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Adaptive capacity of the Municipality of Sindangan to the changing climate

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Abstract: In understanding the potential impacts of climate change in coastal-fishery dependent communities, analysis of combined conditions (economic, environmental, and social) that may contribute to vulnerability is needed. In this study, characterizing locations and segments of society that are most vulnerable was conducted in a municipality of Sindangan, Misamis Occidental, Philippines. Eight (8) indicators were used to provide an interval-level scale of adaptive capacity that include human agency, capacity to change, occupational mobility, material assets, occupational multiplicity, social capacity, gear diversity and infrastructure. Among the studied areas of the municiaplity of Sindangan, the Central area is the least adaptive followed by the South and ranking with highest adaptive capacity is the North. The indicators that needs to be improved and had the lowest Adaptive Capacity Score includes, Occupational mobility, Occupational multiplicity, Capacity to change, Gear diversity and Social capital. Additional livelihood programs intended for fishers and its household should be develop in order to adapt to the impacts brought by climate change. Included also is the commitment and a strong political willof government in protecting the resources of the bay and strictly enforce the laws and regulations of the municipality regarding resource utilization.

Key words: Adaptive capacity; Climate change; Occupational multiplicity

1. Introduction

Climate change is an unstoppable phenomenon. This worldwide problem is expected to extremely impact tropical coastal communities (Nicholls et al., 2007). In the projection study published by Cheung et al., (2010), climate change may lead to a large-scale redistribution of global catch potential with an average of 30-70% increase in high latitude region but a drop of 40% will be experienced in the tropics. Though it is benefial to the Northern part, the complete opposite will be faced by the tropical countries especially those who were least developed nations and are dependent to coastal-fishery as livelihood (Allison et al., 2009 and Cheung et. al., 2010). This will bring cascading impact on the income of the constituents who are socioeconomically vulnerable to change (Cheung et al., 2010). Thus, it is critically important to know how coastal-fishery communities are being affected by and what capacity they have to adapt to climate change impacts (Cinner et al., 2012).

In the context of coastal-fishery dependent communities, understanding the potential impacts of climate change requires analyzing the combination of conditions (economic, environmental, and social) that contribute to vulnerability, and characterizing locations and segments of society that are most vulnerable (Cinner et al., 2012). Quantifying people's vulnerability requires the three components that it is made of: 1) exposure; 2) sensitivity; and 3) adaptive capacity. Exposure is the extent to which a region, resource or community experiences changes in climate (IPCC, 2007). It represents the important climate events that affect the coastal ecosystem, but it also includes other changes in linked sytems that might be induced by climate effects (Marshall et al., 2010). On the other hand, sensitivity is the degree to which a system is affected by, or responsive to, climate changes. In ecological systems, sensitivity is normally described in terms of physiological tolerances to change or variability in physical and chemical conditions (Marshall et al., 2010). Lastly, adapative capacity as third dimension of vulnerability is a latent characteristic that reflects peoples' ability to anticipate and respond to changes and to minimize, cope with, and recover from the consequences of change (Adger and Vincent, 2005; Gallopin, 2006). Although eposure and sensitivity determine the potential impact of a climate-induced change, adaptive capacity can have a major influence on the eventual impact on individuals and society (Cinner et al., 2015). People with low adaptive capacity such as those who feel they have no alternative livelihoods, maybe unable to adapt to changes in the flow of ecosystem goods and services brought about by climate change, or unwilling to take advantage of the opportunities created by change (Cinner et al., 2012). And to communities with high adaptive capacity, they may be better able to convert human, social, financial, natural or

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physical resources that exist ino successful adapation outcomes (Cinner et al., 2015).

In this study, we focused on the third dimension of vulnerability which is adaptive capacity. The researchers examine whether and how local-scale adaptive capacity vary among the three different areas of the municipality of Sindangan (north, central, and south area) and in the household scale. It is known that Sindangan bay is one of the richest fishing ground in the Philippines.

