, 2009).

Climate Variability and Traditional Fishing Practices: Case Study

In order to assess local awareness, cultural belief and community support system that could lead to indigenous climate risk adaptation measures for long-term effect of climate change based on historical events, cultural beliefs, and traditional adaptation measures, a case study

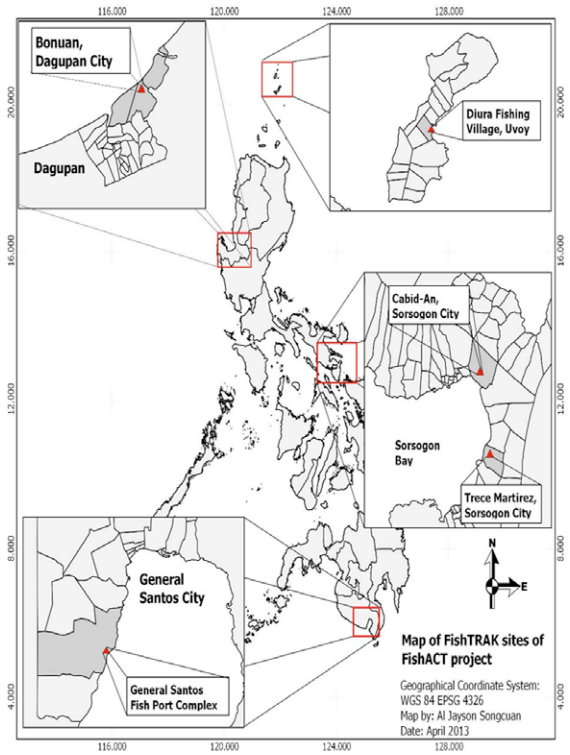

Fig. 1. Map of the Philippines showing the study sites for the case study on the Relevance of Fisheries Traditional Knowledge (FishTRAK) and Indigenous Fisheries Practices in Developing Climate Change Adaptation Strategies

was conducted in major fisheries areas of the Philippines, namely: General Santos, Sorsogon, Dagupan, and Batanes (**Fig. 1**) to assess the effect of climate change on priority fisheries commodities as well as to document traditional knowledge on fisheries practices and climate change adaptation strategies. The four study sites were selected based on different criteria, such as degree of exposure to climate change impacts (General Santos, Batanes and Sorsogon), primary commodity (all four sites), type of fisheries (General Santos, Dagupan, and Sorsogon), and cultural background (Batanes). Data were collected through on-site and house-to-house interviews using prepared questionnaires, so-designed to promote a free flowing and story-telling-like conversation. Respondents were fishers preferably older than 50 years old, with sufficient experience in fisheries and are able to provide historical accounts and traditional knowledge. However, due to some constraints such as time and day of the interview, and unavailability of some respondents, fishers with at least 20 years of experience in fishing and those who are knowledgeable of traditional fisheries practices and adaptation practices were also considered for the interview.

General Santos: Tuna Fisheries in the Heat

Located in southern Mindanao, General Santos City was chosen as one of the study sites due to its low exposure to tropical storms. Based on the 50-year storm trajectory

Fig. 2. Philippines and the 50-year storm trajectory record of National Oceanic and Atmospheric Administration (NOAA)

record of NOAA (**Fig. 2**), General Santos or Mindanao in general, has not experienced any tropical storm for more than five (5) decades. In 2012, however, Mindanao was hit by two (2) strong typhoons (Pablo and Sendong, international code-names Bopha and Washi, respectively). Additionally, General Santos City is considered as the Tuna Capital of the Philippines. Comprising about 30.0% of the country's total annual catch from commercial fisheries, tuna is one of the primary and high-valued commodities in the Philippines (BFAR, 2010). In fact, tuna fishing has evolved and changed totally in time. During early times, about five (5) decades ago, Philippine fishers used to catch tuna using a stone fixed with hook and bait attached to a nylon string.

Fishers of yesteryears were able to catch big and small tunas only a few kilometers away from shore, using traditional practices. However, in the past two (2) decades or so, fishers have to go to farther distances for a good catch of tuna. The emergence of modern fishing methods and gears coupled with the equivalent increase in their fishing pressure resulted in major decline in catch, starting in 1990 according to anecdotal information.

Although not being aware of the issues on climate change or the effects of global warming, local fishers have been experiencing the impacts of climate change. Many fishers have felt the progressing increases in temperature during the past decades, while a keen observation by most of the interviewed fishers correlates high temperature to difficulty in catching tuna. According to long line fishers, warm days are the most difficult times to catch tuna in depths where before they usually got good tuna catch. Nowadays, they needed to use lines which are several meters longer than before. Tuna seem to go deeper to feed during warm days compared with the cooler days. Increase in temperature brought about by climate change causes more frequent stratification between warmer surface water and cooler deeper water which in turn causes a decline in primary productivity (World Bank, 2000). Consequently, increase in the surface water temperature coupled with decrease in primary productivity in the equatorial or tropical region results in migration of tuna population towards higher latitude. This behavior can cause a special distribution shift of tuna population towards higher latitudes slowly depleting the stocks in the tropics.

In view of the pressure on tuna fishing brought about by fishing activity and the impacts of climate change, majority of the fishers relying solely in tuna fisheries slowly began diversifying their livelihoods. Since depending mainly in the slowly declining tuna industry seems unsustainable, some tuna fishers are now engaged in the culture of grouper and milkfish in marine cages, and seaweeds (**Fig. 3**). However, majority of the local fishers, especially those who are not aware of the climate change phenomenon and its impacts on the decreasing fisheries catch, still rely on the country's tuna industry, not only by engaging in fishing but also by working in canning factories and ice plants.

Fig. 3. Seaweeds culture and processing as alternative livelihoods for some fishers in General Santos City

Sorsogon: Growing Seaweed Industry amidst Storm Entry Point

Facing the Pacific Ocean, Bicol is one of the regions of the Philippines most frequented by storms (**Fig. 2**). In fact, the Bicol Region is often the entry point of majority of the tropical storms passing the country. Sorsogon, one of the provinces in the Bicol Region, is in the southeastern part of Luzon. It is bounded by the Pacific Ocean on the east and San Bernardino Strait on the south. The province was selected as one of the study sites due to its high exposure to harsh climatic events being located in storms' entry point.

In addition, Sorsogon is one of the important producers of seaweeds in the country, especially from 13 of its 14

municipalities located in coastal areas including Sorsogon City. The seaweeds industry in Sorsogon started in the late 70s to early 80s when fisherfolks collected wild seaweeds from near reef areas - mostly for commercial purposes. The seaweeds collected belong to genus *Galidiela*, *Eucheuma*, *Gracilaria*, *Sargassum*, and *Kappaphycus*. Traditional harvest methods include uprooting and scraping off seaweeds from their substrates. After collection, instead of immediately selling the harvests, these are sun-dried for 2-3 days depending on the weather condition for better market value. However, such practice of collecting seaweeds was considered destructive especially to adjacent habitats and very unsustainable in the context of conservation. Nonetheless, in order to support the growing seaweed industry in Bicol Region, the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) started its Seaweed Production and Development Project in Sorsogon in 1992 with funding support from the United Nations Development Program (UNDP) of the Food and Agriculture Organization of the United Nations (FAO). The project resulted in the establishment of the Philippine National Seaweed Research and Development Center (NSRDC) in 1998 which was subsequently renamed the National Seaweeds Technology and Development Center (NSTDC) after the Philippine Fisheries Code of 1998 was enacted into RA 8550. Through the NSTDC, research studies and training courses that focus on the improvement of seaweed farming were conducted, resulting in the promotion of highly sustainable seaweed culture methods in the Philippines. Nowadays, majority of former seaweed gatherers adopt such culture methods as the long-line floating system, mono-lines and bamboo stakes methods, and other environmentally-safe culture methods. Henceforth, local seaweed farmers reported that their seaweeds production has significantly increased with the improvement of culture methods and local government support.