2. Material and method

The study area: The study was conducted last July to September 2015 at the 22 coastal barangays of the Municipality of Sindangan, located at Western Mindanao, which geographically lies between 8°14.041'N 122°59.922'E (Fig. 1).

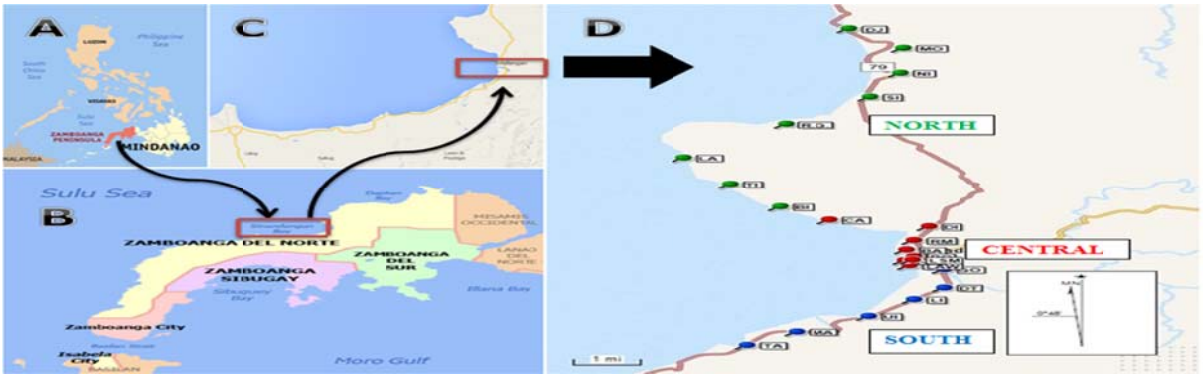

Fig. 1: Shows the geographical location of the barangays in the study area marked with green, red and blue pins; (A) Map of the Philippines; (B) Map of Zamboanga Peninsula; (C) Map of the Sindangan bay; (D) Map of the Municipality of Sindangan

This site is subdivided in three distinct areas: the North comprising eight (8) barangays (from Northest) Doña Josefa, Motibot, Nipaan, Siari, Ricardo G. Macias, La Concepcion, Tigbao and Binuangan; the Central (the capital) with another eight (8) barangays namely, Calatunan, Disud, Ramon Magsaysay, Bantayan, Poblacion Santa Cruz, La Roche San Miguel, Gampis and Lawis; and the South comprising six (6) barangays including, Goleo, Datu Tangkilan, Lower Inuman, Upper Inuman, Maras and Talinga.

Sampling design: Prior to the conduct of the study, entry protocol was initiated firstly with the municipal Mayor down to the respective barangay Captains for recognition purposes and to solicit initial data and the whereabouts of fishers households. Lists of fishers were then collected from each barangay to estimate the total sample size. Alongside, key informant and community leader interview were also conducted. Sampling of fishers within barangays was based on a systematic sampling design. A total of 178 fishers were surveyed and 31, 49 and 98 surveys were conducted in the South, Central and North area respectively.

Quantifying adaptive capacity: This research were patterned to the study conducted by McClanahan et al., (2008). The same eight (8) indicators were used to provide an interval-level scale of adaptive capacity (Table 1).

Table 1: Indicators used to calculate adaptive capacity index.

Indicators	
Human agency (Tompkins 2005)	Whether interviewee suggested factors that affect fish populations and/or interventions to improve fish populations
Capacity to change (Brooks & Adger 2005)	Stated response of fishers to a hypothetical 50% decline in catches
Occupational mobility (Allison & Ellis 2001)	Changes of employment within last 5 years, whether forced or voluntary, and whether new occupation preferred
Material assets (Pollnac & Crawford 2000)	Presence of principal component of material assets: vehicle, electricity, television, fan, piped water, refrigerator,radio, cd player, mobile phone, generator, car battery, satellite dish and the type of walls, roof and floors
Occupational multiplicity (Allison &Ellis 2001	Total number of person-occupations per household (square- root transformed)
Social capital (Pretty & Ward 2001)	Whether the interviewee is a member of community organizations
Gear diversity (IPCC 2007)	Number of different gears or fishing method used by fishing households (square-root transformed)
Infrastructure (Pollnac 1998)	Presence of 30 principal component of infrastructure items in the community. Infrastructure are as follows: hospital, medical clinic, doctor, dentist, primary school, secondary school, piped water,sewer, electricity service, phone service, food market, pharmacy, hotel, restaurant, petrol station, public transportation, paved road, banking facilities, radio, internet facilities, emergency services, telephone landline,daily newspaper, police station, mechanic, fish freezer, Ice plant, fishers' shed, boat jetty

Using Analytical Hierarchy Process (AHP, Saaty 1980) methodology, ten researchers made pairwise comparison of the importance of the eight indicators and the similarity indices between the different researcher's weightings ranged from 73% to 92% (McClanahan et. al., 2008).

The average of the weightings was then used to calculate the adaptive capacity for each fishers' household (Equation 1). Each indicator was normalized to provide a scale of adaptive capacity that will range from 0 to 1.

Adaptive capacity= Human agency x 0.10
+ Capacity to change x 0.11 +Occupational mobiliy x 0.11+ Occupational multiplicity x 0.19+ Social capital x 0.10
+ Material assets x 0.15+ Technology x 0.13
+ Infrastructure x 0.12

3. Results and discussion

The collected data from each barangay were summed to each respective area. The Adaptice Capacity Score of each area was then based on the mean of the household scores of its comprised barangays. Among the three areas in the municipality of Sindangan, the North had the highest adaptive capacity ranging from 0.45 followed by the South area with 0.41 and finishing last the Central with 0.40 as illustrated in Fig. 2. Overall, the Adaptive Capacity Score of the municipality of Sindangan is 0.47.

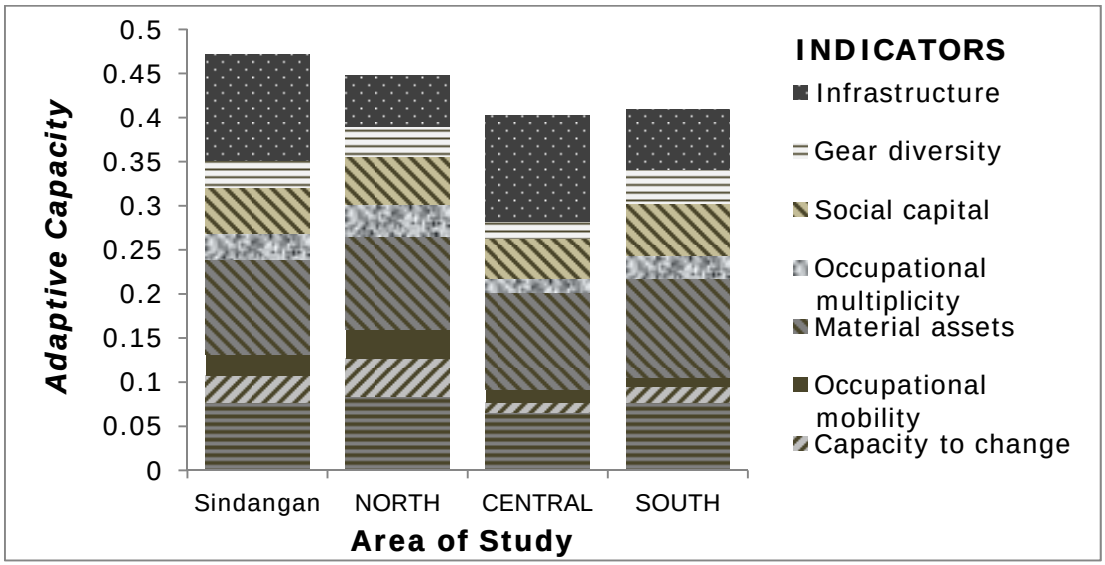

Fig. 2: Weighted contributionof eight indicators of Adaptive capacity for the three subdivided areas of the Municipality of Sindangan ranked according to their overall Adaptive Capacity Score