Although improvements in seaweed farming continue to advance in Sorsogon, productivity of its seaweed industry did not increase much. Seaweed growers through supporting literatures observed that seaweeds are very sensitive to different variables such as water quality, rainfall, temperature, salinity, and weather events. Slight changes in any of these conditions greatly affect the growth and productivity of seaweeds. One of the major problems they experienced is the occurrence of "ice-ice" episodes. As described by seaweed growers, "ice-ice" is a disease condition caused by the occurrence of white "substances" that attach to the seaweeds, which if not immediately removed, could infect nearby seaweed stocks. This disease, in particular, causes whitening as well as fragmentation of seaweed branches which could result in highly decreasing annual production. When asked about what causes the "ice-ice" outbreak, 90% of the respondents remarkably observed that disease episodes most commonly occur after excessive rainfall or during hot weather. Excess rainfall leads to decreased salinity as well as drop in temperature, whereas hot weather increases both salinity and temperature. Both conditions are considered unfavorable for seaweeds to grow and observed to promote the outbreak of "ice-ice" disease.

In addition to seaweeds disease, another major factor that affects the seaweed industry in Sorsogon is linked to its geographical location which is inevitable. This is the occurrence of extreme weather events due to extended and frequent rainfall. In such situation, drying which increases the market value of the harvest by three-folds, takes longer and worse, seaweed growers are sometimes forced to sell their harvests without drying. Complete loss of harvests and materials for culture due to extreme weather events were also recounted by seaweed growers. In an effort to address the concern and in order to minimize losses due to extreme weather events, seaweed growers have properly timed the planting of seaweeds in such as a way that rainy season or months with usual extreme weather events are avoided. In addition, growers have built drying huts in case unexpected rains occur while drying their harvests. Recently however, they have observed that the patterns of extreme weather events are changing and becoming more frequent and more intense. In fact, about 3-4 years ago, majority of them completely lost their harvests due

Actual collection of indigenous knowledge from local people on climate change adaptation and traditional fisheries practices

to an unexpectedly strong typhoon that hit the Province. With years of experience and high exposure to extreme weather events, many seaweed growers have diversified their livelihood as well as made adjustments to adapt to the current and worsening climatic condition. Most of them are now going into aquasilviculture in mangrove areas while some are engaged in service jobs such as carpentry.

Although Sorsogon is highly exposed to the impacts of climate change, the adaptive capacity of the inhabitants is relatively higher than in other areas of the country. This is attributed to the strong community support and awareness program on the impacts of climate change. Educating the people of the Province on the current issue of climate change, its nature, causes, and potential impacts is carried out through radio plugs and television programs. In addition, seminars, workshops, and trainings on how to deal with the impacts of climate change through adaptation and risk reduction, and diversification of livelihoods are arranged by local government and non-government groups.

Dagupan: Bangus Capital under Climate Change Crisis

Located at the southern border of Lingayen Gulf, Dagupan in Pangasinan Province is provided with a unique and favorable site for aquaculture. Regarded as the center of *bangus* (milkfish) production, and known to produce the tastiest milkfish in the Philippines, Dagupan became one of the priority sites for the study. Second to seaweeds as the top aquaculture commodity of the Philippines, *bangus* has been cultured by the people in Dagupan for a very long time. Its *bangus* has been labeled as the tastiest milkfish in the country. However, the trademark slowly diminished alongside with the shift in aquaculture practices. The traditional *bangus* aquaculture method had changed completely since the day that the people of Dagupan first put it to practice.

Traditional *bangus* aquaculture practice includes the use of fertilizer and guano as well as the utilization of natural food source known as *lablab* or the greenish black moss (**Fig. 4**) found in pond soil. In the past, aquafarmers from Dagupan followed a *lablab* growth cycle, so that after one harvest, the pond is not immediately restocked. Instead, the pond water is reduced to a minimum, then, the water and soil is treated with the chemical *Bristan* to kill oysters, snails and other pests that primarily competes with *lablab* as food source (**Fig. 5**). After applying *Bristan*, the pond is dried to avoid contamination of the drainage and irrigation systems. Afterwards, new pond water is let in, fertilizer is then added and *bangus* fry is stocked.