Being the least adaptive, the Central area had the lowest Adaptive Capacity Score for the five (5) indicators; Human agency, Capacity to change, Occupational multiplicity, Social capital and Gear diversity. Based on the answers provided by the respondents in this area, though most fishers pointed several factors that contributes to the diminishing fish population which includes, the increased volume of fishers and different types of gears used in fishing, the illegal fishing that is rampant in the area which includes, dynamite fishing, used of poison in fishing, etc. and the continues encroachment of big fishing boats in the municipal waters, other fishers just simply do not know the reason for the decline of fish catch. This is also might be the reason why most of these respondents (90%) would still continue fishing given a hypothetical 50% decline of fish catch. But some respondents revealed that fishing is the only occupation they know and the only source of income in the family. This confirms the situation of the fishers in the Central because about 77% (38 respondents) never finished high school, 14 respondents were high school levels only and few graduated elementary (8) and unfortunately others did not even finished primary schooling (16). Some fishers continue fishing because they believed that there are good and bad times in fishing and most of them hoped that a jackpot catch is imminent during a fishing trip, thus stopping has never been an option. And also, respondents in the Central area were less diverse in terms in the usage of gears or the type of fishing method used. An average of two types of gears were used by the respondents during peak and lean season thus a lesser option to venture to other type of fishing method which may lead to a lesser income to the family. But this is not the case, on monthly average income on fishing, respondents in the Central area is higher with P4,656 compared to the North with P3,992 and lastly the South with P3,660 monthly average. This tells us that even though fishers in the North and South were more diverse in terms of gears or types of fishing method used, the Central fishers had the higehst income

generating and effective in providing for their families. The following gears were prominently used in the area: hook and line, surface set gillnet and bottom set gillnet. al.,though respondents in the Central area are socially involved, they are the least among the studied area. On average, most of the respondents in the area were members only of two groups or organization paricularly fisherfolks and credit or savings groups.

On the other hand, South area rank the second highest Adaptive Capacity Score. Among the eight indicators, three contributed to the high score of the South which includes, Material assets, Social capital and Gear diversity indicators, which is also highest compared to the North and Central area. This tells us that most of the fishers in this area are well-off enough or had the most material assets compared to the adjacent area of the municipality. Although the South had the highest score in Social capital, on average respondents in this area were socially engage also with only two groups or organization. Most of this respondents were members of the Pantawid Pamilyang Pilipino Program or known as 4Ps and fisherfolks organization. 4Ps is a human development measure of the national government that provides conditional cash grants to the poorest of the poor, to improve the health, nutrition, and the education of children aged 0-18 years old (Official Gazette of the Philippines). Additionally, in terms of the number of gears or type of fishing method used, fishers in the South were more diverse. An average of three gears were used by the respondents and most of them used, hook and line, surface set gillnet and drift gillnet.

Among the studied areas, the Northern part of the municipality had the highest Adaptive Capacity Score. Although this part had the least score in Material Assets and Infrastructure other indicators significantly contribute to the ranking of North in the top includes Human agency, Capacity to change, Occupational mobility and Occupational multiplicity indicators. These indicators were also the highest among the three areas. This concludes that Northern fishers were more adaptive compared to Central and Southern fishers. Fishers in this area were also more knowledgeable and observant to the factors that affect the fish populations, thus can respond more to the changes occuring in the community. Additionally, aside from being responsive to the changes, fishers were more mobile in terms of occupation. The North also had bigger agricultural land which is an advantage for fishers residing in this area. Accordingly, respondents had the option to temporarily leave fishery during planting season to cultivate root crops, rice, corn, etc. for sustenance of the family. Furthermore, among the three areas, the North is the only home of the four Marine Protected Areas in Sindangan namely, Doña Josefa Marine Sanctuary, Don Ricardo Macias Marine Sanctuary, La Concepcion Marine Sanctuary and Binuangan Marine Sanctuary which is favorable for fishers.

Combining the scores of the three areas and average it to produce an Adaptive Capacity Score of the Municipality of Sindangan will give us a score of 0.47. The resulting matrix of the eight indicators is shown in Fig. 3.

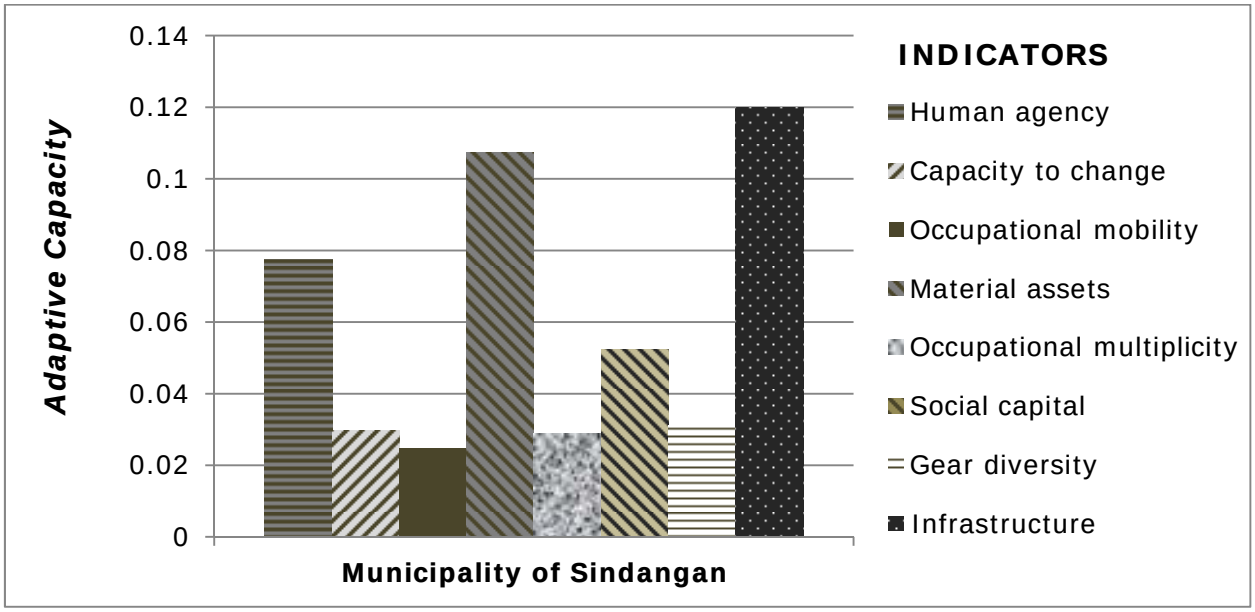

Fig. 3: Overall Adaptive Capacity Score of eight indicators in the Municipality of Sindangan

Based on the results indicated above, five indicators fall short even to reach half of its designated weightings. Ranking from the lowest score is Occupational mobility with a score of 0.024, Occupational multiplicity with 0.029, Capacity to change 0.030, Gear diversity with 0.031 and Social capital with 0.052. Only Infrastructure indicator got a perfect score followed by Material assets indicator with 0.11 and lastly, Human agency indicator acquiring a score with more than half of its weighting with 0.08. This score provides an understanding how adaptive the municipality of

Sindangan. Looking on the result, authorities and policy makers in this area should consider developing livelihood schemes intended for the fishers and its household. Although, fishers in the municipality have multiple occupations that brings income and food in the household which average to four occupations with majority involved in fishing (100%), farming (39%), informal economics (37.6%) and gleaning (27%), this is not enough. On average, the monthly income of the fishers on fishing is only P4,069 and feeding an average household size of 5.7 which is still considered a small family would be still a burden if adding all other expense such as education for children, clothing, and health to the equation. Additionally, in the household level, the average total number of person with occupation in a household is only four (4), thus this implies that only one person is working for the family when compared to the average number of occupations the respondent have. Thus, government should also provide income-generating project for the women in the community to support the fishers' family needs and helped their husbands in feeding the family.