Fig. 4. Growth of *lablab* (greenish black moss) in pond soil provides natural food for milkfish

Fig. 5. Oysters, snails, barnacles are pests and major competitors to natural *lablab* as source of food for milkfish

The use of guano as fertilizer promotes the growth of *lablab*, which, according to milkfish growers, enhances the growth and quality of *bangus* being cultured. Such practice was however last used in 1990s, after most *bangus* farmers shifted to using artificial feeds, a more expensive practice. Such shift in aquaculture practice was due to the ban of *Bristan* by the government when cases of harmful effects of *Bristan* on the skin of farmers exposed to contaminated water from irrigation canals were reported.

The use of artificial feeds resulted in lower income of *bangus* farmers due to high cost of production. Although the use of artificial feeds has been reported to enhance the growth of *bangus* cultured, it poses a threat when coupled with the impacts of climate change. A common concern of milkfish growers using artificial feeds is the high probability of fish kill occurrence due to several factors. Fish kills occur more frequently when artificial feeds are used because of deoxygenation brought about by decomposing feeds from excessive feeding which is worsened by environmental factors such as high temperature and increased precipitation. Excess feeds settle at the bottom of the ponds and when it accumulates, high temperature hastens its decomposition that takes up the dissolved oxygen in the pond water. Also, sudden precipitation especially after feeding causes the deposited feeds to be re-suspended potentially causing gill clogging on the cultured fish. In addition, heavy precipitation causes overflowing of culture ponds leading to loss of fish stocks.

In order to keep up with the changing climate, *bangus* farmers time their restocking to cool and dry months, which are considered the most optimum condition for culturing milkfish according to local *bangus* growers. Increasing the

stocking size also allows them to cope up with the high cost of feeds and also lessens the probability of overfeeding although it could increase the risk of overstocking. Some ponds are also designed with high walls, netted walls or surrounded by *nipa* plants to serve as screens to avoid the escape of stocks during flooding. Some *bangus* growers also allow algae or *lumot* to grow in their ponds to consume any excess organic materials from feeds and eventually to serve as food for the fish stocked.

Batanes: Home to Indigenous Dorado Fishing Practice

Situated on the northernmost part of the Philippines, Batanes has a rich culture and unique traditional fisheries practices. It is home to *Ivatan* tribe and is known for its dried dorado fish, a main source of livelihood for most fishers in the Province. Being located along the typhoon belt, Batanes is very highly exposed to extreme weather events. However, despite being isolated and highly exposed, the *Ivatan*s are known to be adaptive to such changes which made them interesting subjects for the study in view of their traditional adaptation strategies.

Known to be farmers, fishers, and boat makers, *Ivatan*s practice traditional fisheries which are very unique and diverse. Even though some practices or traditional fishing gears are generally no longer used in any other parts of the country at present because of modernization, most of these gears are still utilized by local fishers of Batanes. One of the major fisheries commodities of Batanes is the dorado fish (*Coryphaena hippurus*), commonly known as dolphin fish and locally called *muhi-muhi* (*mahi-mahi* in Hawaii). The fishing season for dorado is from March to May, and fishing for this fish is not simple. The local practice strictly follows a series of preparations and rituals. Annually around February, the *Ivatan*s perform the *vanuvanua* ritual where a pig, cow or carabao is slaughtered and the blood is collected for offering to their gods and praying for good harvests. If slaughtering any of the three animals would not give them good harvest, chicken or other animal blood may be used as offering. Since other parts of the *vanuvanua* ritual are said to be sacred, this is strictly performed by *Ivatan* tribes only. The *Ivatans* believed and experienced that not performing the ritual prior to *dorado* fishing would bring bad harvest.

Since dorado fish does not eat dead bait, fishers have to catch flying fish prior to *dorado* fishing season with the use of *yuyos*, a small piece of wood with hooks attached by nylons to floaters (**Fig. 6a** and **Fig. 6b**) and *tuyungan* (a traditional hook and line (**Fig. 6c**)), with the flying fish kept alive to be used as bait.