Considering the percentages of respondent having other occupations, more than half of them were reliant to fishing as livelihood, and with the changing climate and diminishing fish catch as reported by 92% of the fishers, this puts them in critical situation. Based on the result of the survey, majority of the respondent (72%) would still continue fishing given a hypothetical 50% decline of fish catch for the whole year, because this is the only occupation they know and because of lesser educational attainment. And on the average, only two (2) gears or fishing method were used by the respondent for peak and lean seasons thus a lesser options for fishers to venture to other gears. Although there were supports already given by the Department of agriculture like materials in fishing like nylon, it is only selective and not all fishing communities were given. Additionally, others reported that there were fishing gears given like bu-bo (used to catch squids and other fish species), but were useless because it has bigger mesh or openings. Most of the fishers in Sindangan also reported that other fishers especially big fishing boats like pakpakan and kubkuban used fine mesh nets to catch fish and even used strong and bigger lights to attract fish. Accordingly, most of these operators were not from the municipality and will flock in Sindangan bay during peak seasons (November to March) and even catch in the municipal waters which supposed to be for small-scale artisanal fishers. Some fishers reported that because of this big fishing boats, they move farther to catch fish, thus displaces small-scale fishers and removes teritorial or resource rights. And sadly, dynamite fishing is still rampant in the area. These types of fishing methods could severely affect fish population in the bay although the authorities have been implementing fishing ban periods for three days to allow breeding of fish during new moon. Though the community had lesser gears used, providing additional fishing gears should be carefully decided.

Most of the respondents in the municipality were members of only two groups on average. Many were members of fisherfolks organization (46%), 4Ps (42%) and credit or savings group (39%). This Fig. implies that respondents were socially engaged to organizations related to their peers and groups that provides assistance in times of need. Although it seems good enough to be members of a particular organization, the score of the Social capital indicator tells it is still low. More than half of the fishers were not even members of the fisherfolks organization. Strenthening this community-based organization thru education that causes the decline of fish catch and keeping them involved in the management of the resources in the area particularly in protecting the MPAs would solicit participation and collective action in the group. In this way, it will not only enlighten fishers to the science of fishing, it might also prevent and even lessen the causes of fish decline especially those that were man-made and also strengthen fishers' participation and relationship.

On the positive side, the municipality of Sindangan had the infrastructures to support the needs of the fishers residing in this area. The respondents also had high score in terms in Material assets, thus compliments the income that the bay could give and the capacity of the fishers to purchase such assets. And also, most of the fishers were aware to the changes of fish catch and the anthropogenic causes that affects fish population.

4. Conclusions

Among the studied areas of the municiaplity of Sindangan, the Central area is the least adaptive followed by the South and ranking with highest adaptive capacity is the North. The indicators that needs to be improved and had the lowest Adaptive Capacity Score includes, Occupational mobility, Occupational multiplicity, Capacity to change, Gear diversity and Social capital. Additional livelihood programs intended for fishers and its household should be develop in order to adapt to the impacts brought by climate change. The municipality also needs to address to the demand of Gear diversity but should also take into consideration the risk of providing additional gears to the fishers and the impact it will bring to the resources in Sindangan bay. And also, strenthening Social capital among fishers should be improved and the government should take it seriously. And most importantly, commitment and a strong political will is needed, from the higehst rank of authority down to the lowest servant of the government, in protecting the resource and strictly upholding the laws and regulations of the municipality.

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