Fig. 6. Traditional fishing gears used by *Ivatans* of Diura fishing village: (a) *yuyos*; (b) *yuyos* with floaters; (c) *tuyungan*; and (d) the traditional fishing boat *mataw*

Other beliefs include careful handling of fish harvest as dropping the fish is considered a bad omen which could bring them poor catch and harvest. Another belief is avoiding the use of carts, cars, bikes or carabaos while transporting the fish, so that the fish is usually carried manually to local drying areas. Storage bins for the dorado fish should be left open during the day for the rest of the season to ensure a good catch. Dorado fishing makes use of a traditional fishing boat locally called *mataw* (**Fig. 6d**), where *mataw* fishing has been derived.

After fishing for dorado, the catch is brought to *patarukon*, a local dryer where the catch will be dried for days (**Fig. 7a**). This is meant to increase its market value as well as to

Fig. 7. Traditional drying area for dorado catch known as *patarukon* (a) and (b) cogon house where dried dorado is stored

prolong its shelf life. After drying, the dried fish is brought to cogon houses for storage (**Fig. 7b**).

When there is enough stock of dried fish in the cogon houses, the fishing leader of a village, such as in Diura Village of Mahatao District, convenes local meetings among representatives of each family. During the meeting, the dried stocks are divided and distributed equally to each family in the village (**Fig. 8**). Any excess stock is sold to interested families or traded for other goods such as rice and fruits. The price of dried dorado (regular size) could be as high as Philippine Pesos 1,000.00 each (Philippine Pesos 500 for each half), where Philippine Pesos 40 = USD1.00), thus, providing good income for each family. During off fishing season, local fishers catch groupers or *lapu-lapu*, and rabbit fish or *samaral* using *nanawuy* (**Fig. 9**), a unique traditional fishing gear where gillnet is attached to two long bamboo poles and usually flung in shallow waters or in waters where schools of fishes are espied. Sometimes,

Fig.8. Local residents of a village in Batanes dividing and distributing dried dorado fish to every family in the village

Fig. 9. *Nanawuy*, a unique traditional fishing gear used in shallow-near shore waters to catch *samaral*

fishers also use *hasu*, a traditional hook and line where a hook is attached to a local plant *hasu* using a nylon twine.

Being located along the typhoon belt, Batanes Province is prone to experience extreme weather and severe storms. As an adaptation, in-land houses and those located in coastal areas are designed and made of stones (known as *bahay na bato* or stone houses) while houses near coastal areas are elevated two feet above the ground. The unique design of the stone houses protects the inhabitants from extreme storm events.

During prolonged storms, which usually happen in this Province and scarcity of resources (food), local inhabitants utilize the whole banana plant which are relatively abundant to the area and can tolerate heavy precipitation, for food. The whole banana plant from its fruit, stem as well as roots, is eaten.

Acknowledging the fact that the local people cannot rely solely on fishing due to frequent rains and severe storms, most of them are also engaged in agriculture-related alternative livelihoods. So that even though Batanes is highly exposed to the impacts of climate change, the inhabitants are relatively less vulnerable due to their high adaptive capacity.

Summary and Way Forward

Climate variability is a natural phenomenon. However, increase in variability both in intensity and frequency, driven by different factors put coastal and indigenous communities to a wide range of risks. Indigenous communities are among the most sensitive groups to the impacts of climate variability. Nevertheless, their high adaptive capacity and indigenous knowledge in adapting to climate variability have led to their survival, offering great potential for developing climate change adaptation strategies. Being highly exposed to climate variability despite their sensitivity, affected people on the one hand are offered opportunities to develop more diverse and efficient adaptation strategies. On the other hand, low adaptive capacity due to low exposure to climate variability can also lead to further risks brought about by changing climatic patterns. The study therefore deduces that the effects of climate variability vary in different areas depending on the nature and level of resource dependence of the communities. The results of the study further imply the promotion of varying and more localized management or adaptive strategy that would enable affected communities to cope with climate variability.

Bahay na bato - a traditional stone house of local residents of Batanes Province

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